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Perceptions of Mathematics Success of Undergraduate Women Pursuing STEM Degrees Whose First Language is Not English

Tonya DeGeorge

ACCEPTANCE

This dissertation, PERCEPTIONS OF MATHEMATICS SUCCESS OF UNDERGRADUATE WOMEN PURSUING STEM DEGREES WHOSE FIRST LANGUAGE IS NOT ENGLISH, by TONYA ALICIA DEGEORGE, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty.

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PERCEPTIONS OF MATHEMATICS SUCCESS OF UNDERGRADUATE WOMEN PURSUING STEM DEGREES WHOSE FIRST LANGUAGE IS NOT ENGLISH

by

TONYA ALICIA DEGEORGE

Under the Direction of David W. Stinson, Ph.D.

ABSTRACT

Mathematics success is argued to be linked to science, technology, engineering, and mathematics (STEM) professions that often "provide increased lifetime earning power, suggesting that mathematics is the gatekeeper to higher paying professions" (C.L. Brown et al., 2010, p. 393). Yet, the disconnect between mathematics concepts and students' everyday lives has been shown to contribute to students' negative attitudes toward the learning of mathematics (Ali & Reid, 2012) and can greatly affect whether students pursue STEM degrees and related majors (Li & Schoenfeld, 2019; Maass et al., 2019; Shaughnessy, 2013).

Despite the increase of the number of English language learners (ELLs)—students whose first language is not English and are learning English and mathematics content at the same time––in U.S. classrooms, statistical analyses too often focus on the underperformance of ELLs in comparison to their White counterparts (C.L. Brown et al., 2010). This so-named "achievement gap" between ELL and non-ELL students has often brought the focus of ELLs needing language

support and having deficiencies in mathematics (de Araujo et al., 2016). This deficit perspective has permeated the educational research surrounding ELLs (Gutiérrez & Dixon-Román, 2010) and when students from minoritized groups do succeed academically they are too often considered as non-representative of their group or labeled as "the exception" (de Araujo et al., 2016, p. 34).

Rather than focusing on the so-named achievement gap between ELLs and non-ELLs, in this study, I explored the mathematics successes of undergraduate ELL women from their perspective of their experiences inside and outside of the mathematics classroom and how these experiences have shaped their on-going relationships with mathematics (Civil, 2007). Through an "eclectic theoretical framework" (Stinson, 2004) of postmodernism (Lyotard, 1984; Derrida, 2007; Foucault, 1978), feminism (Lather, 1991; Harding, 2004), and intersectionality (Collins & Bilge, 2016), I conducted a cross-case analysis (Stake, 1995) of how undergraduate women, whose first language is not English, pursuing a STEM degree at a public 4-year college engage with mathematics and how that engagement has contributed to their perception of mathematics success. Specifically, I examined how these women have come to their own definition of mathematics success and how their lived experiences have attributed to their success and motivation in pursuing a STEM degree.

An analysis of the findings suggests that the larger discourses that have too often influenced women's decisions to pursue a STEM degree, such as the "chilly" classroom environment (Parsons, 2016), are still present and were felt in the lives of the four women in this study. These women, who have continued to persist in STEM, shared their stories that highlight issues which are worth investigating and can inform future directions for higher education more broadly. Taking these experiences into account can help educators and policy makers alike

challenge and address the larger discourses of who can succeed in STEM and offer ways to support women in institutionalized spaces. In particular, this work should guide the way in which success is defined in mathematics and STEM so as to expand its definition and draw from the strengths of those who continue to persist.

INDEX WORDS: ELL students, mathematics success, minoritized women, undergraduate education

PERCEPTIONS OF MATHEMATICS SUCCESS OF UNDERGRADUATE WOMEN PURSUING STEM DEGREES WHOSE FIRST LANGUAGE IS NOT ENGLISH

by

TONYA ALICIA DEGEORGE

A Dissertation

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in

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in

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in

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DEDICATION

I dedicate this dissertation to all those who find themselves in those “in between spaces.” As this country continues to grow, my hope is that we all have a place where we feel at home.

I also dedicate this dissertation to my beautiful children, Owen and Avery, who have always brought joy and light to my life and have given me the purpose and dedication to keep moving forward.

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CHAPTER 1

BACKGROUND AND RESEARCH QUESTIONS

I begin this chapter with a brief description of the study, providing a picture of the types of experiences students have when pursuing a Science, Technology, Engineering, and Mathematics (STEM) degree and how it is necessary to explore the successes of those who continue to persist in the field (e.g., the participants of this study). I then present the background of the study, describing my experiences growing up as a non-native English speaker attending a U.S. public school with limited resources for those who do not speak English. Next, I provide the rationale for conducting this study by briefly reviewing literature surrounding the success (or "lack thereof") of minoritized groups.[1] I conclude the chapter with the problem statement and research questions for the study, concluding with brief remarks on why this work is both personal and necessary in the field.

The Study and Its Participants

This study focuses on the perceptions of four academically successful[2] women, whose first language is not English,[3] pursuing a STEM degree and how their perceptions and schooling

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[1] Although the term "minority" has been used throughout all areas of research, Sotto-Santiago (2019) argued that the term is not an identity marker—in other words, those who are members of these groups do not self-identify as being a minority, but rather are labeled as one. And just like other labels, it can perpetuate inequities in academia and society. Changing the term "minority" to "minoritized" recognizes that "systemic inequalities, oppression, and marginalization place individuals into 'minority' status rather than their own characteristics" (Sotto-Santiago, 2019, p. 73).

[2] Success in mathematics is often associated with high scores on standardized tests, receiving above average grades, taking advanced mathematics courses, or a combination of any of these indicators (Martin, 2000). For the purposes of this study, however, a successful student is defined as one who has earned a minimum grade of a C in previous mathematics courses and are continuing to pursue a STEM degree.

[3] In describing these women, I hesitate to use the common acronyms that are often associated with students who come to this country and learn English. The common acronyms, EL (English Learner), ELL (English Language Learner), ESL (English as a Second Language), ESOL (English to Speakers of Other Languages), EFL (English as a Foreign Language), LEP (Limited English Proficient), LES (Limited English Speaking/Speaker), NNES (Non-Native English Speaker), SLL (Second Language Learner), among many others have been used in the literature to describe this population of learners in a variety of ways. Given that I want to include all students who are learning

experiences have contributed to their understanding of success, in general, and mathematics success, in particular.[4] The four participants of this study are women in their second or third year pursuing a STEM degree at a suburban, open enrollment, 4-year college located outside a major city in the southeastern United States (additional details about the college are provided in Chapter 4). At this college, students who are pursuing a STEM degree often take the pure mathematics sequence, starting with Introduction to Mathematical Modeling, College Algebra, Precalculus, or Calculus (depending on placement). To understand how students from multiple backgrounds perceive success, participants were selected from all available STEM path courses (not just those students in advanced mathematics courses).[5]

Participants were chosen on the criteria that their first language (L1)[6] is different from English. Although the participants may speak English on a regular basis, the purpose of the study is to also investigate the possibility of language contributing (or not) to their success. In addition, participants may speak "English well"[7] but it does not indicate that their language skills in social

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English (whether it is their second language or it becomes their dominant language), I use the phrase "whose first language is not English" and the acronym, ELL, interchangeably.

[4] In attempting to understand students' perceptions of success, I acknowledge that success and mathematics success may not hold the same meaning for the participants in this study. Parson (2018), in particular, found that her participants were often challenged by STEM and institutional expectations, which often conflicted with one another and affected how her participants experienced their mathematics/physics courses. A good GPA, for instance, is necessary to maintain scholarships, but earning a B in a mathematics class (often seen as a good grade in STEM) was not enough for students to keep their scholarships if a 3.5 was the minimum GPA. Inconsistencies between the two communities (institutional and STEM) may also highlight how students view success in different contexts.

[5] My assumption at the start of this study was that because these students chose to pursue a STEM degree, they must have experienced some sort of success in mathematics.

[6] Throughout this study, acronyms such as L1 (first language; native language; former language) and L2 (second or additional language[s]) will be used to indicate the language participants use or refer to in their interviews.

[7] I use quotes to indicate that language is a powerful social force (Cargile et al., 2010) and can be used to determine if the person speaking belongs to a specific group. For instance, stating a person speaks "English well" has been shown to indicate that they are perceived as "less foreign," which in turn affects the types of behaviors the speaker will encounter. As Cargile and colleagues argued, "hearers can react to linguistic and paralinguistic variation in messages as though they indicate both personal and social characteristics of the speaker" (p. 61).

situations are like their academic language proficiency. According to Cummins (2008), there is a distinction between "basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP)" (p. 71). Most students can develop their BIC skills within the first 3 to 5 years of learning a new language, but developing cognitive academic language takes longer. While I am interested in working with students whose L1 is not English, I must be able to communicate with and understand my participants. Therefore, participants in this study were selected based on our mutual ability to effectively communicate in conversational English (given that I do not speak another language).

My Story

Like many researchers, I find myself wanting to study an area of mathematics education that is close to my heart. Mathematics, for me, was a saving grace; it has helped change how others perceive me and how I perceive myself. Yet, my journey in acceptance did not happen simply because I was placed in high-level mathematics courses. I struggled with learning English and content at the same time, and often questioned whether I could be successful—in school and life.

My life began in South Korea, where my parents fell in love—so the story is told. During that time, my White American father met my Korean mother when he was stationed as a U.S. soldier in the army. They got married, had two daughters, and continued to live in South Korea for a few years until my father was reassigned back to the United States as part of his fulfillment to the army. Taking his wife and children with him, he continued his work in the military. In the early years of my life, we moved to multiple locations within the United States so that he could serve our country. This time, however, was difficult for all of us. Not only did we struggle with readjusting to a new life with every move, but my father and mother were also dealing with their own demons.[8] Although they were happy in the early years of marriage, love was not enough to keep them together.

When I was about five-years old, my parents went through a difficult divorce. As a result of this breakup, my parents went their separate ways. My father got custody of my sister and me and took us to live with my grandmother (my father's mother) in a small rural town in upstate New York where the population was primarily White. As a biracial child whose first language was Korean, I found myself in a school where I often felt included and isolated at the same time. The transition for me was difficult. Not only did I look different, but I also could not speak English. I spoke primarily Korean when I started second grade and had tremendous difficulty learning English, especially because the school system was not prepared to teach students whose first language is not English. Given that there were few resources for me, the school put me on an Individualized Education Plan (IEP) for speech services from second to eighth grade. I was pulled out of the classroom multiple times a week and worked one-on-one with the speech pathologist. Although this one-on-one time helped me acclimate to the culture of the school and learn English I needed to succeed, it also eradicated all my Korean language skills and made me want to reject a significant part of my identity. Rather than acknowledging and celebrating my differences (those Korean aspects of myself[9]), I chose to try and assimilate into the cultural group I thought was accepting in the society in which I lived. These attempts were reflected in my choices of dying my hair blonde or speaking in a specific way.

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[8] For the privacy of others in my family, I do not provide details of these personal struggles.

[9] When I was a child, the parts of myself that stood out the most included my language (and any accents that came with it) and my outward appearance. While some physical features I was not able to change (e.g., the "slant" of my eyes), I made every attempt to fit in other ways.

Research has shown that stories such as mine are not unique (Valenzuela, 1999). In a 3-year ethnographic study on immigrant Mexican students and Mexican American students and their school achievement, Valenzuela (1999) discovered that students felt the school and curriculum dismissed their language and culture and ultimately wanted to "Americanize" them. According to Valenzuela, "urban school reproduces Mexican youth as a monolingual, English-speaking, ethnic minority, neither identified with Mexico nor equipped to function competently in America's mainstream" (p. 3). This subtractive process left many students vulnerable and set them up for failure (Valenzuela, 1999). Not only were students forced to assimilate into the dominant culture, but they were also encouraged to forget and dismiss their native culture. They ultimately had to "'swim' and 'survive' in this subtractive environment" (Nguyen & Hamid, 2017, p. 142). Similarly, due to the lack of resources and knowledge, I, too, was forced to learn a language and culture that was not a part of my initial upbringing.

Looking back, I realize I never fully accepted the Korean part of myself. I considered being different and knowing a different language a burden; it prevented me from being "successful"[10] in school and made people perceive me in negative ways. Being different created obstacles I did not deserve. Choi (2014) stated, "children who are placed in American classrooms without any L1 support are especially subject to devaluing their home language" (p. 93). By desiring to fit in, I actively chose not to speak Korean. This choice was not too difficult given that I had no one at home who could teach me or sustain the Korean culture in my life. Living with my paternal side of the family allowed me to temporarily ignore and reject my Korean part of myself.

[10] Those who knew me as a child may argue that I was successful. I earned high grades and was able to move from one grade to the next. Still, at that time, I viewed my language ability (or lack thereof) as a huge burden and something that could potentially keep me from being successful in the future.

Although I made the decision not to speak Korean and rejected learning another language for a long time, I now find myself surrounded by people who can speak multiple languages. Half of my family speaks both English and Korean, my husband speaks English and Spanish, and now my children (who are in a Dual Language Immersion program) speak English and Spanish. Still, I struggle with choosing to speak a language other than English comfortably. I am aware of how important it is to our society here in the United States for people to speak English well. While I value knowing and speaking another language, I also know and have experienced the harsh reality of not being able to speak English and how people can treat you differently because of it.

These experiences were usually with adults; those who have already decided how they would treat those who are different. I was fortunate in that students did not pick on me. In fact, students had two types of reactions toward me: either they would try to include me in activities and events in school or they would treat me as if I was invisible. Some did not care about what I looked like or how I spoke; they were supportive and would offer help when I needed it. Others, however, never spoke to me. Nevertheless, at that time, that is what I preferred. It did not bother me when I was not included because it prevented me from having to expose myself as being different or expose the struggles my family was going through.

Teachers, on the other hand, were not always supportive of me in school. Although there were many teachers who cared, they lacked the knowledge of how to support me in my learning. Because I had trouble speaking English, I felt as though I "could not express myself on the same intellectual level as native English-speaking students because of the language barriers" (Zhernokleyev, 2013, p. 51). My lack of confidence in being able to speak English well resulted in my lack of participation in class. This lack, in turn, made many teachers believe I was not capable of doing the work and I soon became known as the "shy, quiet girl." I was often put into the low-level tracks; taking courses that were either boring or were not valued by others in the school. I did not consider myself "smart" and always thought it was something with which one was born with.

It was not until I met my eighth-grade mathematics teacher that I began to think that I had the capabilities to do the same level of work (or more) as other students. She questioned my placement and marched over to the guidance counselor's office inquiring why I was not placed in an honors mathematics course. At the time, I was embarrassed by her determination to seek out the answers. Although I did not know what the outcome would be, I felt, in my heart, that it would not matter what she said because it was already decided. I was placed in that class because I struggled. How could she possibly change the path of my academic career when I continued to struggle with English? Yet, as I know now, that was the turning point for me. Not only was she successful in moving me into another mathematics course—a change that was a catalyst for all the changes and events that occurred later in my life—she also gave me access and the opportunity to shine and pursue the dreams that I did not even know I had.

Her confidence in me motivated me to work harder and somehow, I convinced my grandmother, father, and teacher that I did not need an IEP any longer.[11] I felt I could succeed on my own. I had a teacher who truly believed I could succeed, and I did not want to disappoint her. Once I was moved into the honors track, other teachers began to challenge me in ways I never experienced before. I was able to advance to honors courses in both mathematics and science (even taking some advanced placement [AP] courses my senior year). The move was the transitional point of how I perceived myself and what I was capable of. It also began to change

[11] At that time in my life, having an IEP was embarrassing. My perception of the role of the IEP in my educational journey was not a positive one; it not only highlighted that I was not a native English speaker, but also that I was not capable of doing the work as my peers.

others' perceptions of me. That feeling of success helped change the narrative of me being "deficient" —not only to myself but also to how others in the community perceived my capabilities.

Whenever I retell my story, people have often commented about how it was one teacher who changed the course of my life. Even in a field such as education, there exists power structures that make it difficult for people to climb the academic ladder (Kelly, 2008). There are multiple factors, such as teacher beliefs, students' social class, and parental involvement that affect whether students can gain access to certain knowledges in school (Kelly, 2008; deMarrais & LeCompte, 1995). So, while this single teacher did have a significant role in changing my path, there were many others afterwards who also contributed to helping me make the conscious choice to *stay on*[12] that path. Simply being put into an advanced mathematics course didn't convince all those who crossed my path to believe I could succeed. At every juncture of my life (college, new jobs, graduate school, etc.), I found that I had to "prove"[13] my worth and work extra hard to get to where I am today (with the help, of course, of my champions[14] who continue to encourage me to pursue my dreams). The choices that I made, and continue to make, are not always easy and often have me questioning my self-worth and what I can accomplish. My experiences have helped me realize how it is so easy to fall prey to the power structures and

[12] Simply choosing to pursue a college degree (and eventually mathematics) is just the beginning of my journey. As I continued this path, I found myself having to overcome many obstacles—things that would make it easy for me to choose not to pursue my dreams. Choosing to stay on the path is just as much work (and courageous).

[13] For example, to some people, being part Korean meant I would "automatically" be good at mathematics (i.e., "Asians are good at math")—negating and ignoring all the hard work I have put in over the years.

[14] As J. B. Fournillier (personal communication, February 2021) said, "my success isn't my own." I recognize that my success is the culmination of my own efforts as well as the efforts made by the people surrounding me. I am forever grateful for all my champions and the support they have given me over the years.

perceptions of the "dominant culture"[15] and that I must actively be aware of my participation in it. Once I became aware of my participation, it became easier to acknowledge how I can contest it and not further participate in creating a bigger divide in the inequities I may see.

Rationale

Mathematics, as a discipline of human inquiry, is seen as a field producing scholars in the field of mathematics, supporting scientists or engineers who need mathematics in their careers, or training students to think logically and how to problem solve (Ernest, 2009a). Mathematics success is argued to be linked to STEM professions that often "provide increased lifetime earning power, suggesting that mathematics is the gatekeeper to higher paying professions" (Brown et al., 2010, p. 393). According to Li and Schoenfeld (2019), "mathematics is still perceived of largely as products—a body of knowledge as highlighted in the three schools (logicist, intuitionist, formalist) of thought, rather than ideas that call for active thinking and creation" (p. 3). This way of thinking has traditionally made mathematics something attainable to only a select few yet at the same time is foundational to STEM education and those pursuing STEM careers (Li & Schoenfeld, 2019). Mathematics, therefore, is viewed as the discipline that supports all the other disciplines; seen as the tools and language necessary for students to use to engage in scientific inquiry (Fitzallen, 2015; Li & Schoenfeld, 2019).

Despite the increase in numbers of students entering college wanting to pursue a STEM degree, some obstacles keep students from pursuing STEM degrees. These obstacles include under preparation in mathematics, uninspiring introductory STEM courses, or the culturally uninviting environments within the college institution and STEM fields (Diekman et al., 2010; Griffith, 2010; National Science Board, 2014; Riegle-Crumb & King, 2010; Redmond-Sonago et

[15] As a minoritized woman, I often feel the presence of this dominant culture (whose members mainly consist of White, heterosexual men) both in the workplace (i.e., STEM education) and in society.

al., 2016). Although enrollment in undergraduate STEM majors has improved recently due to a big push in K–12 education, the number of students majoring in STEM declines from freshman to senior year, indicating that there continues to be retention issues in those majors, especially for women and minoritized students (Whalen & Shelly, 2010; Parson, 2016). When controlling for variables such as financial aid, Whalen and Shelly (2010) found

> students who are underrepresented in STEM fields (female or minority students) are significantly less likely to be retained or graduate within six years than to not graduate or be retained, compared to students who are the traditional STEM majors (male and non-minority students). (p. 53)

Despite this reversal of the gender gap between men and women in higher education enrollment, the decline in STEM enrollments has raised concerns about the "leaky pipeline" and have researchers questioning why women continue to leave the STEM field (Parson, 2016).

To understand and identify these reasons and the differences that persistently continue in the achievement between men and women in STEM, researchers have explored many different theories. One area of exploration looked at the biological differences between genders (e.g., Ceci et al., 2014). The results of many of these studies, however, indicated that the differences in spatial and mathematics reasoning did not arise from biological differences, but rather that environmental, social, and cultural differences contributed to whether women entered STEM majors and affected their performance in comparison to men as well (Ceci et al., 2014; Parson, 2018).

The STEM climate (i.e., the teaching and learning environments), for instance, is more beneficial to men and infrastructural barriers of higher education institutions influence whether women persist and advance in STEM careers (Parson, 2016). For women in STEM careers, the "chilly climate, a classroom environment that is male-normed, highly impersonal, and individualistic" (p. 19) is unwelcoming and is often used to "weed out" those who do not fit the dominant culture—often pushing women out who initially enroll and are interested in pursuing a STEM career. These types of norms are permeated within all aspects of the institution, even in the language that is used. The language used in STEM higher education, according to Parson, "reinforces and reproduces stereotypical gendered roles, while establishing lower expectations for men and installing higher, often unachievable ones, for women" (p. 32). So, while women are often the majority, the standards which they are held to were created by a male ideal (Parson, 2016, 2018). STEM education, as a gendered institution, has systematically marginalized women and has negatively affected faculty, staff, and students (Parson, 2016).

To assist women students to be successful in STEM given this "chilly" climate, is to change the institutional characteristics, norms, programs, and pedagogies. For instance, an increased presence of women in faculty and administrative positions have been found to be a powerful influence on women students (Charleston et al., 2014). Other interventions, such as mentoring, providing undergraduate research experiences, learning communities, and inclusive teaching have also been found to help women cope and feel included in the field (Campbell & Skoog, 2004).

Another way to encourage women and other minoritized populations to pursue STEM is to build on students' self-efficacy because "a lack of self-efficacy in mathematical abilities can deter particular groups of students from pursuing the field" (Borum & Walker, 2012, p. 366). Performance in mathematics and science, in particular, is significantly related to performance in STEM courses at the college level. Students who have done well in high school mathematics courses are more likely to be successful in college-level STEM courses (Redmond-Sonago et al., 2016). Therefore, students who have not done well in mathematics courses, such as minoritized groups and women, often internalize the self-perception of incompetence in mathematics (Borum & Walker, 2012).

Additionally, the disconnect between mathematics concepts and students' everyday lives has been shown to contribute to students' negative attitudes toward the learning of mathematics (Ali & Reid, 2012) and can greatly affect whether students pursue STEM degrees and related majors (Li & Schoenfeld, 2019; Maass et al., 2019; Shaughnessy, 2013). Attitudes toward mathematics tend to deteriorate as the mathematics content becomes more abstract and unrelated to students' lives (Ali & Reid, 2012), compelling students to discontinue their mathematics studies because they perceive mathematics to be "hard," "boring," and "useless" (Osborne et al., 2003). Moreover, many students who do not enjoy mathematics may even avoid taking mathematics altogether (Brown et al., 2008; McLeod, 1994), which often limits their opportunities to learn a wide variety of subjects (Li & Schoenfeld, 2019; Maass et al., 2019).

Consequently, many educators repeatedly try to instill a sense of desire and motivation in their students' learning of mathematics, despite its complex nature. Undoing students' negative attitudes toward mathematics, however, can be extremely difficult. Fortunately, educators can create opportunities for students that may increase interest and motivate students to pursue STEM careers. Modeling and integrating STEM activities, for instance, can have a positive effect on students' competence and motivation to continue to learn and apply mathematics to complex situations (Maass et al., 2019). Redmond-Sanogo and colleagues (2016) stated, "the most likely students to pursue STEM degrees in college and STEM careers as a profession are those who are both proficient in mathematics and interested in STEM" (p. 379). This relationship indicates that students who continue to pursue STEM careers already have the interest and motivation for learning mathematics.

Quality of experience therefore in the mathematics classroom significantly affect students' desire and motivation to continue to learn mathematics. Civil (2014) found that the in-school and out-of-school experiences ELLs have can affect mathematics achievement for different groups of students. She argued that mathematics educators "need to take a more holistic approach toward mathematics education of students, and in particular of marginalized students" (Civil, 2014, p. 9). Specifically focusing on students' mathematics experiences *in the classroom* therefore may not be enough. Doing and learning mathematics occurs outside classroom walls as well (Gutiérrez & Dixon-Román, 2010). Due to the increasing numbers of ELLs in the United States, it is crucial to learn about the experiences these students have in and out of the U.S. classroom and how these experiences shape their relationships with mathematics.

Other factors, such as race, culture, and stereotypes also influence students' experiences in learning mathematics. Zavala (2014), for instance, concluded that although many of the students in her study adopted the "colorblind" stance toward how race plays a role in mathematics learning, other factors, such as immigrant status, the number of years spent in the United States, and other personal factors influenced how students perceived their own mathematics experiences and what constitutes mathematics achievement. Although many students claimed that race did not matter in their achievement in mathematics (claiming mathematics achievement was determined by motivation), they did not challenge other stereotypes, such as Asian students being smart in mathematics[16] (describing Asian success as a function of their cultural practice). In considering mathematics specifically, Zavala found that

[16] In Chapter 2, I discuss how Asian Americans being categorized as the "model minority" can have detrimental effects on students and their learning (Wing, 2007; Tran & Birman, 2010).

some students often used their multiple identities (including linguistic and mathematics identities) to exhibit agency. For example, one student, Julieta, did not speak English well and would often state how she felt disadvantaged compared to her English-speaking peers (i.e., doing mathematics in Spanish put her at a disadvantage). She believed students who spoke English were positioned to do well because they could communicate and engage with their teacher and the mathematics content better than she could. But when the teacher asked the language instructional aid to work with her exclusively in English, Julieta chose not to work with the aid, but rather with another student in the classroom who could work on the mathematics with her in Spanish. So, while Julieta understood her "disadvantage" at not being able to speak English, she still chose to speak Spanish in her mathematics class so she could access the mathematics content as well as become an active member of the class (her peer would often translate her thoughts to the group for her). This case highlights that Julieta participated in her class on her terms; choosing to use her linguistic identity as a resource. By maintaining *both* her linguistic and mathematics identities, she could participate in mathematics discussions and therefore viewed herself as a mathematics learner in "positive ways" (Zavala, 2014). Thus, exploring the perspectives of students' mathematics success may help illuminate how students perceive their mathematics learning and ways in which teachers can help develop students' mathematics agencies.

The social and political structures that contribute to students' mathematics experiences and achievement are influenced by the "prevailing equity discourse in the United States" (Gutiérrez & Dixon-Román, 2010, p. 21). One serious issue within prevailing equity discourses is the increasing number of ELLs—students whose first language is not English and who are learning English and mathematics content at the same time—in U.S. classrooms (Brown et al., 2010). Statistical analyses often “indicate that achievement in mathematics is an issue of equity as ELLs are not performing at the same level as those whose first language is English and therefore are ill prepared to enter STEM careers” (Brown et al., 2010, p. 393). While much of the literature has focused on this “gap” and finding ways to help support ELLs, Gutiérrez (2008) argued that “achievement gap studies offer little more than a static picture of inequities in schools” (p. 358). Due to one-time responses from teachers and students, many of these studies cannot capture the histories or the contexts of learning that produced the achievment outcomes of students.

The danger of focusing on a gap that is often determined by standardized test scores is that the attention is always on the achievement of White children, those of the dominant culture, as though they represent the gold standard of who is capable of doing well in mathematics (Martin, 2007). From this perspective, students who are different from the norm by any attribute (gender, race, test scores, etc.) are seen “as either ‘deficient’ (and thus not worthy) or ‘naturally different’ (and thus unable to change)” (Espín, 1993, p. 411). This perspective of deficiency is justified by the comparison of Whites to students of color and influences how intelligence is thought about overall (Gutiérrez & Dixon-Román, 2010). In that,

> this comparison then becomes normalized, as if it is a ‘natural’ way of thinking about achievement, rather than focusing on the excellence of students of color or the many other ways subordinated students may make sense of their experiences with mathematics. (p. 24)

The power and privilege of the White dominant culture constitute what is (or should be) normal (Espín, 1993). Thus, by establishing this as the norm, “public education has successfully shifted the blame for the failure of schools to meet the needs of minorities onto the shoulders of the clients they purport to serve" (Pine & Hilliard, 1990, p. 2). Reasons as to why the achievement gap exists can then be blamed on characteristics such as cultural or linguistic differences. The fact that schools "primarily serve the monolingual, white, middle-class, and Anglo citizens is never questioned" (Pine & Hilliard, 1990, p. 2).

Furthermore, this so-named "achievement gap" between ELL and non-ELL students has often been associated with whether ELLs are getting the "support" they need rather than being challenged in the classroom (de Araujo et al., 2016; Gutiérrez & Dixon-Román, 2010). Needing language support is often associated with having a deficiency in mathematics (de Araujo et al., 2016). Rather than focusing on students' mathematics success, this deficit perspective has permeated the educational research surrounding ELLs, especially when comparing them to their White counterparts or other marginalized groups (Gutiérrez & Dixon-Román, 2010). When students from marginalized (or minoritized) groups do succeed academically they are too often considered as non-representative of their group or labeled as "the exception" (de Araujo et al., 2016, p. 34). Focusing on the gap therefore supports deficit thinking and contributes to creating negative narratives about marginalized students (Gutiérrez & Dixon-Román, 2010).

Rather than focusing on "closing the gap," the discourse surrounding the gap should be on who benefits (or not) by comparing groups. Gutiérrez and Dixon-Román (2010) asked:

> through the discourse of the achievement gap, what do individuals learn about themselves and others (e.g., what people are capable of)? What do people learn about competition and/or inequalities? How does that relate to the formation of self and other? (p. 30)

The focus of mathematics education should shift to redefining what it means to do mathematics and how mathematics plays a role in structuring our realities (of who can and cannot do mathematics) (Gutiérrez & Dixon-Román, 2010). The unique race, ethnic, linguistic, and class makeup[17] of the United States provides an opportunity to learn how individuals produce and engage with mathematics and to disrupt the belief in a universal mathematics.

Problem Statement and Research Questions

Rather than focusing on the so-named achievement gap between ELLs and non-ELLs, this study explored the mathematics successes of undergraduate women ELLs from their perspective of their experiences inside and outside the mathematics classroom and how these experiences shape their relationships with mathematics (Civil, 2007). Exploring the perspectives of undergraduate women ELLs' mathematics success may illuminate how minoritized ELL students perceive their mathematics learning and ways in which educators can help develop students' mathematics agencies. For example: Does mathematics success look different in different contexts and why? How does mathematics success shape one's thoughts and feelings about mathematics (or careers that depend heavily on mathematics)? Therefore, using qualitative case study methodology (Stake, 1995), within an eclectic theoretical framework (Stinson, 2004) of postmodernism feminism (Lather, 1991; Harding, 2004) and intersectionality (Collins & Bilge, 2016), I explored how four undergraduate women, whose first language is not English and are pursuing a STEM degree at a public 4-year college, have come to their definition of mathematics success and the factors that have attributed to this success and motivation. The research questions that guided this study are:

1. What are undergraduate women whose first language is not English perceptions of mathematics success?
    a. What qualities distinguish mathematics success from other forms of success?

[17] Note that there are probably more categories to include in here. I have highlighted the major classifications.

2. What STEM institutional cultural norms have played a role in how they define mathematics success in STEM?
3. What role, if any, does language play in determining how they perceive their success in mathematics?
    a. How do they navigate their gender, race, and language in college, and how does the intersection of language influence their perceptions of mathematics success?
4. How has this perception of mathematics success affected their decision to pursue a STEM degree?
    a. What factors do these women attribute to their success in college?

In the subsequent chapters, I clarify and elaborate the problem statement and research questions to further argue the need for this study. In Chapter 2, I provide a historical account of how ELLs have been perceived by teachers and other students in the field of education and how those perceptions have affected the types of learning experiences and opportunities ELLs have had. Unproductive deficit beliefs about students whose first language is not English (e.g., how they cannot meet learning goals, or their families do not care about education) and can influence students' educational experiences. This deficit thinking reflects the wider societal views that often compare these students to other groups and how they need to be "fixed" to compete with their peers. To shift from this deficit thinking, I explored the perceptions and experiences of ELLs who have been successful. As a community of educators, it is necessary to not only fill this void in the literature but also to gather more "diverse experiences and perspectives" in STEM to "build a robust STEM workforce for national and regional economic development and job creation holds the attention of policymakers and the American people alike" (Espinosa, 2011, p. 211). Learning about how students perceive and obtain success can strengthen our understanding of the needs of our students and how we can challenge and support them to pursue a STEM degree.

In Chapter 3, I offer discussion and details of postmodern feminism and intersectionality, which provide the eclectic theoretical framework for this study. Success in education is often defined by assessments created by those who do not consider that their assessments may not align with how students think about their own success. In addition, many factors contribute to how students can be successful in school. Using postmodern feminism and intersectionality lens opened new avenues for understanding how students defined mathematics success, the factors that have attributed to their success, and their motivation in pursuing a STEM degree.

In Chapter 4, I outline the principles, procedures, and assumptions of case study inquiry and explain why case study methodology was the best fit for this study. In addition, given my experiences as a former ELL and the success I have had in my mathematics courses, I discuss my subjectivity and how I managed it throughout the study.

In Chapters 5 through 8, I provide a description of the participants of this study: Cassandra, Sasha, Skylar, and Wing-Yu.[18] Each chapter[19] provides a narrative of each woman to offer the reader a sense of who these women are and how they have come to their understanding of mathematics success. I not only provide their stories, but also include their ways of thinking about themselves and their own success as they continue to navigate the world of STEM.

In Chapter 9, I provide a cross-case analysis of the women's experiences and their perceptions of success to show that despite their differences, there have also been some

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[18] These names are pseudonyms the women in this study chose to represent themselves.

[19] Due to the complexities of how each woman described herself, I felt it was necessary to provide each of them their own chapter. The order of the chapters is simply alphabetical and in no way indicate the importance of one woman's story over another.

commonalities in the ways in which they experience mathematics and how those experiences have influenced their perceptions of success. This chapter highlights some of the ways in which these women think about themselves and provides some of the answers to the research questions that guided this study.

In Chapter 10, I give a summary of this study and invite the reader in a discussion about how these women's perceptions of success are similar to and different from what has already been shown in the research. In addition, I highlight how despite how these women could be classified as members of the same group (namely, ELLs), their experiences and perceptions of mathematics success vary greatly. Using my theoretical lens of postmodern feminism and intersectionality, I challenge the reader to think more critically about how women continue to be treated in the world of STEM within higher education and how language, as one form of identification, can impact the way students are treated in education.

Concluding Thoughts

In this chapter, I offered a brief sketch of my life and the reasons that I believe this study can contribute to the research community. Societal and cultural norms, which can play a significant role in how students perceive their mathematics ability often shape the experiences students have within mathematics classrooms. These perceptions affect whether students enter, persist, and graduate with a STEM degree. Rather than focusing on the documented gender and achievement gaps to define success, successful students can help the research community (and society) begin to understand other ways to perceive mathematics and STEM success. In addition, those who have been successful in STEM can help people "learn to prize and value differences and to view them as resources for learning" (Pine & Hilliard, 1990, p. 1). Rather than assuming students are entering higher education with deficient characteristics or attributes, educators and stakeholders of higher education should question how they might effectively promote or unwittingly prevent students' success. Students are not the only ones who are affected by social and cultural norms.

In addition, these larger discourses that have shaped the motivations of those who pursue a STEM degree have also been influential in my own thinking and the path I chose to take. I, too, am not immune to what is happening around me and am consciously aware of my place in society. As I sit here and write this chapter, I am reminded by recent events (the overturn of *Roe v. Wade*[20]) that women are still considered second class citizens. Women, despite evidence that has shown they are quite as capable as men, have been told they can no longer make choices about their bodies. While this may not seem to be related to my work, it is one of the underpinnings of what women must face daily. If we cannot control even our bodies, how do we begin to take control of our life? Our choices? This monumental moment in time highlights that there is still much work that needs to be done and that women are still not recognized for their strengths and contributions.

I offered a brief sketch of my life so that the reader might understand how and why I am compelled to conduct this research and why I want to listen to those who have been marginalized based on their gender and language capabilities. My own experiences of not being heard, seen, or valued are not unique—there have been many before me who have had similar experiences who have also been successful. And yet, the conversations that surround ELLs and women tend to focus on deficiencies and how those deficiencies are the reasons why they continue to "fail" in school. My hope is that this study will make contributions to some of the work that is being done

[20] On January 22, 1973, the U.S. Supreme Court ruled that the Constitution of the United States protected a woman's right to have an abortion. The decision of whether to continue with a pregnancy or to terminate it is the woman's right (not the government). In June 2022, however, the U.S. Supreme Court overturned *Roe v. Wade*, giving states the power to create restrictions on abortions.

by others who are attempting to change the narrative of what it means to be a woman or a person whose culture does not match the dominant one in the STEM field (see, e.g., Gutiérrez, 2008; Civil, 2007). By recognizing and highlighting the successes of women whose first language is not English, we, as members of society can: (i) challenge how we think about minoritized populations; (ii) disrupt our underlying assumptions of what it means to be successful in STEM and what that looks like; (iii) and begin to think about how certain attributes, such as language and gender, can contribute to STEM success.

CHAPTER 2

LITERATURE REVIEW

In this chapter, I provide a brief historical account of the larger discourses that have influenced education in the United States in the past 20 to 30 years. Given that participants in this study have had experiences within the U.S. educational system in some capacity requires understanding the history and nature of how teachers, other students, and researchers in the field have perceived ELLs and minoritized women. At times, components of this chapter may seem disconnected and unrelated to one another, but just like me, "students are multidimensional in their experiences, identities, and backgrounds" (Blackburn, 2017, p. 243). To phrase it in another way, I am fully aware that I may hold identities that may appear to conflict with one another or may not make sense. In the process of doing this research, I maintain that an individual cannot separate one identity from other parts of the self or that it is even necessary. The intersectionality of race, gender, language, ethnicity, and so on makes it difficult to talk about one of these components without also talking about several other factors. Despite the format of this chapter, I encourage readers to consider the ways in which each component contributes to the overarching discourse of how educators have perceived women, whose first language is not English and how those perceptions have played a role in the decisions women have made in pursuing a STEM degree. As a former ELL who has had success in education (as evident by being in a doctoral program) and having talked to my participants about their own journeys, I recognize that there are some similarities and differences between my path to success to some of my participants. I therefore start with the larger discourses that have been influential in my own life.[21]

[21] The hope is that by providing a brief historical account of the larger discourses that have affected my own journey, I can begin to understand myself and my role as a researcher and former ELL who has had success in education and provide a foundation for how to begin to understand my participants as they describe their own journey in this study. Although participants' experiences will not exactly align with the experiences of those with

I begin by first describing deficit thinking, and how, within this view, students of color[22] were often seen as needing to be "fixed" due to their poor performance on standardized tests (as compared to their White peers). For ELLs in particular, language was viewed as being a reason that students were not performing to their ability, and rather than looking at difference as another opportunity to learn about others, their difference was used to encourage deficit thinking. Moreover, the ways in which groups of students were too often being compared (primarily because of testing) contributed to the ways in which school personnel (including teachers and administrators) and policymakers perceived and treated these students in schools.

I then define STEM, outline the role of mathematics within STEM culture, and discuss the effects of deficit thinking in the retention models that have been proposed within higher education. Just as K–12 educators struggled to teach to those who were identified as being different, colleges and universities across the nation also struggled with how to teach "underprepared" students and how to retain them. Deficit thinking contributed to the ways in which students were treated and played a role in who would earn a STEM degree; and, in turn, creating systematic barriers and sending coded messages that only certain groups of people belonged in the world of STEM.

Additionally, research on negative experiences of women in STEM education suggests that "environmental, social, and cultural factors contribute to women's non-start or early exit from STEM majors and their diminished performance when compared to man peers" (Parson,

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similar characteristics, the historical account provides a foundation for understanding why certain perceptions, stereotypes, and beliefs continue to exist despite the efforts of researchers who have attempted to redirect these issues in education research (e.g., Gutiérrez & Dixon-Román, 2010). Additionally, I did have to revisit the literature while collecting data as I learned more about the participants. More descriptions about the discourses they spoke about (and those which I was not anticipating) are presented in Chapters 9 and 10.

[22] The phrase *students of color* encompass all students who are not White, including students whose first language in not English. Although my research focused on students who identify as women whose first language is not English, these students are often grouped under the umbrella terms students of color or minoritized students.

2018, p. 9). The culture and structure of STEM has been shown to negatively affect women because the masculine environment often creates the "chilly climate" that discourages women from pursuing STEM degrees (Parson & Ozaki, 2017), pushes out women who initially enroll,[23] and encourages women to perform according to masculine standards (Parson, 2018). Although current research does not support the idea that women are biologically deficient or are less capable than men in STEM (Walls, 2009), the STEM education enterprise is seen as problematic, as it continues to "perpetuate gendered experiences and societal gender norms" (p. 20). Specifically, women of color experience multiple forms of marginality (at the intersection of gender, race, ethnicity, and scientific discipline) in undergraduate STEM programs (Ong et al., 2011). Due to their gender, racial, and ethnic status, many women of color experience gender and ethnic microaggressions (Sosnowski, 2002) and have felt unwelcomed, unsupported, or invisible (Ong, 2005).

Still, there are women who continue to persist in STEM despite the overwhelming discourses that try to convince them to leave. Thus, I therefore conclude the review by highlighting the success of students of color in STEM at higher institutions and ways in which educators have tried to create opportunities for minoritized students to engage in higher-level mathematics. Exploring perceptions and experiences of students who have been successful, despite the systematic barriers that continue to exist, can open avenues for new research and can create a discourse of ways to challenge and support students who choose to pursue a STEM degree. Moreover, understanding the "holistic lived experiences of women in STEM"

[23] Women who initially enroll in STEM and then switch to a non-STEM degree due to the chilly climate or perceived incompatibility between their gender and STEM fields is a concept generally referred to the "leaky pipeline" (Kreutzer & Boudreaux, 2012; Parson, 2018).

(Blackburn, 2017, p. 251) can open avenues to understanding the strategies these women used and the support and systematic systems that led them to their success.

Deficit Thinking

For over a century, students' performance in schools and their successes have dominated the narrative in education. What drives many educators (and policymakers alike) is the idea that schools must educate and create citizens so that the nation itself can be successful. Yet, when schools "fail" at producing such societal needs, who is to blame?

The most common belief (and one that still holds implicitly today) is that children who fail are failing because of "internal deficits or deficiencies" (Valencia, 2012, p. 2), such as linguistic shortcomings, intellectual capabilities, the lack of motivation to learn, and behavior that are often reflected (or "validated") by standardized tests. While many try to refute this thinking and claim to have moved beyond blaming students (and their families and cultures), this type of thinking has infiltrated educational thought and practice (Valencia, 2012).

In identifying the sources of these "deficits" so as to "fix" students who do not succeed, educational policies have ultimately harmed the very people they are trying to fix. Not only does deficit thinking identify and blame students who have not performed well in school, but it also encourages researchers and policymakers alike to focus on the differences in achievement among students. This attention to these differences can lead to placing blame on students, which can then lead to government intervention that can be harmful. For instance, according to Valencia (2012):

> the forced segregation of African American and Mexican American students was based on deficit views that these children were intellectually inferior, linguistically limited in

> English, unmotivated, and immoral—all characteristics that would hold back the progress of white students if racial/ethnic mixing in schools was permitted. (p. 4)

Moreover, test-driven school reform continues to emphasize "individual values and efforts but trivializes social injustice and educational inequalities" (Yu, 2006, p. 325). As a form of oppression, deficit thinking has been used to keep students of color in their place by enacting educational policies too often fueled by class and racial prejudice (Valencia, 2012).

Deficit thinking is not new—it underlies many theories that have been used to describe why inequities between races exist and ways in which education can address them. Most often, "race"[24] has been a prominent way to define and differentiate between groups of people. Although historically the focus has primarily been on the Black/White binary, critical scholars assert that other "layers of subordination," such as immigration status, sexuality, language, and so on, also play a role in the experiences of students of color (Yosso, 2005).

Pierre Bourdieu (1930–2002), a French sociologist interested in the dynamics of power in society and why differences existed between groups, suggested that although economic capital plays a vital role in the development of class, cultural and social capitals,[25] may be *equally* important in the reproduction of class and in sustaining the inequalities between classes (deMarrais & LeCompte, 1995; Devine, 2008; Storey, 2018). He claimed that as members of a particular class, people distinguish their class from other classes in their cultural patterns, such as the way they talk or act, how they dress, and so on (deMarrais & LeCompte, 1995; Devine,

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[24] It has been critically argued in the field of anthropology (and others) that the term "race" is simply a way to categorize people and "is a means of creating and enforcing social order," (Smedley & Smedley, 2005, p. 24) without any biological basis.

[25] Marxism rests on the idea that the relationship between social class and economic power creates the hierarchy of power in a society (Storey, 2018). Bourdieu however argued that Marx's theory did not fully capture why social classes continued to exist from one generation to the next or how people could move from one class to another. Bourdieu further developed Marx's theory of class reproduction to include three forms of "capital": economic, cultural, and social.

2008; Nash, 1990; Storey, 2018). Cultural and social capitals[26] are considered resources, and like most resources, there is value placed on the resource by the dominant culture[27] (deMarrais & LeCompte, 1995). Those born into a lower class, for example, will have limited access to the knowledge considered valuable by society. Despite having the "same" education and access to knowledges as those in the upper classes, social mobility would continue to be difficult (Yosso, 2005).

Although Bourdieu tried to encapsulate all the characteristics and forms of social histories and identities into defining culture and to explain the differences among classes/groups, he failed to consider the capitals of people of color. The hierarchy illustrates that the social and cultural capital of people of color is vastly different than those of Whites, suggesting that people of color "lack" social and cultural capital. Bourdieu failed to acknowledge the wealth of knowledge that minoritized groups already possess and inferred that some cultures are "culturally wealthy while others are culturally poor" (Storey, 2018, p. 76). He fails to consider that by being placed on the lower rung of the hierarchy also means they do not have access to the knowledge, skills, and abilities than those in the higher levels (Yosso, 2005).

[26] *Cultural capital* is defined as knowledges of the upper and middle classes to be considered valuable in a hierarchal society and are often used as the "baseline" in the educational system (Yosso, 2005). *Social capital* is defined as the hierarchal, privileged networks people have entrée to as members of particular classes and in turn the accessible retrieval of useful information and advice (Devine, 2007). Social capital can include networking with members of the wider community like organizations people choose to participate in, such as places of worship, lodges, alumni, and professional organizations, and so on.

[27] Yosso (2005) however questioned whose cultural capital/knowledge is valuable and challenged people to consider an alternative concept called "community cultural wealth." In her cultural wealth model, she examined six forms of cultural capital: (a) aspirational (to maintain hopes and dreams despite barriers), (b) linguistic (social and intellectual skills that are acquired through communication experiences involving more than one language), (c) familial (cultural knowledge nurtured within families, such as their family history), (d) social (networks of community resources), (e) navigational (being able to maneuver through social institutions), and (f) resistance (oppositional behavior that challenges inequality and the status quo). Her model highlights that students come into schools with talent, strengths, and experiences that should be valued and explored.

This form of deficit thinking is harmful for all minoritized groups—even those who are perceived as "good." The stereotype of Asian Americans, for example, referred to as the "model minority"[28] based on their academic success, is often used as an example of what other minoritized groups should be more like. The model minority rhetoric, however,

> suggests more than merely that Asian Americans are high achievers because they work hard. It also suggests that either the achievement of Asian Americans happens despite experiences of racial discrimination or that the United States is color-blind and racial discrimination does not occur. (Tran & Birman, 2010, p. 106)

The success of Asian Americans thus creates a "positive" narrative—one that suggests that hard work can overcome any obstacle and masks the hardships Asian Americans continue to face inside and outside the educational realm.[29]

This "positive stereotype," however, is just another version of deficit thinking. Despite the success Asian Americans have in academics, they are still deemed as being different from the norm and are often compared to their White peers as well as other minoritized groups. For example, when compared on parental bonding and support from friends and teachers, Asian American students reported less parental bonding than White students and their "lack of parental bonding" was mitigated by support from outside their family (Crosnoe & Elder, 2004). Although there is limited "deficit" in their academic performance, the narrative around Asian American

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[28] The phrase "model minority" originated in the 1960s and is a stereotypical view of Asian Americans as being "phenomenally successful and 'problem free'" (Yu, 2006, p. 326). Emerging during the Civil Rights Movement, the stereotype of Asian Americans as being the successful group was a response to African Americans who demanded equal rights and economic opportunity (Yu, 2006). As a political instrument, the model minority was used to show that racial or social injustice did not exist.

[29] Although there is a large portion of Asian Americans who graduate from college every year, Asian Americans have "not yet achieved full equality and participation in American society" (Yu, 2006, p. 326). Despite their educational success, they still face inequities in income (Whites consistently gain a higher return on education) and the poverty rate is still higher for Asian Americans than Whites (Yu, 2006).

students paints an image of lacking something that is deemed important to White culture (i.e., parental involvement in school and the bonding with students). The hidden message is that Asian Americans can benefit from becoming more like Whites despite evidence that Asian Americans as a demographic group out-perform or do just as well as Whites academically.

The model minority stereotype maintains a deficit view of Asian Americans because it reinforces that White, middle-class culture is what constitutes the norm for all children and that all other cultures must be compared to this norm (Martin, 2013; Osajima, 1993; Yosso, 2005). According to Tran and Birman (2010), "Asian Americans are the model for other minorities to emulate, but Asian Americans are not on par with Whites" (p. 113). The only group who benefits from this stereotype continues to be White elites, who still maintain much of social control.

Thus, when schools work with the assumption that students need to be "just like their White peers," it sends a message that students and their families are at fault for their academic performance and that "individual efforts matter more than structural change" (Yu, 2006, p. 330). Deficit thinking infers those factors such as "(a) students enter school without the normative cultural knowledge and skills; and (b) parents neither value nor support their child's education" (Yosso, 2005, p. 75) are reasons that students fail. These assumptions lead educators and policymakers to believe students come to school with a "blank slate" and therefore need to learn specific skills for social mobility.[30]

Deficit Thinking and Mathematics

Learning mathematics has been described as a challenging process; students often describe their mathematics experiences as being difficult and boring (Lockhart, 2009). The

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[30] Paulo Freire (1973) has critiqued this "banking method of education" which assumes that students come into school with limited knowledge and experiences, and therefore teachers need to "deposit" knowledge into students, including the favored cultural views and ways of being of the dominate group.

content itself can be overwhelming for students to learn, given that “mathematics is abstract and logical in nature and many concepts in mathematics cannot be explained easily in terms of physical representations or related to everyday life” (Ali & Reid, 2012, p. 284). Furthermore, mathematics has historically been taught as a system that is about following rules and procedures that an elite group practices (Ernest, 2009b). It thus gives the illusion that mathematics has a “life on its own” independent of humans and somehow represents “truth” (Valero, 2009, p. 238).

In addition, despite the nature of mathematics itself, there are other underlying factors that contribute to students’ struggles with learning mathematics. For example, student experiences and the opportunities they are given are highly dependent upon how they are perceived as being “capable” in doing mathematics. Berry (2008), in his work with successful African American middle school boys, found that “although performance and achievement are factors that influence access to upper-level mathematics, access and success are also influenced by perceived notions of fairness and objectivity, which include teachers’ beliefs, parental influences, and school practices” (p. 465). I argue that these perceived notions can negatively affect students’ opportunities to access higher-level mathematics, students’ self-perceptions and their capabilities in doing mathematics, and in so doing contribute to teachers’ deficit views of students of color. Deficit views, both implicit and explicit, reflect the wider societal views of these students that have also permeated the U.S. educational system.

Effects of Deficit Thinking on Students

While there are many characteristics that are deemed as “lacking,” one defining characteristic that affects many minoritized groups is their use of language: “Not only is race denigrated in educational policy, other critical issues such as ethnicity, social class, gender, religion, and language also are trivialized” (Yu, 2006, pp. 330–331). Due to the large number of students who enroll in schools not knowing English, U.S. schools have had to accommodate these children. Deficit thinking has dictated the ways in which teachers, administrators, and policymakers treat these children in schools. Students are required to learn and use English—even at the risk of losing their native language.

Historically, according to Cummins (1981), many educators considered bilingualism as a "disease which not only caused confusion in children's thinking but also prevented children from becoming 'good Americans'" (p. 17). Although the aim of schools was to teach students English and content, educators were convinced that these students coming into schools needed support and did not have any linguistic capital. This deficit thinking caused many educators to encourage students to use English at school and at home, limiting opportunities for children to use their first/native language (L1). This encouragement often led to the eradication of students' bilingualism, made students feel they had to reject their home culture, and affected students' sense of belonging (i.e., many unable to identify with either cultural group) (Cummins, 1981).

The methods schools employed in schools to "help" children learn English in schools often forced students to reject using their L1 and assimilate into the second language (L2) culture. Table 1 outlines the cycle that would perpetuate in schools around the education of minoritized students and how they were often blamed for their lack of success. Deficit thinking not only offered a description of the types of behaviors that can be harmful or detrimental in student learning (i.e., characteristics seen as deficits), but was also used to provide an explanation for student behavior (i.e., students are misbehaving in school because of their limited English). The way students were described and perceived played a role in perpetuating the idea that an intervention is necessary to "fix" these students (Valencia, 2012). The way in which schools reacted to try and fix students' language follows a similar pattern. The school identified the deficit (i.e., language), used it to provide an explanation as to why these students were not performing as well as their peers, implemented an intervention (i.e., increased use of L1 or eradicating L1 by replacing it with L2), and then used assessments to further prove the need for such interventions (thus, reinforcing the deficit thinking model).

Table 1
Model of Minority Language Education in North American Schools

Blaming the Victim in Minority Language Education

A. Overt aim	Covert aim	D. Outcomes	
Teach English to minority children in order to create a harmonious society with equal opportunity for all	Anglicize minority children because linguistic and cultural diversity are seen as a threat to social cohesion	Even more intense efforts by the school to eradicate the deficiencies inherent in minority children	The failure of these efforts only serves to reinforce the myth of minority group deficiencies
B. Method	**Justification**	**C. Results**	**"Scientific" explanation**
Prohibit use of L1 in schools and make children reject their own culture and language in order to identify with majority English group	1. L1 should be eradicated because it will interfere with the learning of English; 2. Identification with L1 culture will reduce child's ability to identify with English-speaking culture	1. Shame in L1 language and culture 2. Replacement of L1 by L2 3. School failure among many children	1. Bilingualism causes confusion in thinking, emotional insecurity and school failure 2. Minority group children are "culturally deprived" (almost by definition since they are not Anglos) 3. Some minority language groups are genetically inferior (common theory in the U.S. in 1920's and 1930's).

Note. This Table reflects the assumptions of North American school systems in the first half of this century. However, similar assumptions have been made about minority language children in the school systems of many other countries.

Note. A Blaming the Victim Model in Language Education. Reprinted from "Empirical and theoretical underpinnings of bilingual education," by J. Cummins, 1981, *Journal of Education*, *163*(1), p. 18.

Rather than consider that the very interventions schools employed with students might have caused their "lack of success" (i.e., the eradications of students' bilingualism), schools often blamed children and their failures on their bilingualism (Cummins, 1981). These "failures" were often reflected in test scores, which indicated whether students met the standards of excellence. Although not the practices held currently, this example highlights how deficit thinking historically had a tremendous effect on how students whose first language was not English experienced learning in schools.

Yet, traces of such thinking are still present in schools today. Although there is a greater number of students who speak languages other than English in U.S. schools, research still suggests that teachers and policymakers alike consider language as a problem with respect to the gap in achievement between minoritized students and other students (Escamilla, Chávez, & Vigil, 2005)—too often continuing to view language diversity as a problem rather than a resource (Pereira & Gentry, 2013). Gifted programs, for example, continually serve a select group of students, with an underrepresentation of ELLs in gifted programs (Pereira & Gentry, 2013).[31]

The exclusion of culturally and linguistically diverse students in such programs, for instance, may be due to the unproductive beliefs teachers hold about ELLs (McLeman & Fernandes, 2012; Pettit, 2011; de Araujo et al., 2016). Implicit, invisible bias too often, according to de Araujo and colleagues (2016), "perpetuates beliefs that ELs are less capable and may interfere with a teacher's ability to effectively work with ELs in the classroom" (p. 34). In the teaching of mathematics, for example, teachers may feel there is a greater need to emphasize basic mathematics facts or procedures rather than focus on mathematics conceptual understanding (de Araujo et al., 2016). de Araujo and colleagues argued that the focus of many

[31] In their attempt to understand why the underrepresentation of ELLs in gifted programs continue to exist in U.S. schools, Pereira and Gentry (2013) focused their study on Hispanic ELLs in grades 2 through 6 in four midwestern schools. They interviewed students, parents, and teachers to gain a better understanding of the students' schooling experiences. While students in their study enjoyed being in school and viewed themselves as achievers and future-oriented, none of the students in the study were identified as gifted in any of the school districts despite being identified as "high-potential" by their teachers. Pereira and Gentry concluded that "developing appropriate methods to identify high-potential students who do not fit traditional conceptions of giftedness is a task that scholars in gifted education have yet to complete" (p. 186).

teachers continues to be on ways to support ELLs rather than to challenge them.[32] The available resources for teachers for help teaching ELLs, for example, are often available on the World Wide Web. Using a Google search and using search strings, such as "how to support English learners" and "how to challenge English learners," the authors found that "there were 11,000 returns related to supporting ELs in [their] search and no results for 'how to challenge English learners'" (de Araujo, 2016, pp. 34–35).[33] These results suggest that the discourses surrounding ELLs in the classroom centers around the ways in which to support them, rather than challenging or extending student thinking within mathematics.

High-Stakes Standardized Testing

Another form of education oppression too often fueled by deficit thinking that also continues to drive educational policies and reform are high stakes standardized testing. These tests, as a way to measure students' educational outcomes, are still used as gatekeepers of student success. For example, the outcomes of these tests could affect whether a student can graduate high school or determine the types of opportunities that will be given (i.e., the types of courses offered, the types of colleges that are attainable, and the learning experiences in the classroom). Historically, according to Hilliard (2000), high stakes standardized tests have been used for two primary purposes: (a) to measure the student's capacity (i.e., aptitude and IQ tests) and (b) to

[32] Note that the ways in which teachers "support" their ELL students have been challenged by educational researchers within other fields. For instance, Walqui (2006) argued that "it is possible for second language learners to develop deep disciplinary knowledge and engage in challenging academic activities" (p. 159) if teachers know how to provide the necessary support. Teachers can assist students in their development of language and subject matter knowledge, for example, by scaffolding their instruction or changing their instructional tasks to help students develop the necessary skills and abilities (Walqui, 2006; Mantegna, 2014). I argue that although these changes to instructional practices have been implemented in other fields it is not necessarily evident in the field of mathematics education.

[33] de Araujo and colleagues (2016) acknowledged that there are limitations to Google searches and that it does not necessarily correlate directly to how teachers perceive ELLs in their classrooms. It does, however, provide a brief sketch of how ELLs "are being discursively framed within the resources and articles available on the World Wide Web" (p. 34).

measure whether students have mastered the curriculum. Standardized tests have been used not only to determine what students "know" but also to determine whether they will be successful (Hilliard III, 1991). On the other hand, as an instrument, standardized tests have been criticized on whether they are reflecting high standards and have been shown to "measure a very narrow range of behaviors, many of them at a very low level of thinking" (Hilliard III, 2000, p. 299).

Nonetheless, standardized tests continue to exist because proponents of testing claim it is necessary to have high standards in schools and guarantees students get a "quality" education. Many stakeholders are attracted to the notion that standardized testing is beneficial because high scores provide opportunities for students through scholarships and admission to college. On the contrary, students who do not do well, are not necessarily provided the same opportunities because the tests highlight their "weaknesses"; an indication that these students need help to learn content. As innocent as this "help" may seem, however, "making big decisions, such as admissions and placement, based on test scores is unscientific, unprofessional, and bad public policy" (Hilliard, 2000, p. 296). Many of these standardized tests may not measure the intended curriculum and at best, can only indicate how much a student knows at a specific moment in time. In addition, there are many resources available that can help students prepare or excel on these tests without learning the content. For example, SAT/ACT exam courses are available to help students prepare for these exams that often teach strategies to help boost scores (without a focus on content) —highlighting that the tests measure more of students' opportunities to learn rather than how much they have learned.

Relying on test results alone does not necessarily provide an accurate picture, especially for underrepresented students or students whose first language is not English who may be required to take exams in English. Even when children demonstrate full English proficiency on language assessment measures, according to Klinger and Harry (2006), they often still "demonstrate a low verbal IQ and high-performance IQ profile when their intelligence is tested" (p. 2248). Such exams are not only used to determine placement but also are used to predict how students will perform. Relying on test scores alone indicates that "ELL students lag behind their English-proficient peers in all content areas, particularly academic subjects that are high in English language demand" (Abedi & Herman, 2010, p. 724). Given the questions surrounding the validity of standardized tests, it raises the concern of whether ELL students are given opportunities to succeed.

For instance, "language proficiency tests tend to assess discrete points of language skills," (Verdugo & Flores, 2007, p. 181) and may not accurately assess whether students are ready to move out of support programs. On the surface, it may appear that students are proficient (i.e., accent, fluency, and grammar), but they may not have fully developed their cognitive and academic language proficiency (CALP).[34] Students may be able to acquire the language proficiencies (such as basic vocabulary and grammar) in their day-to-day conversations, but it does not necessarily indicate students are ready to be immersed in English-only classrooms or take exams in English.[35] Although there is a high correlation between language proficiency and academic achievement, the relationship is not causal (Verdugo & Flores, 2007).

For ELL students, the reliance on these exams raises issues of whether they can be differentiated between students with learning disabilities or English language acquisition. Relying on test results alone can lead to misinterpreting a student's full potential (i.e., relying on

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[34] According to Cummins (1981), CALP refers to those dimensions of language that are related to literacy, which is different from students' ability to acquire basic interpersonal communicative skills (BICS).

[35] Generally, it takes about seven years to develop English proficiency (Cummins, 1981) and even then, students should be evaluated by a bilingual assessor to determine if they are ready to be evaluated in only English. If a child transitions to an English-only classroom too prematurely, it can negatively influence their achievement (Klingner & Harry, 2006).

IQ tests) and ignoring other factors that could affect students' performance. Low achievement is often blamed on low IQ and when teachers in schools have little understanding of the language acquisition process, they can confuse language acquisition with problems of attention or learning disabilities (Klingner & Harry, 2006). ELL students' academic failure often means they are placed in remedial or Special Education programs (Artiles et al., 2002; Klingner & Harry, 2006).

Thus, the outcomes of these tests therefore too often have placed language-minoritized students[36] in tracks that limit their opportunities, with the real purpose of "segregating students into nonbeneficial instructions" (Hilliard III, 2000, p. 299). Lower-level mathematics classrooms, for instance, tend to have more cultural and linguistic minoritized students who often experience the drill and practice method, rather than being exposed to higher thought processes as those students in the higher-level mathematics courses (Abedi & Herman, 2010). The discrepancies on standardized tests mirror the discrepancies of students' opportunities to learn (Abedi & Herman, 2010) and the different backgrounds students experience in their everyday lives (Gutiérrez, 2008).

Stereotypes and Performance

In addition to the types of opportunities students are given, stereotypes about students, both positive and negative, can have a tremendous effect on student performance (Cheryan & Bodenhausen, 2000; Steele, 1997; Steele & Aronson, 1995). Negative stereotypes can undermine the performance of talented individuals of a stereotyped group and can create an additional cognitive burden on students who worry about confirming the expectations associated with the

[36] Although I present an argument for language-minoritized students, researchers (e.g., Hilliard III, 2000; Gutiérrez, 2008) have argued that the outcomes of tests also affect students of different minoritized groups.

stereotypes of their group[37] (Steele, 1997). Asian American women, for example, are often conflicted about the stereotypes impacting the domain of quantitative skill. Being a woman is often associated with having a negative stereotype in the realm of quantitative reasoning while being Asian is positively stereotyped within the same domain. Shih and colleagues (1999) examined the influence of these two identities and found that women who identified themselves as primarily Asian earned higher mathematics scores than participants in a controlled group of Asian American women and those who identified themselves as primarily women performed lower. They suggested that while negative stereotypes can negatively influence student performance, positive stereotypes could "provide a performance boost" (Cheryan & Bodenhausen, 2000, p. 399).

Cheryan and Bodenhausen's (2000) similar study found that positive stereotypes could negatively affect student performance. Asian American participants did not improve their performance because they feared the possibility of failing to confirm the stereotype that "Asians are good at math." Failing to meet the high expectations can not only undermine the reputation of their group, but also affect their personal well-being. Given the unrealistically high expectations by their peers, parents, and teachers, the pressures could greatly affect their academic performance.[38]

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[37] Steele and Aronson (1995) referred to this as stereotype threat, defined as a "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797). Stereotypes are not limited to merely race—studies conducted on the influence of gender and the existence of multiple stereotypes at once have also been shown to influence student performance.

[38] Another consideration is the negative effect on Asian Americans as a group. One such effect of the model minority label is that it causes or reinforces "people's indifference and ignorance toward these students' needs and problems" (Yu, 2006, p. 330). Asian American students may also experience difficulties in schools. If people however do not recognize that possibility then these students may encounter more difficulties and problems (Wing, 2007).

The Achievement Gap

Consequences of high-stakes tests have also resulted in shifting the focus of education to finding ways to support students who are not performing at the same level as their White peers. This "achievement gap,"[39] which highlights the comparisons between White students and non-White students, often portray students who do not fit the norm as having deficits. This focus has had detrimental effects on students—one of which is that students often believe in the myth of meritocracy—the belief that

> one's social and economic mobility are achieved primarily through individual effort and hard work; regardless of race, gender, socioeconomic status, or other social identity, individuals can claim a piece of the American Dream by 'pulling themselves up by their bootstraps.' (Carter, 2008, p. 466)

The myth of meritocracy requires individuals to take responsibility for their successes and failures, without considering any of the structural conditions (i.e., racism, classism, sexism, etc.) that have prohibited or constrained their ability to perform (Carter, 2008). So, when students fail, it is a consequence of their individual merit.

Gutiérrez (2008) further emphasized the detrimental effects of researchers focusing on the achievement gap as a focal point of study: the achievement gap "supports deficit thinking and negative narratives about students of color and working-class students" (pp. 358–359). By feeding into the achievement-gap lens, researchers also make comparisons between groups, accept quantifiable terms (such as race, class, gender, etc.) as a way to define students (ignoring multiple identities and agencies), rely on comparison groups to validate their research (rather than studying marginalized groups alone), and place groups in opposition to one another. All

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[39] Students are often grouped by race and are compared not only to Whites but also to each other based on their academic performance on a given standardized test.

these components factor into the normalization of linking “low achievement” with Black, ELLs, Latinx, and so on without looking at the social and political structures that contribute to how they are assessed on these assessments (Gutiérrez, 2008, 2013). Furthermore, labeling students as “at-risk” emphasizes students’ deficiencies and ignores their strengths.

Thus, deficit thinking has permeated all levels of education—not only influencing the type of content students should learn in schools (as a consequence of results from standardized testing), but also in how it dictates the types of research that is done. Given the vast influence of deficit thinking on education, it is also important to consider how it has affected students in higher education.

STEM and the Role of Mathematics

STEM is an acronym for the four related yet independent disciplines of science, technology, engineering, and mathematics. The STEM movement started in the early 1990s in response to the widespread knowledge that the United States was “less developed than other countries…and that it was necessary to develop a STEM identity to maintain economic competitiveness” (Martín-Páez et al., 2019, p. 800). With the continuing pressure of students’ performance and achievement (and lack thereof) and the idea that students need to be prepared for jobs that do not yet exist (Maass et al., 2019), there has been a push to incorporate more STEM activities and curricula in schools. STEM is now considered as being essential in creating responsible and ethical citizens in society (Maass et al., 2019; Martín-Páez et al., 2019). STEM education not only relies on mathematics and science content, but also—

> lies in being able to communicate, share, and use information to solve complex problems, in being able to adapt and innovate in response to new demands and changing circumstances, in being able to marshal and expand the power of technology to create

> new knowledge, and in expanding human capacity and productivity. (Martín-Páez et al., 2019, p. 869)

The National Council of Teachers of Mathematics (NCTM), the Common Core State Standards (CCSS), and the American Mathematical Association of Two-Year Colleges (AMATYC) recognize and address that mathematics content cannot be the only standards present in U.S. mathematics curriculum across the nation. Practices of mathematics (such as the process standards of problem solving, reasoning, connecting, communicating, and representing) are just as important as the content itself, and should be woven into the curriculum in conjunction with the mathematics content standards (Li & Schoenfeld, 2019; National Council of Teachers of Mathematics, 2000; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

The role mathematics plays within STEM, however, varies across the nation. While mathematics is acknowledged as being needed in supporting STEM education, it is often underrepresented or not made explicit in STEM activities (Martín-Páez et al., 2019). Mathematics could even be considered as a pre-requisite for STEM learning, as it is associated with being the "gateway to many scientific and technological fields" (Li & Schoenfeld, 2019, p. 1). Students who do not pursue mathematics often limit not only their opportunities to learn a wide variety of subjects but also job opportunities in the future and in becoming responsible citizens (Li & Schoenfeld, 2019; Maass et al., 2019). Regardless of where in STEM mathematics fits, mathematics content and processes have been shown to develop twenty-first century skills such as critical thinking, problem solving, and communication, which are critical in helping students build connections within mathematics as well as between different disciplines (Fitzallen, 2015; Li & Schoenfeld, 2019; Maass et al., 2019; Shaughnessy, 2013).

Although it has been shown how mathematics processes, such as problem solving, reasoning and proof, and communication, can help support the learning of mathematics and other disciplines, it is important to also look at how mathematics plays a role in how students come to choose STEM-related careers. According to Redmond-Sanogo and colleagues (2016), “the most likely students to pursue STEM degrees in college and STEM careers as a profession are those who are both proficient in mathematics and interested in STEM” (p. 379). This relationship indicates that students who continue to pursue STEM careers most often already have the interest and motivation for learning mathematics. Modeling and integrating STEM activities can have a positive effect on students’ competence and motivation to continue to learn and apply mathematics to complex situations (Maass et al., 2019).

Additionally, highlighting for students how mathematics can be used as a tool for social empowerment can keep students interested in learning mathematics. Ernest (2002) claimed,

> the empowered learner will not only be able to pose and solve mathematical questions (mathematical empowerment), but also will be able to understand and begin to answer important questions relating to a broad range of social uses and abuses of mathematics (social empowerment). (p. 6)

Using mathematics as a “thinking tool” to view the world critically can help students think about their own political and social empowerment (Ernest, 2002; Maass et al., 2019). This perspective suggests that knowing mathematics and how to apply it is essential for making socially just decisions and judgements, which can influence the happiness and well-being of others. Recognizing the important role mathematics can play in a political and social realm can help attract and motivate students to pursue STEM careers. All and all, the experiences students have had with mathematics throughout their K–12 education and the opportunities that they have been given to meaningful engage in mathematics have the potential to encourage students to pursue STEM careers.

Retention Theories in Higher Education

Although much of the literature has focused on students in K–12, deficit thinking permeates all levels of education and has affected who chooses to pursue a STEM degree. This affect is highlighted in the number of students who choose to pursue STEM, as fewer than 40% of those who intend to major in STEM actually obtain a STEM degree (Olson & Riordan, 2012) and the number of science, mathematics, and engineering students decline from freshman year to senior year (Whalen & Shelley, 2010). Moreover, students "who are underrepresented in STEM fields (female and minority students) are significantly less likely to be retained or graduate within six years" (Whalen & Shelley, 2010, p. 53). The scientific community, in general, has witnessed wide gaps in STEM degree completion across multiple groups and "the successive jeopardy of lost talent, which has broad economic and intellectual ramifications" (Espinosa, 2011, p. 209).

In an attempt to understand why students were dropping out, early research focused on students' individual characteristics (Aljohani, 2016; Berger & Lyon, 2005), without considering the interactions with the college environment. Students with "less than an ideal background" (Parson, 2018, p. 30), for example, were blamed for their lack of preparation, shifting the focus and responsibility to the individual rather than the institution.

Student performance prior to coming to college have been explored to try and make sense of why specific students (namely, White and Asian) pursue STEM in college. Redmond-Sanogo and colleagues (2016) found that performance in specific mathematics courses, such as calculus, were significantly related to students' performance in college STEM gateway courses. More specifically, “students who performed well in calculus, pre-calculus/trigonometry, physics, and chemistry in high school were more likely to be successful in college STEM gatekeeper courses” (Sanogo et al., 2016, p. 386). For minoritized students, academic preparation in high school has been shown to affect their selection and persistence in STEM majors (Cole & Espinoza, 2008). Students therefore are normally encouraged to take these courses in high school to help support them as they transition to college, as they will be “better prepared” to take STEM gateway courses.

Yet, the suggestion that students should take courses in high school to prepare for college life still ignores the cultural norms within the institutions of higher education. Furthermore, students who attend a high school where many options exist (i.e., advanced level mathematics courses) are rewarded once they get to college by being placed into higher level courses. The problem is that those students who have already had access to these types of courses are those who typically already “fit into the current system” (Parson, 2018, p. 31). So, while there is literature that suggests there “is a strong relationship between precollege measures and persistence in college STEM majors” (Espinosa, 2011, p. 215), the college environment itself can also influence whether students choose to continue to pursue STEM degrees.

Rather than student retention being viewed as a reflection of individual attributes or skills, the focus then shifted to how to get students to successfully integrate into the institution academically and socially (Tinto, 2006). The role of the environment, particularly the institution of higher education, affects students’ decisions to stay or leave higher education. The academic-social integration model,[40] developed by Vincent Tinto (1993), suggested that college students

[40] Many of the early retention models drew from Emile Durkheim’s suicide theory that claimed suicide is “attributed to an individual’s lack of social and intellectual integration into the social life of his or her society” (Aljohani, 2016, p. 3). Suicidal behavior and student attrition behavior are similar in that both behaviors can be thought of as a form of “voluntary withdrawal.”

will most likely persist in completing their college degree program as long as they are able to integrate into the academic and social traditions of the institution. This integration requires students to remove themselves from their old communities and then transition toward the norms of the new community (i.e., the institutional norms).

Tinto's model (1993), however, failed to consider diverse populations and the perspectives of minoritized groups (Winkle-Wagner, 2009) and suggested that these students must learn to assimilate into the majority culture as a prerequisite for success (Tierney, 1992). As Winkle-Wagner (2009) argued:

> The academic and social integration model suggests an underlying assumption that a *student* must integrate into the institution rather than challenging *institutions* to adapt to the needs of new populations of students. To bring new populations of students to the proverbial table of higher education in meaningful ways and to continue to retain students from underrepresented groups, institutions and the people that serve in them must be willing to re-imagine what it means to provide an 'inclusive' environment. This argument is crucial to a deeper understanding of issues of access, retention, and student success in higher education. (pp. 9-10)

Other models, such as the institutional departure model (1993), the student involvement theory (1984), and the student retention integrated model (1993), considered other factors such as faculty-student relationships and environment but were still limited in understanding students of minoritized groups or other non-traditional students.

The STEM Climate

In exploring the reasons that students would be deterred from pursuing a STEM degree, Redmond-Sanogo and colleagues (2016) found that obstacles, such as "uninspiring introductory courses, lack of adequate preparation in the area of mathematics, and an academically or culturally uninviting environment to underrepresented populations" (p. 378), continue to be a concern, especially for women and minoritized students. Mathematics courses, for example, are ranked as the most difficult courses for students to take (especially when compared to the arts, humanities, or consumer sciences) (Whalen & Shelley, 2010). Initially, it was thought that if students could get through the gatekeeper courses (such as calculus, physics, and chemistry), then students would more likely graduate with a STEM degree regardless of gender (Redmond-Sanogo et al., 2016). Yet, upper-level mathematics courses continue to be dominated by White and Asian male students—highlighting that the underrepresentation of women and minoritized students continues to be an ongoing problem (Holm & Saxe, 2016). For instance, "women are almost twice as likely as men to choose not to continue beyond Calculus I, even when Calculus II is a requirement for their intended major" (Holm & Saxe, 2016, p. 631).

Taking courses however does not guarantee students will continue to pursue STEM despite their opportunities and success in previous coursework. The perception and experiences of those who pursue STEM are affected by institutional norms (Parson & Ozaki, 2017). In particular, campus climate and environmental factors have been shown to negatively affect students' persistence to stay in STEM. In that, "impersonal professors, competitive environments, and 'weed-out' courses are often accepted teaching practices in the STEM classroom" (Parson, 2018, p. 19). Moreover, "women in STEM also face stereotypes regarding appearances and behavior," (Blackburn, 2017, p. 244) worrying they might appear too feminine. In response to this stereotype, they may choose to downplay their gender within the STEM environment, feel pressure to "conform to masculine norms," and work harder to show they are just as capable as men (Blackburn, 2017). The chilly climate[41] within STEM has created a disconnect between enrollment and persistence of women (Vogt et al., 2007) and women who initially start in STEM are often pushed out of the field before graduating.

Espinosa (2011) studied the effects of precollege characteristics, college experiences, and institutional settings of both women of color and their White peers and investigated how their pathways might differ and affect their persistence in pursuing a STEM degree. As a result of her study, a conceptual model is presented in Figure 1 to describe why women of color continue to persist in STEM despite these barriers.

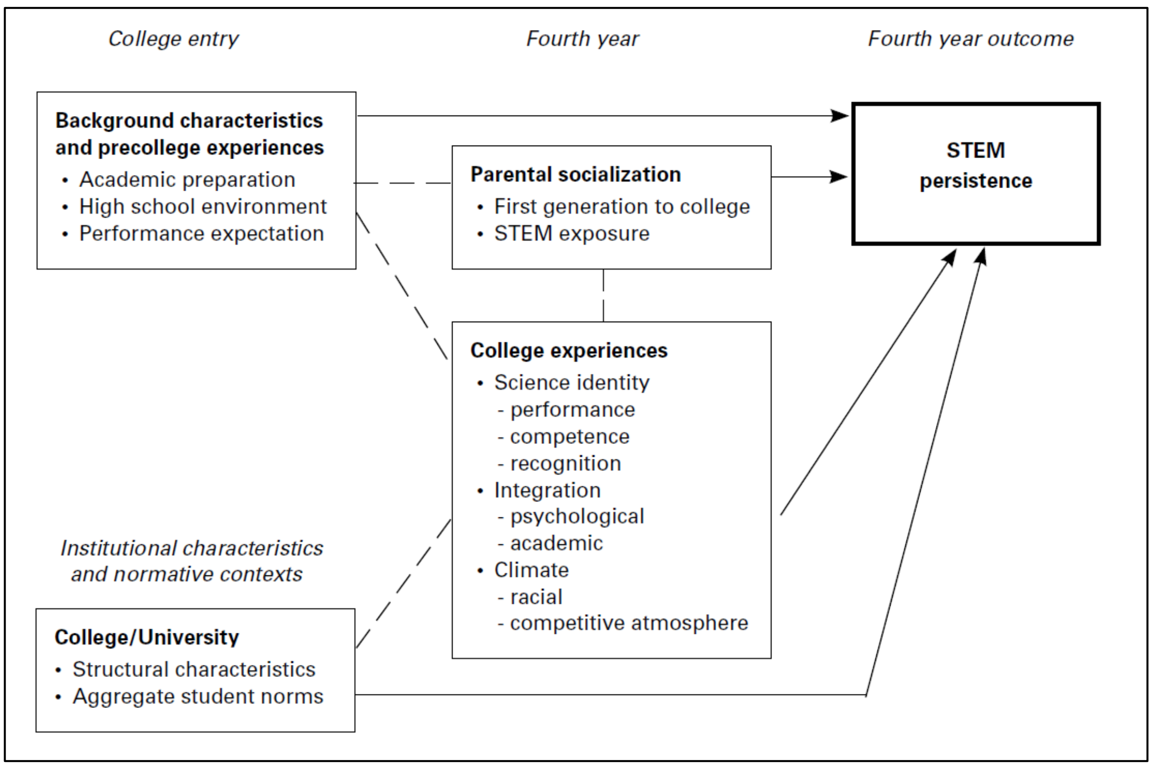

Figure 1: Conceptual model of factors that influence women's persistence in STEM.

Note. Factors that influence women's persistence in STEM. Reprinted from "Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence," by L. Espinosa, 2011, *Harvard Educational Review, 81*, p. 216.

[41] A "chilly climate" within STEM are male-normed classrooms, where the general characteristics are typically competitive and are hierarchically structured, and are seen as "customary, even respectable, teaching practices in traditional research university science, mathematics, and engineering classrooms" (Vogt et. al, 2007, p. 339). These classrooms have been seen to cause self-doubt in women, which have resulted in women leaving STEM.

Factors that seemed to influence whether women of color continued to pursue a STEM degree included: finding satisfaction in their institution's mathematics and science curriculum; a satisfaction of the relevancy of coursework; engaging in peer discussions with other women outside the classroom (creating interpersonal relationships); and having a STEM peer group of women (Espinosa, 2011). Espinosa's findings indicate that "women of color who actively engage in the academic community and who exhibit behaviors and participate in activities that make STEM an accessible career path ultimately persist in STEM through their fourth year of college" (p. 230). There were also indications that the type of institution these women attended affected whether they continued to persist. Women who attended highly selective college and universities were more likely to switch out of STEM, suggesting that these colleges are not as supportive of women in STEM. Although her study confirmed that the level of engagement of women at their institution helped these women persist in STEM, it is still unclear how the institution cultivated this engagement or how women navigated the institutional norms to be successful.[42]

What Does Success Look Like in STEM?

Research has shown that "a college education is considered the key to achieving economic success and social mobility in American society" (Engle, 2007, p. 25). For students to become successful in life outside of college, many students will need at least a 4-year degree. Yet, to obtain success at the college-level can be difficult, especially within STEM.

[42] Espinosa (2011) recognized and stated that a limitation of her study (i.e., how the institution played a role or how the women engaged in these behaviors) would be better addressed with a qualitative or mixed-methods study. Her findings, however, showed that those who were successful in STEM "frequently engaged with peers outside the classroom to discuss course content, joined STEM-related clubs and organizations, and participated in undergraduate research programs" (p. 230). Thus, engagement within the institution seemed to influence the women's overall success.

Students are often categorized and labeled before they step into a college classroom. Initial placement in a mathematics course is based on prior performance or results from placement exams,[43] which are deemed appropriate to assess students' content knowledge. The goal of these placement exams is to determine whether students will be successful in a particular mathematics course and is key to their success in college (Medhanie et al., 2012). Students who enroll in a course they are not prepared to take will most likely not do well and will need to take the course again.

Placement exams, therefore, have a tremendous effect on the types of mathematics courses students can take their first year of college and the number of courses that are required by their degree plan. In particular, those students who do not do well on these exams are often placed in developmental or remedial courses, which "has the effect of requiring those students to pay for noncredit courses and extend the number of courses required toward acquiring a degree" (Medhanie et al., 2012, p. 333). Placement policies not only determine which mathematics courses students can take but also lead to negative labels for students (i.e., labeled as "behind") (Parson, 2018). Students' perceptions of these labels can affect their decisions to stay in STEM and create challenges for students who want to graduate in four years.[44]

Success in higher education is also more complex in that the cultural norms of success differ across disciplines. STEM expectations often conflict with the expectations at the

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[43] Colleges often use several pieces of information to determine where to place students, such as high school GPA/percentile rank or nationally standardized achievement tests (ACT/SAT). A majority of institutions, however, also use placement exams, whether locally produced or developed by an outside agency (Medhanie et al., 2012). Most often the ACCUPLACER exam (a nationally standardized placement test) is used to determine which mathematics course students can take their first year in college.

[44] Categorizing individuals and using language to describe students can have negative consequences on students. Labeling students as behind or off-track sends a message that they do not measure up to the ideal characteristics of a typical STEM student and could increase the likelihood of students changing their majors to avoid such labels (Parson, 2018).

institution (Parson, 2018). GPA, for instance, is often an indicator of success. Students with a high GPA are rewarded with scholarships and are expected to maintain their GPA—reinforcing to students the importance of grades as measures of success. But within STEM maintaining a high grade can be difficult. Parson (2018) found when interviewing both students and faculty around the issue of grades that failure is often common within STEM (and expected). While the institution may stress the importance of maintaining a good GPA (and often determines whether students receive scholarships), grades within STEM were not held to the same standards. Earning a B within STEM was viewed as a high grade but is still not high enough for students to maintain their scholarships. Thus, within higher education, students who are viewed as being successful in STEM often means that they are prepared and take rigorous mathematics courses (such as Calculus within their first semester of college) and can maintain good grades (minimum of Bs in STEM courses).

Achievement as Resistance

Despite the barriers that seem to work against students of color and students whose first language is not English, there have been several students who have been successful in mathematics. With so much emphasis on the achievement gap and students' "lack of success," students who have been successful are considered anomalies (de Araujo et al., 2016). As Hilliard (1995) stated,

> Rarely do we hear of success in producing achievement for African American, Native American, and Hispanic students. When we do hear of such achievement, it is trumpeted as a miracle, as the exception that proves the rule, as the work that can only be done by teachers who have a special charisma, as outliers that have to be regarded as statistical errors or mere accidents. (p. 102)

To understand the "exception to the rule," many researchers have begun to study the success of minoritized students and how they have continued to persist in a climate that is often against them. Gándara (1982) investigated the backgrounds of a group of Mexican American women who successfully completed M.D., J.D., and Ph.D. degrees even though they were not expected to graduate high school. She concluded that Chicanas "tended to credit their own inner strength and abilities for the educational successes [and] most often attributed their accomplishments to the support of their families" (p. 177). The mothers of her participants, for example, wanted their daughters to be economically independent and had either been "equally as or more influential than their fathers on their educational aspirations" (p. 171). Family was emotionally supportive in their endeavors but also instilled a sense of responsibility and inner strength in their children.

Another component Gándara (1982) attributed to their success was the ability for her participants to move between Mexican American and Anglo[45] worlds, which was most likely due to their earlier school experiences. Almost three-quarters of the women attended high schools highly integrated (at least 50% Anglo or virtually all Anglo) and reported that the experiences they had in this previous environment "gave them the confidence to continue their studies beyond high school" (p. 174). She contributed their success to parents who were emotionally supportive, experiencing a "considerable amount" of integration with Anglo culture, and previous success as being "good or outstanding students" (p. 177).

While Gándara (1982) highlighted some of the potential factors that have contributed to her participants' success in education, she also highlighted the need for children of color having to become bicultural to obtain that success. According to Pine and Hilliard (1990), "for children of color, being bicultural is not a free choice but a prerequisite for success in the education

[45] Gándara (1982) uses the term "Anglo" to refer to a White American from non-Hispanic descent.

system and for eventual success in the society at large" (p. 4). Because students of color are generally measured against the performance of their White peers, that often requires that they must understand and learn the cultural ways of their White peers so as to compete with them. At the same time, though, students of color try to maintain their own culture and heritage.

The attempts to become bicultural have also been made by Asian American students, the model minority. When asked about their experiences going to a college that is predominantly White, Osajima (1993) found that many Asian Americans continue to experience racism, questioned their identities, and worried about how they were being perceived/judged. They were aware of their racial differences and worried about possible negative consequences. Their racial subjectivity, according to Osajima, "was constructed in relation to what they believed was good about being 'American' or white, and what they saw as bad about being Asian" (p. 86). These perceptions led to two "hidden injuries"[46]: (a) they wanted to be White or American or (b) they would distance themselves from the stereotypical images of Asians. Thus, many students took steps to ensure that they would not be viewed as "too nerdy" or "too Asian" and would assimilate into the dominant White culture (Osajima, 1993). Blending into the mainstream cultures was considered as one way to ignore discrimination and stay under the radar in order to achieve success.

While some students choose to assimilate or blend in with the dominant culture, "some students of color can successfully negotiate primary and dominant cultural codes in school in order to acquire academic success while also affirming and maintaining strong pride in their racial and ethnic heritages within the school context" (Carter, 2008, p. 469). Students'

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[46] Richard Sennett and Jonathan Cobb (1972) use the term "hidden injuries" to "characterize the complex and contradictory ways class relations in America affect people" (Osajima, 1993, p. 84). Osajima examined the hidden injuries of race that were experienced by Asian American students in his study.

understanding and knowledge of their limited opportunities in schools does not limit or discourage them in achieving their goals (Carter, 2008). Carter claimed that some students often "resist and defy these ideas by embracing the notion that school achievement is a raceless human trait that can be pursued by individuals of any racial or ethnic group" (p. 470). Yet, how students choose to respond to discourses varies.

Opportunities for Success in Higher Education

How do educators convince students to pursue mathematics or STEM when the narrative that is created has already deemed it too difficult for them to pursue? Fortunately, despite the grand narrative of who can and cannot do mathematics, institutions can play a role in motivating students to learn mathematics and pursue STEM degrees. Studies have shown, for example, how students' experiences in mathematics classrooms can help develop mathematics identities and beliefs, which can influence mathematics achievement (Boaler, 1998; Eccles, 2009). More specifically, quality of experience in the mathematics classroom was significantly correlated with grades and the number of ELLs in STEM fields is significantly low in comparison to their White counterparts (Gutiérrez, 2008).

Within higher education, there have been some success in increasing the number of high-achieving mathematics students from racial and ethnic minoritized groups through the Emerging Scholars Program (ESP)[47] (Hsu et al., 2008). Although the implementation of ESP varies according to the local context of institutions, ESP has used different combinations of strategies in addressing the needs and goals of students. Focusing on honors-level mathematics, ESP takes

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[47] ESP was designed in the 1970s in response to an ethnographic study done that compared the study habits of black and Chinese students (Hsu et al., 2008). In the study, researchers noticed that Chinese students tended to work together in support groups and often excelled in their Calculus courses while black students tended to study in isolation. ESP, originally known as the Professional Development Program Mathematics Workshop at the University of California at Berkeley, started as a workshop program that attributes their success to "having students seeing other students from a wide range of ethnicities struggling and then succeeding with the same mathematics" (p. 214).

calculus students from diverse backgrounds and places them in workshop courses—courses where students work on challenging mathematics in collaborative ways. In general, these workshops are small (12–20 students), meet for longer blocks of time (75–120 minutes), and occur 2–3 times a week (Hsu et al., 2008). Emphasizing excellence (as opposed to non-failure), the mathematics work "pull ideas together from across multiple chapters, fill in gaps in student preparation without resorting to remediation, and are challenging enough to incite student collaboration and to teach students to persevere" (p. 207). The model of ESP challenges students by having them work on higher-level mathematics while also making the university environment more welcoming, both socially and academically.

While there has been success in encouraging more students to pursue higher-level mathematics, however, the focus of the program is on students who have already gotten to calculus. Many students do not take calculus their first semester and thus, the ESP model eliminates many students who might want to pursue a STEM degree but who do not or did not have the support to do it. Nevertheless, the ESP model does illustrate that there are ways to support and challenge students at the same time, with certain institutional services that can effectively foster success for all STEM students. The ESP program also highlighted how an ethnographic study, which looked at how students worked through mathematics and studied for their calculus courses, shaped a response that provided support and challenges for students who needed it. Thus, starting with the perspectives of the groups who have been deemed as "unsuccessful" in STEM should provide a starting point in how educators in higher education might provide resources, support, and challenges in students' learning.

Concluding Thoughts

Although many changes have been implemented in K–16 to address the inequities that can be seen in educational outcomes (such as standardized testing) in school, many of the discourses highlighted in this chapter continue to influence students' educational experiences. For instance, despite the dramatic increase of the number of women in STEM majors in universities and colleges across the nation, the overall representation of women in STEM does not match the increase of the number of women seen at the college level pursuing a STEM degree; "women and minorities comprise 70% of college students but less than 45% of STEM degrees" (Blackburn, 2017, p. 236). So, although work has been done to encourage women to pursue a STEM degree, it has not been enough to stop or slow down the "leaky pipeline" and keep women in STEM fields once they graduate. Persistence for women in STEM programs relies heavily on several factors, both at the micro and macro levels (Blackburn, 2017). Despite the strides made toward gender equality, it is clear from a review of the literature of women's lived experiences, that they still experience stereotypes, biases, and chilly campus cultures (Blackburn, 2017). These experiences appear to be significant factors in their willingness to continue to pursue STEM.

Deficit views can encourage a perspective that devalues or fails to recognize knowledge and skills both women and ELLs possess (Civil, 2007; Moll et al., 1992). By providing this brief review of the literature, I have shown that deficit thinking has permeated all levels of education and has affected the ways in which minoritized students, including students whose first language is not English, continue to be affected by these perceived notions. Although educators and policymakers may have good intentions in wanting to educate all students, actions taken within all levels of education can reinforce deficit-oriented views and embrace the "achievement gap" ideology (Gutiérrez, 2008; Martin, 2013). Not only do these views encourage the thinking about these students as inferior or having deficits, but it also encourages society to make comparisons between groups in their attempts to "close the gap" (Gutiérrez, 2008). Moving beyond deficit thinking means considering the potential strengths of students of color and troubling the idea of what success looks like[48] (and how/if we measure it).[49]

In an attempt to understand how students whose first language is not English define success, I hope to broaden our understanding of how language is used and how we continue to use language to define and group people. Language produces meanings and positions people in relations to power (Stinson & Walshaw, 2017). For instance, students who do not meet the institutional academic standards are often labeled as having "academic deficiencies" and are placed in remedial courses. These actions can have detrimental effects on how students view themselves as well as "how students are treated throughout the institution" (Parson, 2018, p. 31). Math placement policies often lead to negative labels for students in higher education and increases "their likelihood to change majors to avoid those labels" (p. 31).

To move beyond deficit thinking requires "a substantive shift in our underlying structural and ideological paradigms, as it relates to the academic excellence of students of color" (Lemons-Smith, 2008, p. 909). To accomplish such a task, academic success cannot be viewed primarily as a "white character trait" (Carter, 2008, p. 472)—it must be broadened to include the cultural and lived experiences of all students and build upon students' strengths (Lemons-Smith, 2008).

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[48] By analyzing the narratives of my participants and hearing how they define and understand success, I can contribute to the development of a critical lens of how language, just as other constructs such as race and gender, can affect students' perceptions of success and themselves. Hearing their experiences can expose how stereotypes of their affiliation group and language feed into deficit thinking and highlight other ways of thinking about success that can help restructure the ways success is defined.

[49] I am still troubled by the idea of "measuring" success—that is, is success really quantifiable?

Moreover, listening and learning about students' strengths can assist in documenting how women whose first language is not English have been able to navigate a system that too often works against them (Yosso, 2005). In particular, studying women whose first language is not English and who continue to persist at the undergraduate level, is critical to "understanding and replicating in practice those experiences and interventions that contribute to their persistence in STEM majors and scientific careers" (Espinosa, 2011, p. 210). It is important to understand how students think about their own achievement while existing in a society that continues to view them in a deficit way. Analyzing the narratives of "others" who have been successful in STEM can offer new perspectives of what mathematics success can look like.

CHAPTER 3

THEORETICAL PERSPECTIVE

In this chapter, I outline my current philosophical and epistemological understandings on mathematics teaching and learning and how they have changed throughout my doctoral journey (and will continue to change). I then discuss how these understandings influence my thinking and discuss the theories that frame my study by describing the major tenets of postmodernism, feminism, and intersectionality. Next, I provide a rationale for why these theoretical frameworks are necessary for this study, by offering how each theory has informed me in my work and will continue to shape how I conduct research.

My Theoretical Positioning

Growing up I always thought mathematics was finding that definitive "truth." It was the one subject in school where I could easily tell if my answer was "right," and it felt good knowing I could achieve the correct answer without there being any ambiguity. Mathematics was stable and a constant in my life that I didn't think would ever change. Yet, over time, I have learned that mathematics is so much more than obtaining the "correct"[50] answer.

When I was an undergraduate student at Boston University, I had no idea what I wanted to do with my life—having changed my major four times! I went to school determined to be a pediatrician, but after spending time in a hospital during my senior year of high school,[51] I realized I did not want to pursue that path any longer. During my sophomore year, I took a course with Dr. Carol Findell, a mathematics educator who has established her career in the

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[50] I now understand that "correctness" is defined by others who decide which mathematics is correct (not if it actually is).

[51] I participated in the Boards of Cooperative Educational Services (BOCES) program in New York where I spent half the day in a nearby hospital observing and learning about medical practices.

teaching and learning of mathematics with a focus on the elementary education curriculum. In that class, Dr. Findell required us to think deeply about mathematics and examine how others understand and do mathematics. On the first day of class, for example, she asked us to reduce the fraction $\frac{16}{64}$. Many of us completed the task quickly and eagerly told her the answer is $\frac{1}{4}$. When she asked us how we got the answer, she listened patiently as we spoke about how we reduced the fraction by pulling out the common factors. She then proceeded to tell us that an elementary school student she worked with found a much faster method by "canceling out the 6s" and wrote it on the board:

$$\frac{1\cancel{6}}{\cancel{6}4} = \frac{1}{4}$$

Although many of us laughed initially, Dr. Findell insisted we give a reason as to why that method doesn't work. What could you say to a child who had used this method in solving the problem? What rationale could you give to show that that method could not work all the time? These questions sparked an interest in me because now I had to explain why something works (or in this case, why this method does not[52]). It was the first time I had to question my content knowledge and how I would communicate that to my future students.

Since then, I have tried to learn more about how others think and do mathematics and how it may or may not align with my understanding of it. These thoughts and motivations propelled me to start teaching at a nearby school in Boston and then continue with higher education by earning a master's degree in mathematics education and then later, enrolling in a PhD degree program in mathematics education at Georgia State University (GSU). But while I

[52] Some people may actually argue that this method did work as it did help the student obtain the right answer. But if the goal is to help students understand how to reduce fractions and not about just obtaining the right answer, then this method fails to explain how canceling out the 6s is not a logical method to reduce the fraction.

was being questioned about how people think and do mathematics, I was never pushed to think about what knowledge is or how people obtain it until I became a student at GSU. Throughout the degree program, I have taken courses that have pushed my thinking about my own ways of knowing and how that affects everything I do. To understand the nature and philosophy of mathematics, I first had to understand the various ways in which people think about reality and truth. Prior to coming to graduate school, I viewed reality as fixed and the way in which we know about reality is dependent upon facts and our interactions with those facts. This belief aligned well with my understanding of mathematics—every problem had one answer and that answer was often verified by the number of people who would obtain the same answer. Part of my success (or at least how I perceived it) relied on the notion that I was able to get the same answer (or come to the same conclusion) as everyone else.

As I continued to take courses that challenged my ways of thinking, however, I began to see that the way I thought about mathematics and the learning of mathematics conflicted with my initial views of reality. In my early educational career, I viewed mathematics as reflecting a reality that existed independently of me but could not articulate how the mathematics that I knew was really a "true" representation. I began to see that mathematics is not simply an object that can be found or even that all mathematics knowledge is certain (Ernest, 2009a).

Objectivism vs. Constructionism

Historically, mathematicians held onto objectivism as their primary epistemological perspective (Crotty, 1998). According to this view, "things exist as meaningful entities independently of consciousness and experience, that they have truth and meaning residing in them as objects" (p. 5). As a discipline, mathematics provides certainty for many; always providing the “one” correct answer or truth. Knowing that a person could obtain the same truth as another validated for many their understanding of the content.

Mathematics education researchers, however, recognize that experiences—both inside and outside the mathematics classroom—can affect how people come to know and learn mathematics (Civil, 2014). But despite this research, many students continue to speak about mathematics as a “cold rationality” and often focus on the “importance of using ‘the right’ method” or “about following rules” (Bibby, 2010, p. 28). Rather than seeing mathematics as something created and shaped by humans through their interactions, logical reasoning, and historical and social practices (Crotty, 1998; Ernest, 2009a), many students continue to view mathematics as an object that exists outside the human mind.

Unlike objectivism, constructionism claims that “meanings are constructed by human beings as they engage with the world they are interpreting” (Crotty, 1998, p. 43). In this view, an individual’s knowledge and meanings are constructed and influenced by the interactions within the discourses that surround them. Many factors affect how one can learn and understand mathematics and the interplay between these factors is how the human mind constructs mathematics knowledge.

The idea of what counts as mathematics knowledge has been one of the most fundamental debates among mathematicians and mathematics educators in the field (Ernest, 1999). How one comes to know what they know and how knowledge can be verified is based on the philosophical standings of the researcher. For example, for radical constructivists,[53] knowledge resides in people’s heads and knowers (or those who think) constructs what they

[53] Radical constructivism in mathematics is derived from Von Glasersfeld’s interpretation of Piaget’s constructivist theory of knowing. Knowing is an active process and the individual plays an active role in knowledge construction. The mind is constantly adapting and reorganizing every moment that the individual experiences a phenomenon in the world.

know based on their life experiences. The experiences that the individual has in the world is what makes the type of knowledge that is constructed within the mind of the individual. And those who make this claim also claim that there is no way to refute it because individuals can only know what they know based on the experiences they have.

Social constructivists, however, focuses on the collaborative nature of learning (i.e., like a connected network between the self and others). Knowledge is not just dependent upon the role of an individual mind but also is considered within a broader context in relation to others. The mind, according to Belbase (2011), "constitutes social entity which creates meaning through conversation, dialogue, interaction, and social exchanges of ideas" (p. 3). Knowledge is actively constructed by the individual who also participates in social relations with others. When experiences of the individuals are shared, they become social and collective experiences, which are then retained as knowledge.

Mathematics knowledge, similarly, cannot exist in a vacuum. As individuals come from multiple cultures and societies, these differences can account for multiple interpretations. As individuals encounter different phenomena in the world, they make sense of them by following those who share the same culture (Crotty, 1998). Through conversations, mathematics is then constructed out of shared experiences of individuals, either from society and/or culture and from the physical world (Belbase, 2011).

The Effect of Theory on My Thinking

I now believe mathematics is socially constructed—"through its development located in various specific historical, geographical, cultural, and social contexts" (Ernest, 2009a, p. 55) — and can have tremendous influence on who has access to mathematics success in schools. The narratives that surround mathematics, however, often perceive it to be "a highly democratic rational discipline in which knowledge is accepted or rejected on the basis of logic, not authority" (Ernest, 2009a, p. 59). But by acknowledging the social, cultural, and historical context, mathematics (and who has the opportunity to learn mathematics) is not based solely on logic. Power relationships play a major role in how mathematics is perceived and who has access to it. According to Gutiérrez (2013), power is related to two main constructs in mathematics: (1) "the power of mathematics" (as a discipline) and (2) the "power associated with *being successful in mathematics*" (p. 46). The first construct relates to the idea that mathematics, as a discipline, is known to be the "ultimate arbiter of truth" (p. 47). The certainty and the evidence have given people ways in which to model real-world phenomena and have put the discipline in a privileged position (Gutiérrez, 2013).[54]

Given that mathematics, as a discipline, is a powerful entity, those who can and practice mathematics are seen as valued, high-status people in society. The ability myth, prevalent in the United States, has people believe that some are "just good" at mathematics while others are not (Gutiérrez, 2013). Schooling tends to perpetuate this discourse by tracking students into particular courses based on the perceived ability of students' mathematics knowledge (Gutiérrez, 2013). Entering discourses with other students and faculty however has allowed me to understand that, just like other forms of knowledge, mathematics has been kept from certain populations.

Women, for example, have often been excluded and historically have not been allowed to participate in the mathematics community (Walls, 2009). Understanding this placement helps explain why "achievement gaps" (such as gender and minoritized groups) exist in mathematics

[54] Due to its rational and logical nature, many people would argue that proposals without data, for example, can be easily dismissed within the realms of politics, education, and so on. To show or prove that a reality exists within this realm, sufficient data or facts are often required to back up such claims (Gutiérrez, 2013).

education (Gutiérrez, 2013). As an educator who is concerned about the welfare and success of students (and who also happens to be a woman whose first language was not English), I now understand the responsibility and role educators have in educating students on mathematics content as well as how to navigate the educational system (Ernest, 2009a). Despite the myth of meritocracy[55] that continues to prevail in education, students must be aware of their structural surroundings and how those influence their success (or lack thereof).

Theory and Mapping Moments of Mathematics Education

In reflecting upon my own theoretical positioning, I began by pondering Stinson and Walshaw's (2017) adapted table of mapping moments of mathematics education research onto paradigms of inquiry (see Table 1). Here, Stinson and Walshaw (2017) outlined different theoretical framings and how they have contributed to key historical moments or shifts in mathematics education research.[56]

Stinson and Walshaw (2017) highlighted the progression of theory in mathematics education research beginning with a brief historical timeline and an overview of the different theories used and applied, illustrating where some of these theories began and how they have evolved over time. Four paradigms of inquiry (predict, understand, emancipate, and deconstruct) are categorized based on "defining moments" in mathematics education. Theories new to mathematics education research and how they have contributed to the field are highlighted: critical, poststructural, critical race, and feminism.

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[55] Carter (2008) stated that meritocracy is the belief that one's social mobility is dependent upon individual effort—and that when students fail, it is a consequence of their individual merit. The myth of meritocracy, however, fails to consider the structural conditions (i.e., racism, classism, etc.) that can also prohibit or constrain students' ability to perform or succeed.

[56] Although portrayed in a linear fashion, Stinson and Walshaw (2017) noted that the moments did not necessarily occur in this way. Table 1 is just one representation to highlight how paradigms of inquiry have influenced the possibilities and impossibilities of mathematics education research.

Table 2
Mapping Moments of Mathematics Education Research to Paradigms of Inquiry

- Process–Product Moment (1970s–)→***Predict***
- Interpretivist–Constructivist Moment (1980s–)→***Understand***
- Social-turn Moment (mid 1980s–)→***Understand*** (albeit, contextualized understanding) or ***Emancipate*** (or oscillate between the two)
- Sociopolitical-turn Moment (2000s–)→***Emancipate*** or ***Deconstruct*** (or oscillate between the two)

Paradigms of Inquiry

Predict	***Understand***	***Emancipate***		***Deconstruct***
*Positivist	*Interpretivist	*Critical	*BREAK*	*Poststructural/
Experimental	Social constructivist	<Feminist>		Postmodern
Quasi-experimental	Radical constructivist	Critical Race Theory>		Postcritical
Mixed methods>	Sociocultural>	Latino/a Critical Race		Postcolonial
	Phenomenological	Theory>		Posthumanist
	Ethnographic	Critical Theories of Race>		Post-Freudian
	Symbolic Interaction	<Participatory Action		<Discourse
		Research		Analysis
		Critical Ethnography		

Note. *Indicates the term most commonly used; < or > indicates cross-paradigm movement. The BREAK in the original Lather and St. Pierre table indicated a shift from the Enlightenment humanist paradigms on the left to the post-Enlightenment, posthumanist paradigm on the right. Here it indicates a hybrid, in-between space where the researcher might adopt a critical postmodern theoretical tradition (see Stinson & Bullock, 2012, 2015).

Paradigms of inquiry adapted from table by P. A. Lather and B. St. Pierre, 2005, found in "Paradigm Proliferation as a Good Thing to Think With: Teaching Research in Education as a Wild Profusion," by P. A. Lather, 2006, *International Journal of Qualitative Studies in Education, 19*(1), p. 37.

Note. Reprinted from "Exploring Different Theoretical Frontiers for Different (and Uncertain) Possibilities in Mathematics Education Research," by D. W. Stinson and M. A. Walshaw (2017), *Compendium for Research in Mathematics Education,* (p. 133). National Council of Teachers of Mathematics.

As a student in Professor Stinson's postmodernism class, I was asked to place myself theoretically somewhere on Table 1. I responded to "the break" —the space between the emancipate and deconstruct paradigms of inquiry and part of the sociopolitical-turn moment. Although my thinking began to shift in undergraduate education, I focused primarily on how others learn and do mathematics as if they were in a vacuum. The sociopolitical-turn moment, however, moves beyond the classroom walls and "recognize(s) knowledge, power, and identity as interwoven and constituted in and through sociocultural and sociopolitical discourses"

(Stinson & Walshaw, 2017, p. 134). As a woman whose first language was not English, I have come to learn that my success in mathematics has many contributing factors, some of which encouraged me to conform or assimilate to the dominant culture. For example, learning how to speak English “well”[57] has not only been beneficial to me but also has forced me to be cognizant of “sounding White.” The more I sounded like I belonged in the dominant culture, one in which many people speak English, the more I was perceived in a positive light. While I chose the path to continue my education within the realm of mathematics and it has been beneficial to me in many ways, assimilating to the dominant culture also took some parts of me away. One such piece is my native language.[58]

My experiences, along with my education, have helped me recognize my place in this world, how I have adapted, and how I intend to address the inequities I see. Stinson and Walshaw (2017) described researchers whose work might be characterized as being in the sociopolitical-turn moment as “adopt[ing] a degree of social consciousness and responsibility in their attempts to both understand and expose the wider social and political picture of mathematics and mathematics teaching and learning” (p. 134). Now that I have begun to see how factors, such as gender, language, race, and other social/political factors might affect the learning and teaching of mathematics, inaction is no longer an option. Aligning with the ideas of postmodernist and feminist research, I explored concepts of who has access to mathematics and

[57] Those who speak “well” are usually those who speak English without an accent or who can assimilate into the English-speaking culture with ease.

[58] Many people have asked me why I have not learned Korean. As an adult, I am aware that I can take courses and learn the language, but my insecurities always seem to get in the way. I attempted to in college—even enrolling in two college-level courses to learn Korean. But my insecurities of not knowing myself (am I Korean or not?) and sensitivities to being “wrong” pushed me into thinking I “am not a language person.” Since then, I have grown more secure with who I am and do intend to learn the language (a goal once the PhD is done).

what counts as legitimate mathematics knowledge (given it is "democratic nature") and to critically think about and question the current structures of mathematics.

Postmodernism

Postmodernism[59] developed in the mid-twentieth century, as a rejection to modernism, which rests on the idea that absolute truth can be founded on rationality (Usher & Edwards, 1994). Jean-François Lyotard (1924–1998), one of the major theorists of postmodernism, defined "postmodern as incredulity towards metanarratives"[60] (Lyotard, 1984, p. xxiv), and questioned the nature of scientific knowledge and how those who take part within that community have come to legitimatize it in other words, demanding "radical reflection on our interpretative frames" (Lather, 1991, p. 13). For instance, with any scientific discovery, a scientist must prove that a discovery is true by providing evidence (assuming that a reality can be known based on logical reasoning). Lyotard (1984) argued, however, that a "proof" is only considered a proof because it fits within the metanarrative that has already been established within the scientific community (i.e., how one can prove something without having to prove that the proof is also true). From this perspective, knowledge then is a social construction because it is through the shared culture that people can legitimize it (Ernest, 2004).

Lyotard (1984) critiqued the discourse of modernity and the claim to a "universal truth." Rather than a universal, objective truth, he reconceptualized truth as being bounded within these metanarratives, which are constrained by the participants in it and the language used. Within the

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[59] Postmodernism (or postmodern theory) is often used interchangeably with poststructural theory. Although Lather (1991) does make a distinction between the two, stating that sometimes she uses "*postmodern* to mean the larger cultural shifts of a post-industrial, post-colonial era and *poststructural* to mean the working out of those shifts within the arenas of academic theory" (p. 4), she also stated that she uses the terms interchangeably. Here, I use the term postmodern, but acknowledge and believe that the two terms can be used interchangeably.

[60] Bertens and Natoli (2002) defined metanarrative as "the supposedly transcendent and universal truths that serve to justify and legitimate modern Western culture" (p. 246).

scientific community, for instance, there exists a narrative and participants take part in the language games[61] within that narrative. This game also occurs within other domains, such as mathematics, science, art, and so on, where knowledge is legitimized based on the narratives in which participants engage. Additionally, due to the participants constantly learning and adapting to the metanarrative in which they engage, Lyotard questioned how knowledge can be transmitted in shaping society as a whole when the system is ever-changing.

Structure and Language

Just as Lyotard (1984) questioned the legitimization of knowledge and the structure of metanarratives, Jacques Derrida (1930–2004), a French philosopher known as the founder of "deconstruction,"[62] also participated in criticizing the hierarchal construction of knowledge and the individual elements of language and cultures embedded within structures.[63] Derrida (2007) did not perceive the overlying societal structures as being stable, explaining that all structures have a center that gives the structure its "structurality." These centers, the crucial part of any structure, are what makes the structure hold its shape and keep all the parts together. But the center limits the movement (what Derrida refers to as the "play") of the elements within those structures and is not a part of the structure itself. For example, many would believe that God created the world and rules it, but He is not actually a part of the world.

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[61] Lyotard's (1984) use of language games is derived from Ludwig Wittgenstein. In his theory of language games, he proposed that a word or a sentence has meaning as a result of the "rule" of the "game" that is being played within discourse. "Mastering" the language then, according to Arsith (2011), "is to be able to use expressions in different language games to which they belong" (p. 15). For instance, through our social discourse (i.e., language games), we behave differently depending on who we talk to or what we are talking about (thus, highly dependent on context).

[62] Deconstruction is a form of philosophical and literary analysis that questions the meanings and interpretations of words (i.e., distinctions between opposites [binary pairs]). For instance, it disrupts the idea that binaries exist (neatly on their own side) and looks for examples for where something can fit both sides of the binary (Ernest, 2004).

[63] In his work, Derrida (2007) explained that the concept of structure is as old as the "concept of episteme" (i.e., a principal system of understanding, such as scientific knowledge or practical knowledge). Structures are considered constructs, not absolute truths.

Derrida's (2007) ideas of structures and centers led to his concept of deconstruction. In understanding the relationship between text and meaning, Derrida asserted that meaning is not static and is continually evolving because the structure of language is dependent upon the language within the structure. Meaning cannot be derived from some absolute truth; meanings are derived from other words (i.e., not defined in isolation) and interpretation. The goal of deconstruction "is to keep things in process, to disrupt, to keep the system in play, to set up procedures to continuously demystify the realties we create, to fight the tendency for our categories to congeal" (Lather, 1991, p. 13). Derrida coined the term "différance" to explain that the meaning of words can be understood in contrast to other meanings of words. For instance, when describing something as "hot," people will often say "it is not cold" —using the phrase "not cold" to help describe the meaning of "hot." The meaning of a word is dependent upon the meanings of other words (a continuous process Derrida refers to as "deferring") and cannot exist on its own outside the binary. Therefore, "meaning is generated through difference rather than through identity" (St. Pierre, 2000, p. 481). The meaning of the word is never fixed and is constantly changing because people continually interpret the meanings of words. The process of endless interpretation is what create the multiplicity of truths, making it impossible to arrive at one truth (Usher & Edwards, 1994).

Derrida's concept of difference is also used to explain how the meaning of language shifts depending on social context so that meaning can always be disputed. For example, even with the binary, the way in which people define "hot" or "cold" is also dependent upon context (i.e., where they live in the world). Those who live in the northern states, for example, may have a higher tolerance for the cold than those living in the southern states.

Perceiving the world in terms of binaries, however, is problematic to Derrida because binaries often create hierarchies. Derrida argued that words are not simply reflections of the world—rather words used reinforces the hierarchy created by them. Deconstruction aims to analyze the origins and meanings of words and is a process of questioning how they have come to exist. As St. Pierre (2000) noted:

> One of the most significant effects of deconstruction is that it foregrounds the idea that language does not simply point to preexisting things and ideas but rather helps to construct them and, by extension, the world as we know it. In other words, we word the world. The 'way it is' is not 'natural.' We have constructed the world as it is through language and cultural practice, and we can also deconstruct and reconstruct it. (p. 483)

Deconstruction therefore is not intended to break down structures or systems, but rather to understand how such structures have come into existence and to open other possibilities of meaning and other possibilities of constructing (i.e., alternative ways to understand ideas and concepts and alternative ways to construct structures and systems).

Discourse and Power

The way in which language is used is constructed within the discourses and structures people find themselves in—and these structures are often hierarchal and determine who has access to certain discourses or knowledge. Yet not everyone has access to or understands how to participate within those discourses. The language used within the scientific space is "always implicated in cultural practice, always produced *in medias res*" (St. Pierre, 2000, p. 483). Theories of language generally accepted the idea that words reflect reality, as if there is a direct correspondence between the word and the world (St. Pierre, 2000). Derrida (2007), however, with his theory of deconstruction showed that language and meaning are not objective and that to use them to establish objective and impersonal laws is problematic.

Knowledge itself has become a particular kind of power—something people are often in pursuit of and want to hold for themselves. For example, technology has become a large part of society in the last century and has forced people to redefine many elements of the societal structure.[64] Lyotard (1984) questioned how knowledge is defined, how we transmit knowledge through discourse (and who has access to it), and whether stability can ever be reached or maintained. Existing power in societal structures today can change based on who has access to the technology with these data banks and can serve to maintain the status quo (Usher & Edwards, 1994). Additionally, because meaning can never be found,[65] the way in which people communicate and participate through discourse creates the fundamental ways in which people are treated and thought of in society.

Just as Lyotard (1984) was concerned about how knowledge is governed by power, Michel Foucault (1926–1984), another prominent figure of postmodernism, examined the functions of language and its link between power, knowledge, and truth. Foucault (1978) examined the "archeology"[66] or "genealogy" of knowledge production through discourse.[67] His

[64] Technology has changed the way in which language is used in society. For example, the phrase, "google it" is a common phrase now but did not exist 25 years ago. The introduction of technology in society has affected not only the way in which language is used but also who can access information. Google, as one type of technology, offers access to information that was never allowed previously. Given that people and the societies they become a part of change, Lyotard (1984) argued that nothing is permanent and should always be critically analyzed.

[65] As Derrida (2007) shows that meaning is often deferred.

[66] Although Foucault (1972) analyzed the history of discourses or knowledge production, he did not do so in the traditional sense. Rather, he attended to the continuities and discontinuities between different types of knowledge (i.e., how knowledge systems informed the thinking and what constitutes as being permissible during certain points in time).

[67] Discourse, as defined by Foucault (1972), are the ways of constituting knowledge, working together with social practices, subjectivity, and power relations.

theory of discourse "illustrates how language gathers itself together according to socially constructed rules and regularities that allow certain statements to be made and not others" (St. Pierre, 2000, p. 485). When thinking about structures and the way that structures organize how humans behave, power is often considered as something that a person can possess—it can be given away or taken back and is often associated with being evil. Within these analyses of discourses, however, Foucault (1978) argued that there needs to be an understanding of what power is and what it is not—power should not be seen as only a negative thing, one-sided, or necessarily take the form of law: "Power is everywhere; not because it embraces everything, but because it comes from everywhere" (p. 93). Power, according to Foucault, does not belong to an individual or system, but rather exists in the relations between people.

Moreover, people can use power in different ways—playing a major role in how society functions. For example, discourses, such as mental illness, punishment, and sexuality, have been historically produced. In *The History of Sexuality: An Introduction*, Foucault (1978) argued that sex was confined to marriage (between a man and a woman) and any form of sexuality that does not fit within those bounds were prohibited and repressed. In his repressive hypothesis,[68] Foucault examined the history of modern sexuality, questioned why people participated in this discourse, and argued they should liberate themselves from it. The history of modern institutions can help explain how discourses are produced and how discourses should continue to be critically examined. Discourse (and power) can be positive, negative, repressive, or liberating and is determined by each one of us—as we are the subject of discourse but also help create it.

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[68] Foucault (1978) argued that the repressive hypothesis is a widespread idea that modern society continues to struggle with sexuality and sexual repression. In this hypothesis, he stated three doubts that he tried to address: (a) "Is sexual repression truly an established historical fact?" (b) "Do the workings of power, and in particular those mechanisms that are brought into play in societies such as ours, really belong primarily to the category of repression?" and (c) "Did the critical discourse that addresses itself to repression come to act as a roadblock to a power mechanism that had operated unchallenged up to that point, or is it not in fact part of the same historical network as the thing it denounces (and doubtless misrepresents) by calling it 'repression'?" (p. 10).

Thus, discourse is more than just thinking or producing meaning; it also organizes the way people think and how they act in the world (St. Pierre, 2000). As discourses can shape people's thoughts and perceptions, it can also alter their actions to fit into the norms and expectations they perceive to be a part of the discourse.[69] In a sense, "we are all responsible for those structures and the damage they do. We cannot appeal to some absolute authority out there somewhere to justify 'the way things are'" (p. 487). There must be a sense of ownership because people define the discourses in which they find themselves.

Subjectivity and Truth

In attempting to understand how power affects the individual and society, Foucault (1982) theorized that humans are made "subjects" by their relationship with power and power structures in society. According to Foucault, the term "subject" holds two different meanings. The "subject" is the center of experience—which means that the subject can experience, feel, and think. Unlike objects, they are active and possess agency (also called the "self"). The subject, however, is molded by the discourses in which they are a part of (i.e., political power structures). Agency, self-knowledge, or individuality of the subject is determined by power relations with other humans (i.e., laws, church, family, etc.). Thus, power is "created" or manifested through individuals but also determine subjects.

In analyzing the ways in which human beings are "made subjects," Foucault (1982) argued that the subject is in constant flux, negotiating between the inner selves and the discourses of which they are a part of. Knowledge, individuals, and relationships can have multiple meanings and are constantly changing depending on contexts and historical locations (Mohammed et al., 2015). Identities (or "the self") develop through discourses and are "not fixed

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[69] Foucault (1982) argued that one reason why discourses continue to exist is because people continue to "police themselves" based on what they believe the norms and expectations are within the discourses they are a part of.

and structuring sources of information, but are, rather, flexible and temporal attachments of the individual to the discursive practices of which he [she or they] is part" (Stentoft & Valero, 2010, p. 90). As identities emerge, they are fragmented and are dependent upon context and time (Stinson & Walshaw, 2017). Thus, committing to any particular identity over long periods of time is not possible and knowers are not interchangeable spectators. Knowledge is contextual, historical, and discursive (Usher & Edwards, 1994).

Feminism

Feminism, in simplest terms, is an approach to issues of equity and equality based on gender, sexuality, gender identity, and so on. Feminist scholars have argued that "most of our beliefs, perceptions, and scholarship, including most of our scientific methodologies and findings, are dominated by male perspectives or interpreted through masculine eyes" (Fennema, 1996, p. 20). According to this view, the world as we have come to know it is incomplete (and often wrong) as it only represents 50% of the human population (Fennema, 1996). By bringing the focus to women's actions and perceptions, it can add an enriched understanding to the knowledge structures within many different realms. Yet, how feminists approach these issues is dependent upon their epistemological views and standpoints. There are three broad areas of feminist work: feminist empiricism, feminist standpoint theory, and postmodernism feminism. Using postmodernism as a frame for how I understand feminism, I am drawn to elements of both feminist standpoint theory and feminist postmodernism.[70]

[70] Feminist empiricists argue that sexist biases can be eliminated if they stick to the empirical methodological norms of scientific inquiry—that "bad science" is responsible for the inequities we continue to see today (Harding, 1991). From a postmodern perspective, however, I believe that sticking to the norms reinforces biases and prejudices of women because they were formed within those discourses originally (i.e., when men had control). By not acknowledging the origin of the norms (such as the political and historical accounts that helped create that discourse), the discourse around women in science cannot possibly change. Thus, the focus here is on feminist standpoint theory and feminist postmodernism.

Feminist Standpoint Theory

Knowledge can be influenced by a person's race, gender, social class, ethnicity, age, and so on, and is constantly changing; it is produced and reproduced depending on the nature of the context (Ezzy, 2002). In a gender-stratified society, for instance,

> women and men are assigned different kinds of activities in such societies; consequently, they lead lives that have significantly different contours and patterns. Using women's lives as grounds to criticize the dominant knowledge claims, which have been based primarily in the lives of men in the dominant races, classes, and cultures, can decrease the partialities and distortions in the picture of nature and social life provided by the natural and social sciences. (Harding, 1991, p. 121)

The experiences and voices of women provide the grounds for critical inquiry into the nature and social relations within society, taking into consideration the patterns of thought and the historical accounts that have contributed to the norms (Harding, 1991).

Feminist standpoint theorists make the claim that (a) knowledge is socially situated and that human activity "not only structures but sets limits on human understanding: what we do shapes and constrains what we know" (Harding, 1991, p. 120); (b) marginalized groups are more aware of their positionality than non-marginalized groups due to their social ranking; and (c) research focused on power relations should begin with the lives of the marginalized. Men and women, being from two different opposing groups would then come from different standpoints[71]—both of which are partial and distorted. Feminist standpoint theorists claim that the standpoints of women are less partial and distorted and assert that "women can see more

[71] The term "standpoint" does not simply mean the experience or the perspective of a person. Although the experience and perspective may bring to light some of the inequities that exist in society, Harding (1991) claimed that in order to consider a position as a standpoint (rather than just claims made by different women), "we must insist on an objective location—women's lives—as a place from which feminist research should begin" (p. 123).

clearly the forces that keep them oppressed because those forces directly affect their lives" (Parson, 2018, p. 19).

In contrast, the male standpoint has been a part of the narrative within many discourses while women continue to be silenced. Feminist standpoint epistemologies, however, "reject the modernist assumption that there is a single ideal knower and that he (it is typically a male) can know or describe one true and final correct representation or reality" (Ezzy, 2002, p. 20). Standpoint thinkers thus argued that women "are valuable 'strangers' to the social order" (Harding, 1991, p. 124) and their exclusion actually provides an advantage—providing an explanation as to why current social order norms exist and teaching other women (and men) how to see the social order from an "outsider" perspective. The knowledge they acquire emerges from being oppressed and struggling against their oppressors (i.e., knowledge gained through critical reflection on how power is functioning in society) and "can provide the starting point for asking new, critical questions about not only those women's lives but also about men's lives and, most importantly, the causal relations between them" (Harding, 1995, p. 443). Understanding the hidden aspects of the social relations between genders requires that research start from the lives of women.[72]

Although feminist standpoint theory recognizes the sociological and historical accounts of women's lives, it also requires "a critical evaluation to determine which social situation tend to generate the most objective knowledge claims" (Harding, 1991, p. 142). Simply declaring that all women voices heard are "true," for instance, goes against what standpoint theorists claim.

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[72] Another underlying assumption here is that women's perspectives is "from the other side of the 'battle of the sexes' that women and men engage in on a daily basis" (Harding, 1991, p. 126). Historically it has only been men's voices who have been heard (i.e., "the winner tells the tale"). But as Espín (1993) argued, "No matter how privileged that perspective may have been in the past, it is as partial as all others" (p. 411). Understanding women's perspectives offers another side to the "story."

Some may argue that the need to differentiate between the perceptions of women from the realities of women's experiences is essential to determine which knowledge claims are objective (as an independent object) or subjective (as the thoughts of an individual's mind).[73] On the other hand, Harding argued that knowledge claims are always situated and dominant groups have failed to critically and systematically interrogate their own social positionings, making their accounts less objective.[74] Claiming that human thought could be independent of its production process is a delusion, one in which many researchers have claimed when they attempt to be a "neutral" researcher (Harding, 1995). The culture-wide assumption of the "neutral researcher" has not been criticized within the scientific research process; often assuming that the data and conclusion from scientific study are value-free.

Thus, knowledge that is socially situated and grounded "require and generate stronger standards for objectivity than do those that turn away from providing systematic methods for locating knowledge" (Harding, 1993, p. 69). Given that knowledge is grounded in the historical and societal context, standpoint theorists do not claim to perform the "God-trick," which refers to the way that knowledge has traditionally been generated through research by scientists who claim to be objective and who can see "everything from nowhere" (Haraway, 1988, p. 581).

Conventional conceptions of objectivity are actually not objective enough. Strong objectivity, a term coined by Harding (1993), requires consideration of the researcher's positionality, through researcher reflexivity, and how that can affect research. The beliefs that the

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[73] Historically, socially situated beliefs are often counted as opinions, rather than knowledge (Harding, 1994).

[74] The history of feminist standpoint theory can be traced to Georg Wilhelm Friedrich Hegel's master–slave dialectic where he analyzed the standpoint of the slave's life versus that of the master's. The activities that occur in the top level of a given hierarchy (i.e., the master) both organize and set limits to what the people at the top can understand about themselves and the world around them—this hierarchy makes their point of view, or knowledge, limited. In contrast, those in the bottom class (i.e., the slave) can provide starting points for thought for everyone in research because their experiences and lives provide particular problems that need to be explained or solved (Harding, 1993).

researcher carries are a product of the culture and experiences of the researcher and thus, affect every part of the research process (i.e., selection of problems, design, interpretation, etc.) and the knowledge that is produced from the research. Standpoint epistemology seeks to understand the relationship between knowledge and politics and the effects of different kinds of politics can have on the production knowledge (Harding, 1993). Thus, some social locations are better than others in providing starting points for research as the knowledge learned from these standpoints can challenge assumptions taken for granted within the scientific community.

Feminist Postmodernism

Postmodernism troubles the notion of language; questioning how meaning is constructed and used to describe objects—the construction of meaning and how words are used is limiting. Objects that are similar but not "significantly different" are often grouped together and are assumed to carry the same meaning (St. Pierre, 2000). Coming from a postmodernist frame, feminists within this epistemological view trouble the category, *woman*, as it includes many different women across different identity categories (race, class, ethnicity, sexual orientation, etc.) and has often been used to describe one type of woman. More specifically, the postmodernism view of gender is concerned about breaking down the male/female binary and shifting the current understanding of gender toward "understanding gender as emerging from social contexts, processes, and actions that are always relational" (Stinson & Walshaw, 2017, p. 146). Rather than viewing gender as a quality following from biological sex, it is more a societal norm that also creates the illusion of the male/female binary (Butler, 2002). Understanding the position of women in society requires critical analysis of the discourses surrounding women.

This claim to social research not only considers the standpoints of women but also has been used to make comparisons of situations across different groups. For example, men who are not a part of the dominant group (i.e. African American men) may not be as privileged as other groups (like white women) in different social situations. The "intersection"[75] of these identity categories are just as important as gender. Postmodern feminism thus questions "what specific contexts, among which specific communities of people, and by what textual and social processes has meaning been acquired?" (St. Pierre, 2000, p. 484). In a more general sense, what meanings have been constructed, how do meanings change over time, and how do meanings operate within the societal structure (i.e., who has been silenced)?

In the construction of meaning, language can both constrain and open up discourses, as it is powerful, not always transparent, and has the power to produce the world (St. Pierre, 2000). Due to its tremendous power, the types of language used can shape not only the structures of society, but also people. Feminists "use poststructural critiques of language, particularly deconstruction, to make visible how language operates to produce very real, material, and damaging structures of the world" (St. Pierre, 2000, p. 481). Dichotomies, for instance, often privilege one element over the other, with the male often being associated with the privileged element (Usher & Edwards, 1994). Characteristics, such as "rational, subject, and culture" are often associated as being male terms, with women being "irrational, object, nature." These characteristics, amongst others, often place women in the category of subordination (Usher & Edwards, 1994). Feminists then argue that language should be used differently in order to "produce different possibilities for living" (St. Pierre, 2000, p. 484). Thus, the power of language, can be used for women (and young girls) to learn about themselves and their self-worth, which is a combination of how they see themselves and how others see them.

[75] Kimberlé Crenshaw (1995) coined the term intersectionality to describe how aspects of a person's social and political identities (i.e. gender, race, class, sexuality, etc.) intersect and overlap and can be both empowering and oppressing. It broadened the lens of feminism, which, at the time, focused primarily on the experiences of White, middle-class, cisgender women, to include difference experiences of women who did not belong to that group.

Intersectionality

Although postmodernism and feminist thought provided the initial framework of my thinking, these theories were not enough to understand the complexity of the lives of women who I intend to learn from in this study. The category "women," for example, often includes all kinds of women (race, class, etc.) and does not necessarily look at the intersection of the different identity markers that women experience (see St. Pierre, 2000, as she troubles the language used to describe women). "Rather than seeing people as homogenous, undifferentiated mass, intersectionality" according to Collins and Bilge (2016), "provides a framework for explaining how social divisions of race, gender, age and citizenship status, among others, positions people differently in the world, especially in relation to global social inequality" (p. 15). The intersection of individuals' identities represents the filter through which they view the world. Intersectionality provides a way of understanding the complexity of the world as it acknowledges that individuals hold multiple social identities simultaneously and that those identities shape and are shaped as they navigate the world (Collins & Bilge, 2016).[76]

A Brief History

To understand intersectionality and how it aided in framing my study, I began with its history. Although Kimberlé Crenshaw is given credit for coining the term "intersectionality," the core ideas of intersectionality appeared much earlier with evidence of some of its original thought stemming from as early as the 1960s and 1970s (Collins & Bilge, 2016).[77] Social

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[76] Intersectionality focuses on more than just identities (as will be described later). I begin with its work with identity because my first encounter with intersectionality required me to reflect upon my own multiple identities before understanding how those identities are associated with power and social structures.

[77] Note: This is not to say Crenshaw's work was not significant to the growth of intersectionality within the educational realm. Although Crenshaw was not the initial person to conceive the idea of intersectionality, she was the first to coin the term, which provided the language that was necessary to move the idea forward. The point, however, is that the core ideas of intersectionality were created within the context of the social movements of U.S. history (due to challenges such as colonialism, racism, sexism, etc.) (Collins & Bilge, 2016).

movement activism provided the catalyst for many of the ideas of intersectionality to form—but there was no common language to describe these ideas (Collins & Bilge, 2016). Women of color, for example, were not just affected by one system of power. Although they were typically subordinated to men, they were also experiencing racial and class segregation. As women worked to find a space within the patriarchal culture, women of different groups began to see how sexism was just one element of discrimination.

In response, women created their own political organizations to create space for empowerment. Within these spaces, women "expressed their ideas in political pamphlets, poetry, essays, edited volumes, art, and other creative venues" (Collins & Bilge, 2016, p. 65). Several texts, such as *The Black Woman,*[78] *Borderlands/La Frontera,*[79] and *The Forbidden Stitch,*[80] highlight the multitude experiences of women from different backgrounds and the interlocking systems of oppression (such as racism and sexism) that affected them all. Yet, to address the oppression they faced, they recognized that they could not address one type of discrimination at a time and needed a common language to describe these spaces of intersections. In an attempt to create that shared vocabulary, some women activists started to describe the intersections of their experiences as "jeopardy,"[81] "interlocking systems of oppression," "simultaneous," and

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[78] A 1970 volume edited by Toni Cade Bambara which attended to the idea that Black women would never be able to gain their freedom without addressing race, class, and gender (Collins & Bilge, 2016). For example, one essay called "Double Jeopardy: To Be Black and Female," a pamphlet published in 1969 gives an intersectional argument about Black women's lives and addresses capitalism and racism (Collins & Bilge, 2016).

[79] This volume by Gloria Anzaldúa (1987) describes her personal experiences as a woman of color, as a lesbian, and as a Tejana living between and across borders. In her work, she described *nepantla* as "that uncertain terrain one crosses when moving from one place to another, when changing from one class, race, or gender position to another, when traveling from the present identity into a new identity" (p. 50).

[80] This book included short stories, poems, and artwork of Asian American women with different backgrounds, including Chinese, Japanese, Filipino, Korean, Vietnamese, and Indian.

[81] For example, the concept of triple jeopardy was the intersection of sexism, racism, and economic oppression.

"manifold" (Collins & Bilge, 2016). These vocabularies, however, did not gain momentum within the social and academic realms.

It was not until 1989, when Kimberlé Crenshaw, then a law student interested in critical race theory, began to question the ways in which the law treated cases that centered on sexism and racism, was the term "intersectionality" born. To understand the phenomenon of violence against women of color, Crenshaw (1989) argued that focusing on one aspect of identity, such as gender or race, is inadequate in understanding critical social issues. Most laws looked at gender and race separately and ignored that African American women (and other women of color) experience overlapping forms of discrimination.[82] "Women of color's multiple identities" according to Collins and Bilge (2016), "position them differently within complex social inequalities than white men or white women" (p. 82). Thus, understanding the experiences of women of color is significant in understanding (and remedying) important social issues (Collins & Bilge, 2016). Intersectionality provides the framework to bring to light dynamics within discrimination law that were not being recognized in court.

Outside the courtroom, the ideas of intersectionality grew tremendously as modern feminists built upon Crenshaw's (1989) work, which now includes more than just the intersections of race and gender. Intersectionality is widely used to illustrate how people experience many types of discrimination, whether it is based on gender, race, age, class, socioeconomic states, sexual orientation, religion, and so on.

Bringing the ideas from social activism into the academic domain, many educators use intersectionality as an "analytic framework to critically evaluate intersecting dimensions such as

[82] One of the cases Crenshaw used to illustrate this point was the 1976 case of Degraffenreid vs. General Motors. In this case, five black women sued General Motors over a policy they argued targeted black women. Crenshaw argued that the policy was not just race or gender discrimination (as separate entities).

race, gender, social class, and sexuality in contemporary educational contexts" (Jones & Wijeyesinghe, 2011, p. 12) and have made connections of these identity dimensions to larger structures of oppression and privilege (see, e.g., Núñez, 2014). This type of research does not only help create new interpretations of the experiences students have when going through the educational system, but also has the potential to facilitate important institutional changes within the educational system (Collins & Bilge, 2016).

Intersectionality, Identity, and Power

One of the main ideas of intersectionality is that it brings to focus the identities[83] and experiences of the marginalized population. Rather than seeing individuals as having unchanged, or fixed, identities that they carry with them from one social situation to another, intersectionality offers a new perspective in that individuals are seen as having multiple identities that are constructed from one situation to the next (Collins & Bilge, 2016). These multiple identities are not separate entities that an individual has but rather are multifaceted and influence one another. A single identity, such as gender for instance, cannot be understood in isolation because other identities can interact with gender that can qualitatively change the experience of gender (Warner & Shields, 2013).

Moreover, individuals express varying combinations of their multiple identities across different situations and experience their multiple identities simultaneously. Holvino (2012), in describing her model of simultaneity, indicated that such an orientation toward identity

[83] Identity, as its own category, is very complicated and multifaceted. From a psychological perspective, identity can be understood as an individual's claim to membership of particular social groups (Shields, 2008), which can be both "visible," such as race and ethnicity, or "invisible," such as sexual orientation. From a sociological perspective, self- and social-identities can vary and an individual's participation in specific discourses and social groups can influence and construct their self-identities (Corlett & Mavin, 2014).

> attends to ways in which race, gender, class, sexuality, and nation are not just about a personal and individual identity, but about the social and institutional processes that determine opportunities, which also produce and reproduce racial, gender, class, and other social differences. (p. 172)

Thus, the discourses that the individual participates in influences not only their self-identity, but also contributes to how others within that discourse identify within that singular entity/domain.

Acknowledging that an individual has multiple social identities not only creates a complete portrayal of a whole person, but also helps understand that "their experiences in relation to various groups or roles they inhabit, incorporate specific attention to socially constructed groups that are tied to larger systems of power, privilege, and inequality" (Wijeyesinghe & Jones, 2014, p. 10). At the micro-level, for instance, an individual may experience multiple social identities (e.g., race and gender), but these identities are interconnected to the social inequalities (e.g., racism and sexism) at the macro-social-structural level (Bowleg, 2012).

More Than Just Identity

Intersectionality has been criticized for its alleged emphasis on identity and identity politics (Collins & Bilge, 2016; Cho et al., 2013) and its exclusive focus on subordinated subjects[84] (Cho et al., 2013). The overuse of personal identity as a category of analysis underemphasizes the power relations between an individual's multiple identities and the social

[84] A critique that is frequently made about intersectionality is that it excludes the experiences and lives of White men (Cho et al., 2013). Historically, intersectionality has focused on the experiences of the marginalized groups (with a specific focus on how race and ethnicity intersect with other forms of identity, such as economic class, gender, and sexual orientation), as those groups have often been neglected or overlooked and can yield new knowledge of the current social structures (Jones & Wijeyesinghe, 2011).

structures that are encountered daily (Collins & Bilge, 2016). In other words, intersectionality focuses much more than on identities; it also focuses on the structures that influence identities.

The intersections and relationships between the self and the community suggests that the power relations that are created are also determined by such relationships. It is not possible to understand the "complex interplay of power, privilege, and social structures if we view forms of oppression as singular and separate units (like racism, ableism, sexism, classism)" (Wijeyesinghe & Jones, 2014, p. 15). Social divisions in a given society, such as race, class, gender, and so on, are not separate entities that operate singularly; they intersect and build upon one another (Collins & Bilge, 2016), gaining meaning in relation to one another. Power relations must be analyzed both at these intersections as well as across other domains of power, such as structural or cultural.

Thus, intersectionality is not just about multiple identities, which all people have, but how those multiple identities are connected to structures of power. Highlighting these connections embraces the "both/and" frame (Collins & Bilge, 2016; Wijeyesinghe & Jones, 2014) and helps individuals see how their "life experiences are connected to broader social forces," (Collins & Bilge, 2016, p. 120) creating a collective political consciousness.

Using intersectionality as an analytical tool encourages people to move beyond seeing social inequality as a result of only one entity and that power is not gained or lost but rather as created through relationship of power (see, e.g., Foucault, 1978). So, although intersectional may begin with multiple identities, it does not end there; it is "a starting point for intersectional inquiry and praxis and not an end in itself" (Collins & Bilge, 2016, p. 132).

Application of Theory within the Study

Using an “eclectic theoretical framework” (Stinson, 2004), I attempted to show that postmodernism, feminism, and intersectionality each offer a unique way for me to think about this research project. I begin by discussing how each framework provided tools to begin to understand the ways in which women, whose first language is not English, perceive mathematics success.

Postmodernism

Postmodernism provides the tools to understand that knowledge is heavily influenced by context and time (allowing multiple realities to exist) and offers a way to question what is considered normal by examining the structures and discourses people find themselves in through the analysis of language (Lather, 1991). Postmodernism questions how “truths” are produced and how these truths are not just a reflection of the world, but how they structure the world as well. Student success is largely “driven by discourses of achievement and proficiency on standardized exams, tangible outcomes that can be measured in some way” (Gutiérrez, 2013, p. 43). The emphasis on testing trumps the educational and personal outcomes of students and how they define and perceives success. A postmodernist

> view works against singular meanings and truths such that concepts like ‘success,’ ‘proficiency,’ ‘achievement gap,’ even ‘mathematics’ are now open for debate. Unless learners and practitioners have the means to challenge these discourses or re-inscribe them with other meanings, they can come to believe they are successful or unsuccessful based on the discourses that operate in schooling practices. (Gutiérrez, 2013, p. 43)

As such, students may only evaluate themselves against these dominant discourses that have already perceived them to be unsuccessful based on their educational background, race, and so on.

Furthermore, students may internalize these discourses as one form of truth and may behave in ways that are in line with discursively understood habits of successful learners—which Foucault (1977) may consider as a form of internal surveillance (Gutiérrez, 2013). According to Gutiérrez, "rarely do our definitions of success include self-actualization—the idea that we should be allowed to become better people by our own definitions, not just those prescribed by schooling" (p. 43). Thus, by learning from students in how they think about success—how they define it and how they have used that definition of success to further their career—can help understand how some truths are privileged over other ones.

Postmodern Feminism

In attempting to understand how these structures of success were created (or how society has come to define success), deconstruction allows critical analysis of the current structures—how it has been constructed and what currently holds it together (St. Pierre, 2000). Looking at these structures, however, also requires the understanding that human lives cannot be explained by single categories, such as gender, race, language, and socio-economic status—people's lives are multi-dimensional and complex and lived realities are shaped by different factors and social dynamics operating simultaneously. Considering that the women of my study come from a variety of backgrounds, speak different languages, and come with varied experiences, I had to consider that they may experience privilege and oppression at the same time, depending on what situation or context they are in. Relationships and power dynamics between social locations and processes (e.g., racism, classism, heterosexism, ableism, ageism, sexism) are linked and can change over time. Thus, intersectionality provided an additional lens to understanding how these women experience success not just as women or individuals whose first language is not English but also as individuals with multiple identities[85] who have successfully navigated (and continue to do so) a world that traditionally works against them.

Because I am interested in broadening the notion of success and question how our current definitions may have limited our understanding of what it means to be successful and limit the potential success students might have, I begin with the perspectives, standpoints, and stories of women whose first language is not English and who have successfully navigated the world of education. Critically analyzing the notions of mathematics success from the perspectives and standpoints of women highlights not only parts of the structure that are harmful or detrimental to those within that structure but also ways to rebuild the structures surrounding success.

Mathematics, in particular, comes with a multitude of power structures that have shaped who has had access to it and who can be successful. The differences between boys/men and girls/women in academic performance (Fennema, 1979; Nosek et al., 2002), for instance, is not new to the field of mathematics education and have continued to be the focus of research. Postmodernism has given me the ability to see and accept that these types of discourses do not need to exist and can potentially change. Foucault's theories of discourse and discursive practices, St. Pierre (2000) claimed illustrate "that shifts in historical thought do occur when people think of different things to say; therefore, resistance to discourses of domination is possible" (p. 486). Rather than focus on the so named gap between different groups of students, I focused on those who have been successful so as to shift the narrative of what success looks like

[85] Although this study draws from the work of intersectionality and looks at how participants' perceived identities, the focus of this study is not on their identities themselves, but rather on the relationships between their identities, their experiences, and the structures within education that have influenced their notions of mathematics success.

and who can obtain it. Postmodernism demands that I examine my "own complicity in the maintenance of social injustice" (p. 484) when I have focused on the gap in the past. Reflecting upon my own prejudices and standpoints and recognizing that through language, discourses and worlds are created and re-created (Usher & Edwards, 1994, p. 16).

Postmodern feminist scholars assisted me in bringing my focus to women and the nature of their experiences and perceptions within a world dominated by men. I needed a way to understand my own experiences being a woman and how those have shaped the way I have come to understand my place in the world.[86] Feminist standpoint theory and feminist postmodernism assisted me in understanding that we all have a partial understanding of reality, and that different perspectives and approaches are needed to move theory and understanding forward (Espín, 1993). While all perspectives are biased, it is necessary to hear from multiple standpoints to generate a wider understanding and the best people to hear from are the ones who have traditionally been silenced. If the goal, for instance, is to increase the number of women in STEM and to help them navigate a world that is male-dominated, then "we must commit ourselves to breaking down barriers, abolishing policies of exclusion, and building on students' strengths, so we can widen the path, clear some of the barriers, and reach that elusive goal" (Solorzano & Yosso, 2001, pp. 487–488). Starting from the perspectives of women who are "in the trenches" may illuminate the types of discourses and behaviors that need to be critically examined and understood.

[86] It was not until I had conversations with Professor Stinson in our advisee meetings, did I come to the realization that not only do I already hold these beliefs about how women are treated but also that I had women who advocated for me—those who helped me become successful in mathematics and school. These women, Mrs. Timpson and Dr. Carol Findell, were not just women who supported me in my education but were also my advocates and encouraged me to find my own strength. As a woman who has persevered through school and has had success with it, it made sense to welcome that strength within me and to explore it further.

Intersectionality

Lastly, intersectionality, as a way of understanding and analyzing the complexity of the world and people (Collins & Bilge, 2016), allowed me to make sense of those "in-between" spaces that I have so often found myself in. As a "mixed" woman, I have so often been asked to categorize myself as if I can separate my race, class, sex into different bins. This practice is not new and continues in all aspects of life. Collins and Bilge (2016), for example, highlighted how even during the 2008 U.S. electoral campaign, African American women were repeatedly asked whether they were going to vote for Barack Obama or Hilary Clinton. Although the question itself may seem innocent on the surface, the underlying question really becomes "which part of yourself is the most important?" Will these women vote for Obama because he is Black, or will they vote for Clinton because she is a woman?

In a world where "either/or" has been the way to categorize people, we must ask ourselves "what about those who don't fit fully into either category?" I am Korean, but I am also White, a woman, a first-generation college student, a mother, a daughter, a wife, a student, and so on. I am not defined by one identity and have experienced life through the lenses of all these identities. To artificially separate one identity from myself and culture forces me to deny the way I experience the world (Monture-Angus, 1995).[87]

In reflecting upon my own identity and how I describe myself, it has helped me begin to understand the interconnections between systems of power and privilege. For example, my outward appearance as a mixed woman (with some prominent Asian features) affects the way in which people first perceive me and often places me as a minoritized individual. My spoken

[87] Patricia Monture-Angus (1995), a law professor at the University of Saskatchewan and member of the Mohawk Nation, spoke about aboriginal people' experiences with education, racism, and the criminal justice system, in conjunction with cultural dilemmas, such as the role of women in education and the complexity of humans.

language of English, for example, offers me the privilege to gain access to spaces that my physical appearances alone would deny. Many individuals, like me, inhabit both privileged and oppressed identities (Wijeyesinghe & Jones, 2014). Understanding my own identity has helped me begin to understand how those identities, experienced simultaneously, interact and influence the larger social systems, which in turn can affect the types of privilege and oppression I may continue to face. Intersectionality has encouraged me to consider my multiple identities as well helped me to address and recognize the interconnectedness of the power structures that continue to influence my day-to-day activities.

Concluding Thoughts

In this chapter, I began by outlining my own theoretical positioning and how I come to frame this study. As a former ELL, who has had success in education, I have had to critically think about my own perceptions of success. While my experiences of success may not be unique, the ways in which I have participated in and have been influenced by the larger discourses that have surrounded the concept of success certainly affected how I perceived every aspect of this study. I then outlined the theories that have shaped my thinking and will continue to influence how I think about success, as it is situated within the larger discourses of STEM and higher education, which I am also a member of. Drawing from postmodern feminism and intersectionality, I showed how each theory contributes to this study and how the combination of these three theories is necessary in understanding how women, whose first language is not English, perceive success. The foundation of this study is guided by my theoretical framework and elements and traces of each of these theories are visible, explicitly and implicitly, throughout the research project.

CHAPTER 4

RESEARCH METHODOLOGY

In this chapter, I begin by providing my background and subjectivity and how the work in this study is not only personal but also worth attention. I then provide my perceptions of language and success and how the relationship between the two have affected my own educational journey, which has ultimately led to my study. I then outline my research design, giving details to how I approached this research, analyzed the data, and the ethical considerations I had to consider before throughout the duration of this work. I conclude the chapter with providing justifications to my methodological decisions and some concluding thoughts.

Researcher Subjectivity

As a woman whose first language is not English, I have successfully navigated the education system of the United States. I have graduated from high school, earned a B.S. and Ed.M. from a prestigious university, and am currently enrolled in a Ph.D. program. I am aware of my accomplishments but am cognizant that my success is not the exception to the rule. Many other students who come from different cultural backgrounds and who have adapted to learning in an environment foreign to them have also attained various “levels of success.” Yet, those who have been successful in education, and mathematics in particular, are still seen as anomalies, especially if they are not a part of the dominant group (de Araujo et al., 2016). I aim to change the narrative on how educators think about those students and suggest that educators explore students’ perspectives of mathematics success and how students perceive their own mathematics learning to open new discussions of how educators can assist in developing students’ mathematics agencies.

My views about mathematics and what it takes to be successful have been affected by own life experiences and will permeate "every step of the entire investigation process, from selection of the phenomenon of interest that is put under scrutiny to the way the ultimate report is composed" (Yazan, 2015, p. 136). My epistemological position, which draws from both social constructionism[88] and subjectivism,[89] is that knowledge of one person might not be the same as the knowledge of another person (due to their different experiences and interactions). In attempting to understand how women, whose first language is not English, perceive mathematics success and how those perceptions have influenced their decisions in pursuing a STEM degree, I seek to build an awareness of what "success" means by examining those who may understand success in different ways.

Students of mixed racial identities may feel as though they do not belong to any particular social group. Acceptance to these groups or the sense of feeling like they belong are often not dependent upon how they feel—but rather how society perceives them. Being biracial myself (Korean/White), people have treated me differently based on their perceptions of me. For example, to White people, I am viewed as Asian because I have many of the dominant physical characteristics of an Asian woman. Koreans, however, don't view me as Korean because I do not speak Korean (among other reasons). Nevertheless, I do not think of myself as being one or the other—I am simply both. I may not speak Korean, but I am still Korean. I may not look White,

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[88] More details are given in Chapter 2, where I outline my theoretical framework for my study. My underlying belief is that knowledge for an individual is based on individual experiences and the influence of others surrounding the individual (i.e., interactions with others). Within this perspective, "the construction of knowledge is viewed specifically as a result of our experiences with human practices that prompt understanding, which inherently vary from individual to individual" (Egbert & Sanden, 2020, p. 23).

[89] My work intersects with subjectivism because knowledge "exists in a realm of uncertainty" (Egbert & Sanden, 2020, p. 23). Postmodernism operates within this realm as it not interested in "finding" or "discovering" the "Truth." From this perspective, exploring individuals' perception or knowledge of mathematics success can vary depending upon cultural activities and allow for multiple truths to exist.

but I am still White.[90] Although I may define myself as being a part of both worlds, many people treat racial composition as a binary—you are either a part of their group or not. In my experience, language plays a significant role in how people perceive a person's affiliation to a culture and understanding the role language plays for students specifically could illuminate how language is used in the development of their learning of mathematics and their engagement with it.

Language is an Identity and Culture

Despite the success I had in my mathematics courses, I still did not believe I was (or could be) successful. Grades may have indicated that I was successful,[91] but the perceptions and cultural norms within education—and in particular, Science, Technology, Engineering, and Mathematics (STEM)—have often made me question my abilities (even to this day). Language had a tremendous effect on my sense of belonging in school and social groups and influenced my perceptions of success (Espín, 1993). Given that my first language was Korean, a language that was not spoken by anyone else during my elementary and high school years, I often felt isolated and alone. Language, as a form of communication and identity, modified my reality and influenced the choices I made. I was so self-conscious about my use of English (i.e., using the correct words, my accent, etc.) that I often chose not to participate in discussions in classrooms. I became the quiet student who was afraid to speak up in fear of being ridiculed or made fun of for having difficulties with English.

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[90] "Whiteness" here is being used to define White as a cultural group (and the cultural capital that comes with it). On the outside, I may not look like I belong to this racial group, but I have participated and grew up in predominantly White area – having access and privilege that may not have been available to me otherwise. I also acknowledge that growing up within this cultural group has also affected the way I perceive myself and others and how I have come to perceive what the "norm" should be.

[91] As a student, success always meant I needed to earn at least an "A" (or as close to 100% as possible).

I held onto this fear in all aspects of my life—school, social situations, and home. While most non-English speaking students would probably have support at home—or at least someone to speak to in their native language—I was not as fortunate. Growing up with my White American family was difficult on many levels. Not only was I the only person in the family who did not speak English,[92] my sister and I looked different from the rest of the family. Living with family who had blonde hair and blue eyes as an Asian kid often led to a lot of stares and questions whenever we went out in public. These experiences highlighted how different people perceived me to be and rather than confirming that I was different, I tried desperately to have them see I was just like them. My looks may have made me appear to be different, but language could help unite me with other groups of people.

With these ideas in mind, I chose to practice my English every day. Although I did not have the choice to maintain my Korean language,[93] I felt English could get others to see I was not that different from them. Noah (2016) contended that "language, even more than color, defines who you are to people" (p. 56),[94] and the way people treat you is greatly affected by how you sound.[95] Regardless of how one may look, language can either unify or separate groups. Just as Noah (2016) stated,

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[92] I do have a younger sister, but her first language was English. During my mother's pregnancy, I spent the majority of my time with my Korean grandmother in her home where Korean was the language spoken.

[93] My mother, at that time in my life, was not a major part of it. After my parent's divorce, my dad took my sister and me to live with his mother where English was the language spoken.

[94] Although Trevor Noah is not an educational researcher, I found myself relating to many of the experiences he shared within his book. His work helped me to start thinking about language and to start thinking critically about how language can be used to "gain power."

[95] I have witnessed how people can treat others based on their initial perceptions of them (often based on outward appearances) and how that can change once they hear how "well" they can speak English.

> the quickest way to bridge the race gap was through language.... If you're black in South Africa, speaking English is the one thing that can give you a leg up. English is the language of money. English comprehension is equated with intelligence. If you're looking for a job, English is the difference between getting the job or staying unemployed…English is the difference between getting off with a fine or going to prison. (p. 71)

Even at a young age, I knew the "power" of English and valued it so much that I spent most of my time perfecting my language skills.

My desire to learn how others have been successful is also influenced by attempting to understand how they are able to negotiate themselves in the process—in particular, how they use (or do not use) their language in negotiating spaces to be successful. Language is a contributor to how individuals negotiate themselves in social situations and can alter the ways in which they are perceived by others. Speaking multiple languages, for instance, can help individuals become the "chameleon" (Noah, 2016, p. 73) —they cannot change the color of their skin, but could change people's perceptions of their skin color. Thus, language can help gain entrance in certain discourses that might not have been an option otherwise.

Whiteness All Around Me

In every social situation, I found myself gravitating toward White people. Even if there were other Asians in the room,[96] I chose to be a part of the White group—not because I thought they were better (at least not consciously aware of it), but because I was surrounded by White people all the time and saw myself as being White. My participation in this group has served me well. I have been able to gain access to certain knowledges that are privileged within these

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[96] Being a student at Boston University exposed me to many other people and cultures. During my undergraduate education, I became friends with many other Asian students but still did not feel I was one of "them."

spaces. I did not realize however how other societal, political, and hegemonic factors were playing a role in how I perceived myself or how those contributed to my success until I went to college.

So… What Does Success Look Like to Me?

In attempting to understand what success might "look like" or how students may perceive it, I recognize that I have been using the term "success" loosely. As a product of our educational system in the United States, I too have fallen prey to the idea that success is easily measured by grades, standardized tests, and comparisons made to other groups. I excelled in school and was the "model student." I earned high grades and used them to determine my self-worth. And if I earned a low grade, I made every effort to earn a higher grade the next time—because grades and other accolades were used to make predictions about my future.

Despite these accomplishments, this way of thinking hindered my self-confidence. While grades demonstrated that I "knew" the content, I struggled with feeling that sense of belongingness and often questioned why I was pursuing a STEM degree. Other people questioned it too. I still remember when I told my chemistry teacher that I was going to Boston University to pursue my initial dreams of becoming a pediatrician. Rather than congratulate me on being accepted into the college, she questioned my acceptance and stated that "they must have needed to meet the minority quota." At the time, I did not quite understand what she meant, but I knew that grades were not enough to prove I could be successful.

When I went to college, I faced other complications that challenged my notion of success. In high school, the number of girls outnumbered the boys in my math and science classrooms. Conversely, walking into a huge lecture hall in college and only seeing a handful of girls in my mathematics class was an eye-opening experience. I couldn't understand where all the girls went.

In addition, many of the girls were international students (who did not speak English). While it was interesting to see different ethnicities of people in my class, it made me start thinking about what "type" of people pursue STEM. As an Asian American woman who only speaks English, there were few people who were like me.

Once I became a teacher, I began to see how grades and how student success is measured can be both motivating and detrimental to students' perceptions of themselves and their capabilities. Success is not an isolated event or is something that an individual can achieve alone—it is interwoven in the relationships people have with one another and is influenced by an individual's experience (which is historically and culturally situated). Having taught in both a minority-majority school and a public school with the majority of the students being White and Asian, I have seen how students have been affected by these definitions of success. Standardized tests, for instance, can greatly change the course of a student's life. Those students who cannot pass the mandated state exams cannot graduate from high school. In my experience, most of the students who kept failing were students with Individualized Education Plans (IEPs) or those who did not speak English. Despite the evidence I had of their understanding of the content (i.e., work done in class), it was not enough to "prove" to the state their competencies in mathematics.

These experiences as an Asian American woman whose first language is not English in both the K–12 and undergraduate education systems along with the experiences and insights I gained from being a mathematics teacher for over eight years, propelled me to think more critically about what success is, what it looks like, and how students have come to achieve it. With this study, I highlight new ways of thinking and how educators might begin to change the dominant perceptions of success.

Qualitative Research

Qualitative research is the best way to understand and explain the meaning of a phenomenon within a specific context. As qualitative research is exploratory in nature, "data-driven and context-sensitive" (Mason, 2002, p. 24), qualitative research provides opportunities to learn from participants and to understand their perspectives[97] by focusing on process, meaning, and understanding. Thus, qualitative research allows me to gain knowledge of the meaning the participants of the study have constructed around success and how it makes sense in their world.

In my study, a case study methodology was used to provide a description that enriches understandings of how women, whose first language is not English, perceive mathematics success while pursuing a STEM degree in a public, 4-year institution. This type of inquiry provides opportunities for multiple truths to exist as each participant will be given opportunities to share their experiences and perceptions of success. In addition, it allows the exploration of the discursive contexts that have shaped the way in which these women think about their own success and the actions they have taken to obtain that success.

Qualitative Case Study Methodology

Case study, as a methodology, is more than just studying individuals or historic events. The emphasis of case study methodology is on interpretation and process—trying to understand rather than predict or find a solution. To differentiate from other qualitative work, case studies provide intense descriptions and analysis of a single unit or "bounded system" (Stake, 1995),

[97] This understanding is often referred to as the emic, or insider's perspective, and often focuses on the viewpoint of the participant. Etic, or outsider's view, is often the perspective of the researcher (Merriam, 1998).

such as an individual, a particular group, event, or community. "Voices"[98] of those within the case can inform researchers by providing first-hand perspectives of a specific phenomenon.

Two key approaches that have guided case study methodology have been proposed by Robert Stake and Robert Yin. Although both have provided an in-depth analysis of defining a case and a roadmap in the utilization of case study, they each approach case study methodology from different epistemological positions and methods. Yin (2009), leaning more toward a positivist frame, argued that a case study researcher should "maximize four conditions related to design quality: construct validity, internal validity, external validity, and reliability" (p. 40). He considered these aspects of quality control as a crucial step in conducting quality case study research and thus provides a systematic way for researchers to conduct a case study.

On the other hand, Stake (1995) argued that qualitative case study researchers should be more focused on being gatherers of interpretations and report on the knowledge that they gather from their investigation. There are multiple perspectives or views, according to Stake, "of the case that need to be represented, but there is no way to establish, beyond contention, the best view" (p. 108). Thus, the primary interest of qualitative researchers is to understand the way people make sense of their world and how they have come to construct the meaning or knowledge of a particular phenomenon. Providing a systematic way in which to conduct a case study goes against his epistemological position—the path of the researcher will depend on nature of the case. While Yin (2009) defined case study as a research process (i.e., empirical inquiry), Stake focused on the defining the unit of study as being the case.

[98] I have come to understand that the term *voice* limits the types of knowledge that the broader society deems as "true" or "more accurate." St. Pierre (2008) troubled this idea further, stating: "We know that people say all sorts of things, so why is what they say treated as more authentic than, for example, something they write or draw?" (p. 320). Thus, when using the term voice, I refer to all the data that is gathered in the case as the "voices of participants."

Although case studies have typically been used with researchers from the postpositivist frame, the use of a case study is "a valuable methodological approach in poststructural research because it facilitates a deeper understanding of the social, political, and historical circumstances that shape a phenomenon and how power relations shape the actions and perceptions of people" (Mohammed et al., 2015, p. 99). Coming to the research with a postmodern feminist and intersectionality orientation and understanding that multiple realities can exist, case study methodology provides the in-depth exploration of how women within STEM achieve their success. A case study that is descriptive provides a rich, "thick" description[99] of the phenomenon, illustrates the complexities of the situation, and invites the reader to understand the phenomenon, often bringing the discovery of new meaning. Presenting information in a wide variety of ways and from viewpoints of different people can highlight or give reasons for a problem or case.

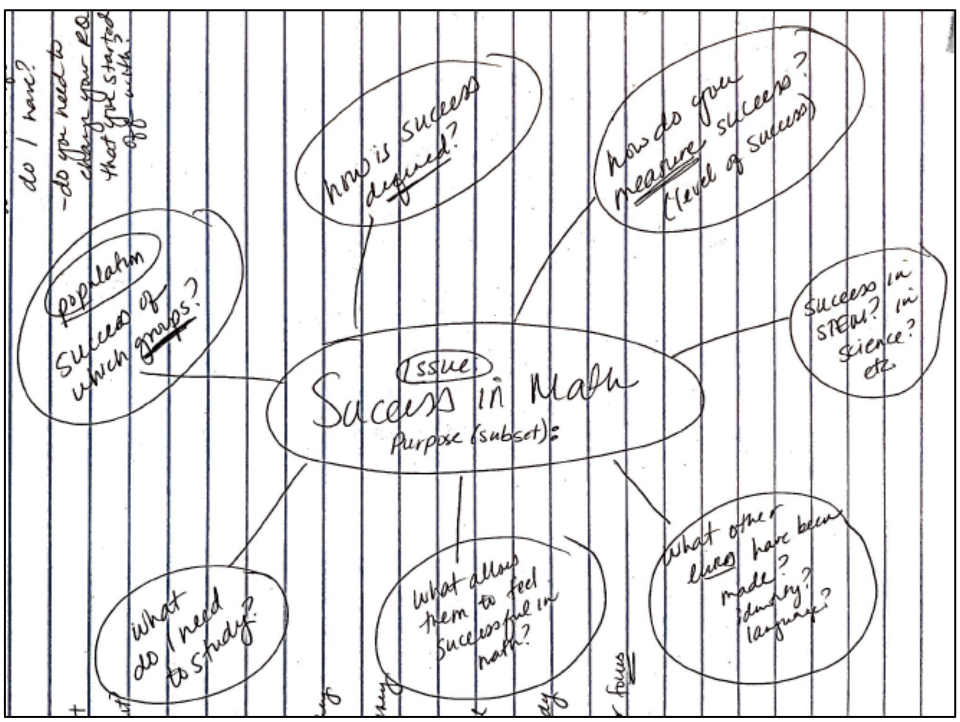
Designing My Study

As an emerging educational researcher, I position myself more closely to that of Stake's (1995) interpretation of case study methodology in that "no aspects of knowledge are purely of the external world, devoid of human construction" (p. 100). In addition to his "traditional" definition of case study, I used this methodology to critically analyze and explore the discourses (i.e., the power/knowledge relations that operate within STEM) that have come to shape the participants' thinking and actions surrounding success in STEM (Mohammed et al., 2015).

[99] Thick description comes from anthropology and is often referenced to Clifford Geertz (1973)—a thick description not only describes the physical behaviors of participants but also provides descriptions of the interpretation of the actors within a specific context. Meanings provided by people within a particular place and time are often associated with the underlying meaning that is attributed to a physical act (i.e., the act of winking/blinking the eye) within a particular culture or community.

My research endeavors are geared toward seeking understanding and interpretations within historically and culturally situated discourses within higher education; preserving multiple realities, even when they contradict each other (Stake, 1995). More specifically, I did not necessarily look for a solution or one definition of mathematics success across individuals; rather I gathered these women's interpretations of mathematics success to challenge others to rethink how success has been conceptualized within higher education. Case study methodology allowed for intense analysis rather than relying on statistical measures to "capture" how students defined success (Flyvbjerg, 2006).

To begin my research design, I first thought about my issue and issue questions, "which will lead to the design of the research questions" (Yazan, 2015, p. 140).[100] The graphic organizer, shown in Figure 2, offers a brief sketch of how I began to think about mathematics success as an issue within education and the factors that contribute to students' success.



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[100] In Professor Janice Fournillier's class (Spring 2021), I was asked to provide my "issue" to the class and so created a graphic organizer so that I could visualize my issue.

Figure 2. My interpretation of mathematics success as an issue.

Note. This graphic organizer shows my initial thinking as I thought about the success of minoritized students.

Within the realm of mathematics success, I am most interested in how minoritized students have perceived mathematics success, especially given the permeated notions of deficit thinking that continues to pervade our institutional systems surrounding those who are different from the norm. Because the issue of students' perceptions of success is the driving force for the study, the type of case that was considered for this research was an exploratory intrinsic collective case study[101] (Stake, 1995).

Stake (1995) claimed researchers should view a case as "a bounded system" and inquire into it "as an object rather than a process" (p. 2). A case can be complex and is also "an integrated system" (p. 2). Thus, the case (or unit of analysis) in this study is the individual participant's perceptions of mathematics success and her decisions of pursuing a STEM degree bounded within a 4-year public higher education institution in the southeast portion of the United States during one semester of her educational journey. Additionally, the findings from this intrinsic case study "can have implications both for theory development and theory testing" (Crowe et al., 2011, p. 7).[102] The overarching ways students may define and experience mathematics success can also "provide insight to an issue" (Baxter & Jack, 2008, p. 549) — namely, the ways in which one perceives or experiences mathematics success can vary greatly

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[101] Stake (1995) differentiated between two types of case studies: intrinsic case study (where the case is dominant and "of highest importance") and instrumental case study (where the issue is important; "we start and end with issues dominant") (p. 16).

[102] The results of this study can potentially provide insight into the current structures of STEM because the way in which these women perceive success has been influenced by the experiences they have had. Although this research undertook an intrinsic case study methodology, the findings suggest (as will be later discussed) that these women's experiences may resonate with other women across institutions. This sentiment is not to say the results are generalizable—only that this research highlights the need to study the issue of mathematics success within STEM more closely.

depending on political and social structures. And because each participant may have her own definition of success and reasons for pursuing a STEM degree, each participant is the unit of analysis. Given that there are four participants in this study and each participant is a unit of analysis, this collective case study[103] (Stake, 1995) examines several cases (i.e., individual participants) to explore the perception of undergraduate women ELLs from their perspective of their mathematics success (inside and outside of classrooms) (Civil, 2007) and how these experiences shape their decisions in pursuing a STEM degree while also highlighting their stories. Because case study is concerned with how participants might function and act within limited contexts (Stake, 1995), this methodological approach also lends itself well to "examining the nuanced ways that people resist power relations" (Mohammed et al., 2015, p. 103).

Research Setting and Questions

Participants of this study are undergraduate women, whose first language is not English, enrolled as STEM majors in a 4-year public college in the southeast portion of the United States. This institution has a current enrollment of over 12,000 students, including both residential and commuter students and is described as being a minority-majority open-access institution, ranked as the most ethnically diverse regional college in the southern region. Additionally, it has recently earned the title as a Hispanic Serving Institution (HSI). The student body demographics are: 58.7% women, 41.3 % men; and 31.8% Black/African American, 26% Hispanic/Latino (of any race), 25.6% White, 11.6% Asian, 3.9% Two or More Races, 0.2% American Indian/Alaska Native, and 0.1% Native Hawaiian. While the majority of the student population are the

[103] Stake (1995) used the term "collective case study," while others, such as Baxter and Jack (2008) used the term "multiple-case studies." Regardless of the term used, both examine several cases and then make comparisons across cases (similarities and differences).

"typical" student (i.e., 64% between the ages of 18–22 years old), 27.3% of students are between the ages of 23–34 years old. The research questions guiding this study are:

1. What are undergraduate women whose first language is not English perceptions of mathematics success?
    a. What qualities distinguish mathematics success from other forms of success?
2. What STEM institutional cultural norms have played a role in how they define mathematics success in STEM?
3. What role, if any, does language play in determining how they perceive their success in mathematics?
    a. How do they navigate their gender, race, and language in college, and how does the intersection of language influence their perceptions of mathematics success?
4. How has this perception of mathematics success affected their decision to pursue a STEM degree?
    a. What factors do these women attribute to their success in college?

Recruiting Participants

The unit of analysis is each individual who is situated within the context of higher education with a focus on the experiences and perspectives of women whose first language is not English. Participants in this study, therefore, are women whose first language is not English[104] within higher education, who have been "successful" thus far in mathematics and are pursuing a STEM degree. Participants also speak English ("well enough") to have back-and-forth

[104] I wish to state explicitly that I am not ignoring race, but because my focus is on those whose first language is not English, I did not choose to focus on a particular racial group. Using language as one form of identification allowed me to recruit participants from varying racial groups and experiences. This method may seem counterintuitive given that I am also asking my participants to be women, but given that individuals have multiple identities, and my focus is on the intersection of gender and language within higher education, this method of selection is valid. The common characteristic amongst my participants therefore is that they identify as women whose first language is a language other than English.

conversations within the interviews.[105] Therefore, participants must have been either in the United States or have spoken English for at least 3–5 years to develop their BIC[106] skills.

Success, as a criterion for participant selection for my study, is determined by earning the minimum grade ‘C’ (i.e., 70–79%) in a mathematics course. At this institution, students pursuing a STEM degree often take the pure mathematics sequence, starting with Introduction to Mathematical Modeling, College Algebra, Precalculus, or Calculus (depending on placement) and are required to earn at least a C to take the next mathematics course or other STEM courses, such as chemistry and biology. Students who have been able to earn these minimum grades and continue to pursue a STEM degree are considered successful in this study.[107] Thus, my participants are enrolled in a variety of courses, but all have had success in completing at least one of the mathematics courses in the STEM sequence.

I began my selection process by sending an email (Appendix A) to former students who are continuing to pursue a STEM degree, along with a consent form (Appendix B). Initially, I sent 21 emails, focusing on students I had most recently (within the last 2 years). Of the 21 students, six students responded indicating they were interested in being a part of the study. Of the six students, three students asked to speak to me in person to discuss the nature of the study

[105] Although I would love to interview students whose first language is not English, I, unfortunately, only speak English.

[106] BIC, as referenced in Chapter 1, is an acronym for “basic interpersonal communicative skills,” which take about 3–5 years for a student to engage in conversational English when learning a new language (Cummins, 2008).

[107] At this institution, a “passing” grade is a D, but is not considered the minimum for the course to count toward students’ degree plan. Because a C is the minimum grade that allows students to take the next mathematics course, I selected students who had earned at least a C in their mathematics course(s).

and, thus, I met with all three students individually. While speaking with these students, however, we realized they did not have the necessary time to participate in the study.[108]

With only three students who had confirmed their participation in the study, I then asked colleagues in the institution to assist in recruiting students by sending emails to their students. I forwarded my initial email and the consent form. With faculty assistance, two additional students responded indicating they wanted to participate in the study. At the beginning of Summer 2023, five women agreed to take part in the study.[109]

Participants

Before sharing each of these women's stories in Chapters 5 through 8, I provide a summary of some of their characteristics to provide a general picture of who they are as individuals and their background. While these characteristics do not necessarily define any of these women, it was important to know and understand how each of these defining characteristics, such as age or when they first learned English, contributed to their perceptions of themselves and mathematics success. Although they shared some of these characteristics with one another, these characteristics did not necessarily mean they viewed success in the same way. More on how these characteristics potentially affected how they perceive themselves and their success will be discussed in Chapters 5 through 8.

[108] Of the three students who initially expressed interest, one student really wanted to participate in the study but did not think she would be able to because she was planning to take summer courses. In addition to her coursework, she is also a mother and wife and felt that she would not be able to give much time. Two other students indicated that they were leaving the country during the summer and would not be available till fall semester started. Given that I was trying to set up interviews in the summer, we decided it would be best to exclude them due to time commitments.

[109] Note that one woman did decide to discontinue participating in the study due to personal reasons. Although she wanted to participate, she did not think she would be "of value" given that she had many other responsibilities and obligations that she did not foresee before the study began.

Table 3
Description of Research Study Participants

Participant	Age	First Language	Birth Country	First Generation?	First Learned English	Current Undergraduate Major
Cassandra	21	Spanish	United States (Georgia)	Yes	Elementary school	Applied Math/Pre-engineering
Sasha	20	Spanish	Dominican Republic	Yes	15 years old when she moved to the U.S.	Information Technology
Skylar	24	Vietnamese /Cantonese	Vietnam	Yes	Primary School in Vietnam	Information Technology (Software Development)/ Applied Math
Wing-Yu	19	Cantonese	United States (California)	Yes	Elementary school	Computer Science (Intelligence & Media)

Note. This table provides a brief overview of participants' backgrounds, highlighting certain characteristics that are discussed in Chapters 5 through 8.

Data Collection and Management

Case study methodology does not claim any particular methods for data collection (Yazan, 2015), but does emphasize the importance of using multiple methods that will provide an in-depth analysis of the case (Stake, 1995; Yin, 2009). Interpretive approaches "see people, and their interpretations, perceptions, meanings and understandings, as the primary data sources" (Mason, 2002, p. 56). Thus, as I am interested in how these women perceive success, the primary data sources will come from the women.

As a researcher coming from a postmodern feminism and intersectionality frame, I view "data collection" as "data construction" because both the researcher and participants engage in constructing the data during interviews that "may be subject to deconstructive analyses" (Roulston, 2010, p. 64). Interviewing is a process of "knowledge construction" (Kvale & Brinkmann, 2009, p. 48), where the knowledge that is constructed "exists in the relationship between persons and world" (p. 53). Meaning is constructed through "negotiation with research participants" (Lather, 1991, p. 59) and the data that are constructed throughout this study is a co-constructive process involving me and the participants.[110]

The interviews, not just a site for the construction of knowledge, should also contribute "to the advancement of women's causes in a patriarchal, capitalist society" (Roulston, 2010, p. 23). Given that these women have had success within a historically male-dominated field (i.e., STEM), conducting this type of research allows me to also focus on language-use—both within the interview and beyond (DeVault, 1990). I used a slightly alternative, innovative approach by combining concept mapping with semi-structured interviews. Concept mapping, in conjunction with interviewing, can provide a more comprehensive picture of the participant's perspective as visuals, such as a concept map, can reveal insights about a person that may not be accessible by another method (Striepe, 2021).[111]

Concept maps

Concept mapping is a visual method that can help "assist individuals in visualizing the journeying nature of a concept's development" (Wilson et al., 2016, p. 1151). These maps typically include concepts that are enclosed in a circle or a box and indicate relationships between concepts with unidirectional and bidirectional arrows. The way in which participants construct the map will give clues of their values and beliefs as well as the

[110] Other researchers have approached their work in a similar manner. For instance, Stinson (2008) used a participative inquiry methodology, which emphasized "the systematic testing of theory in live-action contexts, resulting in changed lived experiences for all those engaged in the inquiry" (p. 982). In this methodology, both participants and the researcher were active participants (i.e., coresearchers); engaged in discussions surrounding specific readings that were "assigned" by the researcher. Another example is Lather and Smithies (1997) work with women living with HIV AIDS. They worked collaboratively with women within the context of support groups and involved them in representing their stories by having them write their own introductions.

[111] Recall that St. Pierre (2008) troubled the idea of voice and stated that other forms, such as writing or drawing can also be gathered as the "voice" of participants.

anchoring concepts they define related to success. Concept mapping, as a visual methodology, has the "capacity to capture the multiple facets of social action, provide opportunities for deeper reflection and promote a participant centric approach" (Striepe, 2021, p. 519). Concept mapping not only encourages participants to more fully engage in the interview (and the creation of the map), but also provides participants with opportunities to recall and reflect on their prior experiences, enabling the researcher to gain a deeper understanding of their perspectives that interviews alone may not be able to obtain.[112] Using concept maps as an activity within the interview can also "illustrate a form of multimodal communication"[113] (Wilson et al.) and elicit conversations around participants' educational experiences from kindergarten to higher education (providing the context and background of the individual's successes within education and their cultural background in regards to language).

These maps allowed me to obtain preliminary feedback on how participants are thinking about the relationships between concepts they have and how they interact with the data by covering new relationships or viewing it from a different perspective (Muir & Geiger, 2016; Wilson et al., 2016). Moreover, the concept maps helped guide the interviews, as questions arose in response to the creation of the maps. Each participant created three concept maps: one with a focus on how they perceive themselves, one with a focus on their perceptions of mathematics

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[112] There have been studies that have incorporated concept mapping at different times during the interviewing stage. Newman (2004), for example, had his participants create their concept maps prior to the interviews. Pegg (2007), however, employed the concept mapping as part of the interview process, having her participants create the concept maps during the interview. I have chosen to follow a similar route to Pegg (2007), since Newman indicated that some of his participants did not complete the mapping before the interviews started. In addition, by allowing my participants to engage in the creation process during the interview, I was able to expand or clarify their thoughts as they were thinking about them while also giving them time to add to or revise their maps throughout the study.

[113] According to Wilson and colleagues (2016), multimodal communication allows "participants to find and share their voice in new ways" (p. 1152) by interacting with multiple resources such as language, art, and photography.

success, and one that combines the concepts and ideas in the two maps into one.[114] For each interview, I brought an interview guide (see Appendices C–E) to keep me focused during the interviews.[115]

According to Striepe (2021), the literature surrounding the development of a concept map identified several elements that should be included in the map. The elements include (a) concepts, such as events or objects that are generally represented by a word or symbol; (b) focus phrase or question, which provides the participant a stimulus and context to reference a situation or event; (c) cross-links, which show relationships between concepts; (d) flexibility with its design, to provide participants opportunities to add to or revise the map; and (e) a way to represent the concepts in the map in a hierarchal way. This study included all the elements except the last one, as I advocated and encouraged participants to use any approach (including non-linear ones) so they can show their thinking in a way that makes sense to them.[116] Participants in this study were not confined to represent their maps in this manner and, in fact, presented their maps in a variety of ways (as shown in Chapters 5 through 8).

Interviews

Each participant was interviewed three times, with each interview lasting about 90 to 120 minutes. An outline of the interviews can be shown in Table 4.

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[114] In an attempt to visualize how participants view themselves in relation to mathematics success, I am following a similar model to Striepe (2021), who asked her participants to create two separate concept maps (one on educational leadership and one on instruction). Unlike Striepe, however, I encouraged my participants to not only create the two maps but also to somehow combine them to illustrate the connections between the maps.

[115] The semi-structured interview guide allows the interviewer to probe for more details and descriptions based on what the interviewee has said as well as help the interviewer ascertain whether research topics have been discussed (Roulston, 2010).

[116] Striepe (2021) does reject the hierarchal way and adopts the non-linear approach as well. In her study on understanding her participants' perspectives of educational leadership, she used this method to open avenues for her participants to share their ways of thinking.

Table 4
Structure of Interviews and Concept Maps in Data Collection

Interview	First		Second		Third	
	Part A	**Part B**	**Part A**	**Part B**	**Part A**	**Part B**
Focus of Interview	Background: Get to know participant	Mathematics Experiences	Mathematics Experiences and Perceptions of Mathematics Success	Perceptions of Success	Identity and Perceptions of Success	
Concept Map	Creation and Revision of Identity Map		Creation and Revision of Success Map		Merge/Connect Identity and Success Maps	

In the first interview, participants were informed about the concept map activity and how the concept map activities will be used to focus our conversations on their understandings and perceptions of success. Additionally, they were given multiple opportunities to revise and reflect upon their maps within and across interviews. Participants were asked to describe themselves by creating their own concept map[117] by hand.[118] Directions about the creation of the concept map were given verbally as providing examples can influence participants' creation of their maps.[119]

The first interview began by having participants create a concept map with the focus of how they see themselves. Once they created their maps, they were asked to explain their map and

[117] Concept mapping is "founded on the understanding that knowledge is constructed among individuals" through their engagement and interaction with the world (Wilson et al., 2016, p. 1152). In the creation of the concept map, "how the participant finds his or her own voice and shares his or her story is a unique and individualized process" (p. 1152). Previous studies have used concept mapping to understand how well an individual is learning or understanding a phenomenon (i.e., analyzing maps by looking at the number and arrangement of concepts on the map and the "correctness" of it). In this study, the concept maps were used as a form of elicitation as well as a product that was later analyzed.

[118] According to Prosser and Loxley (2008), using a computer or virtual tool can potentially hinder the process in the creating of the concept map.

[119] Striepe (2021), in her attempt to learn about how her participants thought about educational leadership, noted that when she gave her participants a concept map template (with one bubble in the middle with spokes coming out), the number of spokes influenced participants' responses. For instance, some participants believed she was looking for a specific number of connections so some would struggle filling in all the spokes while others questioned whether they could add more.

share information about themselves as well as a short history of their educational journey and background. Each map looks differently depending on the participant. Striepe (2021), for instance, found that participants reacted to the concept map activity in different ways. Some participants chose to reflect and think a few minutes silently before they were willing to share while others spoke as they were creating the map. Some participants chose to ignore the activity altogether and focused on the interview instead. In this study, I recommended participants to create their maps (and discuss the significance of them), but I also allowed them to choose how they wanted to respond.

The first interview focused on the participant's background so that I could begin to understand who my participants are as individuals and how they navigate the world based on their perceptions of themselves (see Appendix C for interview guide). The interview process allowed me to dig deeper—to ask questions about their map but also ensuring that I began to understand them as individuals and their backgrounds.

Participants were then asked to describe and reflect upon their mathematics experiences (see Appendix D). During this part of the interview, participants still had access to their identity map they just created as they engaged in a discussion about their mathematics experiences. The intent in allowing participants access to their identity map provided opportunities for participants to think about how mathematics (or how engaging in mathematics) might have potentially influenced how they perceive themselves (for example, do they consider themselves mathematicians?). Participants were then given an opportunity to add to or revise the concept map based on our discussions surrounding the map. Additionally, I took note of the types of changes these women made to their maps to follow up on any of the ideas discussed, as preparation for the second interview.[120]

The second interview continued the focus on mathematics experiences but also began the discussion on what mathematics success and success in general looks like based upon their experiences. Just as in the first interview, participants were asked to create another concept map titled "My Understanding of Mathematics Success," which defined and described mathematics success (based on their educational experiences and perceptions). With this new focus, participants again had time to create their map and had the option to discuss their map in the process of its creation or after they have completed their initial draft.[121] As we engaged in a discussion about their mathematics successes (see Appendix D), participants had the opportunity to add to or revise their map before the end of the interview.[122]

Within the second interview, participants were asked to refine the Success concept map they created. The refinement process of these maps provided opportunities for me and my participants to engage in conversations about the creation of the concept map; delving deeper in understanding why specific constructs were created and how they relate to other constructs within the realm of success. The focus of this interview, however, focused more on their

[120] As I analyzed data during and in between interviews, there were questions I needed to ask my participants to gain a greater understanding of how they are thinking about a particular concept. Thus, this process helped me systematically check my understanding of what participants have already said and helped me refine and interpret the data (Roulston, 2010).

[121] Of the four participants in the study, three of the four chose to speak about their maps as they were creating them. One participant requested time to draw her maps first (also requesting I leave the room for a short period of time) and then discuss them afterwards.

[122] Note that for the first and second interviews, I used the interview guide provided in Appendix D. Although not the focus of the second interview, some participants wanted to revise or add to their Identity map that was created in the first interview. Part of the second interview was also spent on revising the Identity concept map from the first interview and the third interview picked up where the second interview left off.

perceptions of mathematics success and not just on their experiences (see Appendix E for interview guide).

The last interview focused on the intersection of aspects of their identity (including language and gender) and success. The goal of the last interview was to encourage participants to think about their identities and how those identities have influenced their perceptions of mathematics success (and vice versa). Participants were again asked to create a final concept map that links their identity and their perceptions of success, using their first two maps as a guide in its construction.

Immediately after each interview, I wrote my initial thoughts and feelings in my personal journal as another data source (Bogdan & Biklen, 2016). Then, I transcribed and listened to the interview multiple times to determine which additional information I needed before conducting the remaining interviews (Ezzy, 2002). For each participant, I kept a separate folder with the transcripts from interviews, my personal notes, and any other significant information that is relevant to the participants perceptions of success in this research study. Throughout this process, data has been locked away to preserve the privacy and confidentiality of all participants involved in the study.

To organize and analyze data, I initially tried to use software, such as NVivo, to combine data from interview transcripts, audio-recording of the interviews, notes from my journal, and the concept maps participants created during the interviews.[123] Although not ideal, I decided to go "old school" and do most of the work and analysis by hand.[124] I wanted to try and learn a

[123] I tried to use NVivo multiple times but had a difficult time learning how to use the program to fit my needs. Despite time spent watching video tutorials and contacting the company directly, I never felt confident in using the software for this study.

[124] To help with transcribing the interviews, I initially also tried Otter AI, an online tool that can be used for transcription. Although this software was a little helpful, I did run into a couple issues. The first is cost. Just like most other companies, there are tiered pricing for using this program. The more money you spend, the more the

software given the large amount of data I had collected for this study, but found myself overwhelmed with learning the software that took time away from my research.[125]

Choosing a Data Analysis Strategy

Data analysis is an ongoing process in a qualitative research study, and "begins during data collection" (Ezzy, 2002, p. xv). During the interviews, I needed to constantly assess and interpret what my participants were saying (or not saying) so to ask meaningful follow-up questions during the interviews. When transcribing interviews, I listened again to what my participants were saying to think about what additional information I might need for upcoming interviews. I also wrote analytic notes that included my perspectives and ideas regarding possible codes and themes as I revisited the data that were generated from the concept maps and interview transcripts. The concept maps created during the interviews and the transcript of interviews was analyzed as another form of analysis.

In the process of figuring out what type of analysis to use, I found myself struggling with choosing one. I initially gravitated toward grounded theory because my background as a mathematician have always been to find the "truth," and grounded theory seemed like a good method of working from the ground up to "find" those themes from the data. As my understanding of myself and the construction of knowledge have grown, however, I have come

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program will transcribe for you. I do not have the financial means to pay for the entire service, so I was only able to get about 30 minutes of each interview transcribed. In addition, some of my participants have a strong accent. Although Otter AI was able to transcribe some of the interview, I found many mistakes in the transcripts as the program could not understand some of my participants' language use.

[125] Saldaña (2013) acknowledges that while it is helpful to use software to help with analysis, he also recommends "that for first-time or small-scale studies, code on hard-copy printouts first, not via a computer monitor" (p. 26). Coding on printed paper with a pen/pencil has helped me take more control of how I was analyzing the data and felt more personal. Although I did not use software for this particular research, I do intend to learn a program in the future.

to understand that this conflicts with my epistemological view that multiple truths can exist and to "find" what those truths are is impossible.

In addition, while interviewing these women, I realized that they were not just sharing their understanding of mathematics success, but also their stories[126] and how they have come to their relationship with mathematics. As such, ignoring their stories to simply do a thematic analysis (or grounded theory) could take away the essential elements that have participated in their understanding of success. Thus, understanding that "there are no clear rules for determining boundaries, but the analytic decision is important, for it shapes interpretation and illustrates interpretation and illustrates once again how we participate in the construction of the narrative that we analyze" (Riessman, 2008, p. 41) and that I have also participated in the construction of the interviews and their stories, I decided to employ multiple coding methods (Riessman, 2008; Saldaña, 2013). My intent, therefore, was twofold: (a) to understand each of these women's stories and to tell it so that it highlights their success in mathematics and (b) to examine their narratives to "categorize" their experiences to compare them across all four women (in cross case analysis).

The Coding Process

As I continued to learn more about these women, I began to realize that the stories, or narratives, they were sharing with me were more than just them telling me about their experiences. While sharing their experience with mathematics, they were also telling me about

[126] Grbich (2007) stated that a key defining feature of a narrative is that the "stories are narrations of events which unfold sequentially over time" (p. 125). When listening to the women of my study talk about their experiences with mathematics, it became evident that they were telling their stories, starting in elementary school up to how they think about mathematics today. As stated earlier, this telling was initially what I was attempting to do, as many of the questions in the semi-structured interview guide asked them to describe their experiences at different moments of time.

who they are as individuals and how they interact with society around them. Thus, there were two routes that I took during the analysis phase.

As soon as the first interview began, I had already started my analysis. According to Ezzy (2002), "the task of interpreting qualitative data begins during data collection" (p. xv). During each interview, I had to constantly assess and interpret what the participants were saying in the interviews to ask follow-up questions for the next interview. Although I did not take notes during the interview itself (so as not to distract my participants while they were speaking and creating their concept maps), I did write down notes and memos[127] in my journal, which I referenced in between and after interviews. In addition, I listened to the audio multiple times in between interviews.[128] These notes and memos I wrote after each interview were my "pre-codes,"[129] as these were specific things I noticed during, after, and between interviews and were used to formulate questions for the next interview.[130] For instance, after Sasha's first interview, I wrote a note to myself stating, "ask about Sasha's family structure" because Sasha mentioned a few times during the first interview about how her family was "not supportive." To understand why she perceived this view of her family regarding her mathematics success, I created an initial code called "family structure," as something to consider as I continued with the interviews. This

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[127] Charmaz (2014) viewed memo writing as "crucial," as it prompts the researcher to "analyze data and codes early in the research process" (p. 162). These memos are meant to capture the researcher's thoughts, comparisons and connections the researcher may make, and provide future direction in the research.

[128] Although my intent was to transcribe the interviews in between them, I had a difficult time transcribing all of them before the next interview began (due to time constraints). With only about 2 weeks between interviews, I thought the best way to prepare for future interviews would be to rely on my notes and re-listen to the audio for each participant.

[129] Saldaña (2013) defines a code as "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data" (p. 3). Saldaña call this "pre-coding," as these codes guided the research process.

[130] Saldaña (2013) emphasizes the importance of this "pre-coding," and encourages the researcher in the process of "circling, highlighting, bolding, underlining, or coloring rich or significant participant quotes or passages that strike you – those "codable moments" worthy of attention" (p. 19).

process of referring to my notes and the audio continued throughout the interview phase of my study and helped me think more critically about how they connected to the women's narratives. With each interview, the number of pre-codes increased but also started to push me into thinking about the connections between the codes I was initially seeing.

Coding Cycles

Once the interviews were complete, I then fully transcribed all the interviews to begin the next phase of analysis. But before creating categorial codes, I wanted to determine the best way to code the data that would allow help me understand how these women perceived mathematics success, while also considering my eclectic theoretical lens. I decided to follow Saldaña's (2013) coding cycle methods and began to think critically about my researcher lens in how I would code the data.[131] Saldaña offers 25 coding methods that are divided into two main sections: First Cycle and Second Cycle coding methods. First Cycle methods are "processes that happen during the initial coding of data" (Saldaña, 2013, p. 58) and consists of seven subcategories: Grammatical, Elemental, Affective, Literary and Language, Exploratory, Procedural, and Themeing the Data.[132] Each of these subcategories involve coding methods that are shown in Figure 3.

[131] Saldaña (2013) emphasizes that "the act of coding requires that you wear your researcher's analytic lens" and shows how using In Vivo coding, for instance, can create a very different code than if the researcher used Descriptive coding.

[132] I offer a brief description of each of the coding methods Saldaña (2013) describes in his text. "Grammatical Methods are techniques for enhancing the organization, nuances, and texture of qualitative data. Elemental Methods are foundation approaches to coding qualitative texts. Affective Methods investigate participant emotions, values, and other subjective qualities of human experience. Literary and Language Methods draw on aspects of written and oral communications for codes. Exploratory Methods are those that permit open-ended investigation, while Procedural Methods are, for lack of a better term, "standardized" ways to code data. The final section, Themeing the Data, acknowledges that extended passages of code in the form of sentences can also capture the essence and essentials of participant meanings" (p. 67).

FIRST CYCLE CODING METHODS

Grammatical Methods
- Attribute Coding
- Magnitude Coding
- Subcoding
- Simultaneous Coding

Elemental Methods
- Structural Coding
- Descriptive Coding
- In Vivo Coding
- Process Coding
- Initial Coding

Affective Methods
- Emotion Coding
- Values Coding
- Versus Coding
- Evaluation Coding

Literary and Language Methods
- Dramaturgical Coding
- Motif Coding
- Narrative Coding
- Verbal Exchange Coding

Exploratory Methods
- Holistic Coding
- Provisional Coding
- Hypothesis Coding

Procedural Methods
- Protocol Coding
- OCM (Outline of Cultural Materials) Coding
- Domain and Taxonomic Coding
- Causation Coding

Themeing the Data

FIRST TO SECOND CYCLE CODING METHOD
- Eclectic Coding

SECOND CYCLE CODING METHODS
- Pattern Coding
- Focused Coding
- Axial Coding
- Theoretical Coding
- Elaborative Coding
- Longitudinal Coding

Figure 3. Saldaña's (2013) First Cycle and Second Cycle Coding Methods for Qualitative Data Analysis.

Note. Reprinted from *The Coding Manual for Qualitative Researchers,* by J. Saldaña (p. 59). SAGE.

First Cycle of Coding. In choosing a coding method, I took Saldaña's (2013) advice and thought about which method would best align with my research questions. Because I am attempting to understand how these women have come to experience and perceive mathematics success and wanted to closely align to their descriptions of success, I began my First Cycle coding with in vivo coding. "In Vivo Codes use the direct language of participants as codes rather than researcher-generated words and phrases" (Saldaña, 2013, p. 61). Thus, as I read through the transcripts, I began coding by aligning pieces of the transcript with a code that the participant used, "honoring the participant's voice" (Saldaña, 2013, p. 91).

As I continued with this First Cycle coding, I noticed, however, that this type of coding was not "capturing" the ways in which these women were describing their experiences as members of their family and society (i.e., it seemed to separate them from context). For instance, Cassandra began the first interview describing her decisions in why she initially pursued a non-STEM degree. Her aspirations of wanting to pursue a leadership position in helping other women advance in their careers was lost when I initially coded with the in vivo code "girl bosses." Although this code seemed to portray her views of women, it did not "capture" the struggles she herself had faced and the decisions she made to want to move in that direction in her life. I also found it difficult "choosing" the right words to describe the data. Charmaz (2014) stated that codes should fit the data to "the degree to which they capture and condense meanings and actions" (Charmaz, 2014, p. 118). Although it would have been "easy" to stick to the words participants used in interviews, I noticed that sometimes the language barrier made that more difficult in ensuring that the words they used had the same meaning as I was interpreting them. Working with people whose first language is not English caused some confusion on word choice. This possible misinterpretation highlights the importance of going back to the participants for clarification and the intent of their meaning when in doubt.[133]

I then went back to the First Cycle coding and decided to refocus my efforts into thinking about what my purpose was in speaking to these women. I then decided to use the Literary and Language methods (narrative coding in particular) to help me "capture" how these women saw themselves while pursuing a STEM degree. Saldaña (2013) defined narrative coding to explore

[133] I discuss member checking later in the chapter.

"intrapersonal and interpersonal participant experiences and actions to understand the human condition through story" (p. 132). Narrative analysis, however, include diverse methods, such as thematic, structural, dialogic, and performative (Riessman, 2008). In addition, the way that researchers decide to conduct a narrative analysis depends on what outcome they are trying to obtain. Polkinghorne (1995), for instance, distinguished analysis of narratives from narrative analysis. Researchers who choose to do an analysis of narratives "collect stories as data and analyze them with paradigmatic processes" (Polkinghorne, 1995, p. 12), which result in creating themes across stories. Narrative analysis, on the other hand, requires researchers to

> collect descriptions of events and happenings and synthesize or configure them by means of a plot into a story or stories (for example, a history, case study, or biographic episode). Thus, analysis of narratives moves from stories to common elements, and narrative analysis moves from elements to stories. (Polkinghorne, 1995, p. 12)

Although I wanted to portray these women's stories, I also wanted to focus on the content of their stories (Riessman, 2008); focusing on what was said (or not). Personal narratives and stories, according to Tuitt and colleagues (2009), "are important to understand lived experiences and how those experiences may confirm or contradict dominant belief systems" (p. 66). Discussions centered around their initial acceptance into college and the influence of their family, culture, and language on their educational journey, for instance, can help make sense of their experiences and perceptions of mathematics and how to be successful in it (Flyvbjerg, 2006). In addition, "when not much is known about a particular topic, narrative inquiry can be used to identify researchable questions" (Gubrium & Holstein, 2009, p. 18). Using narrative thematic analysis as an exploratory purpose allowed me to learn from my participants, as the goal of this research is to understand a particular group of women (those whose first language is not English), understand their perceptions of mathematics success (Saldaña, 2013), and to open avenues for further research.

The use of concept maps (as a document and as an elicitation method) not only allowed participants to think about and organize their thoughts of success but also served as a useful means of recall, providing a venue to capture experiential context cues. I therefore heard about participants' personal narratives and stories surrounding success, as their perceptions are based upon their prior experiences (which are historically and culturally situated). Codes were also created from the concept maps as well and focused on the content (what each women decided to portray in the map and how each concept was connected to other concepts).

Although thematic narrative analysis was employed in the coding process, I also paid attention to some of the narrative/structure of speech for each participant. To understand how these women positioned and presented themselves as women pursuing STEM degrees, I used "the poststructural strategy of 'hearing between the words': listening for both what was said and what was not said" (Stinson & Walshaw, 2017, p. 146). In other words, my intent is not to seek out the "Truth" but to "understand multiple, localized, contextual truths" (Power, 2004, p. 859). DeVault (1990) offered a number of strategies to consider, such as (a) using terms and categories used by women in their daily lives; (b) listening carefully to how women construct their experiences and accounts[134] (and also focusing on "what has been incompletely said" (p. 104); (c) considering the speech women use; and (4) representing the research in a way that new audience members can understand.

[134] DeVault (1990) argued that because women have had to assimilate or navigate in a man's world, "they learn to 'translate' when they talk about their experiences" (p. 101). The language they use may not actually represent the way in which they think or perceive a concept. The researcher must be able to "recover" these aspects of their lives by "listening around and beyond the words" (p. 101).

After First Cycle Coding. Before moving forward to the second cycle coding (as determined by Saldaña's, 2013, analytical process), I found myself with multiple codes after having applied the in vivo coding and the narrative analysis coding. Although some of the in vivo coding did not fully capture some of the content of what my participants were saying, I went back and did a narrative coding, which produced other types of codes. Not wanting to get eliminate all the initial coding from the in vivo codes, I took this opportunity to do an eclectic coding (see Figure 3), which employs "a select and compatible combination of two or more First Cycle coding methods" (Saldaña, 2013, p. 188). In this phase of analysis, I was able to combine codes from both the in vivo coding and the narrative coding. In Table 4, I provide an example of an excerpt of Cassandra's first interview with both in vivo and narrative codes to highlight what eclectic coding looked like at this phase of analysis.

Table 5
Example of Eclectic Coding

Excerpt from Cassandra's first interview	Code [attribute code]
I applied to all these schools as a political science major/human rights minor and stuff like that. I wanted to be like this lawyer, go to law school, etc. So that's why I really liked the appeal of [college], because it was a woman's college and like, Stacey Abram's sister went there. And like, the emphasis on leadership and developing women until you know, girl bosses and things like that. So, I went there. And I'm taking humanities. I told myself, like STEM sucks. I'm never gonna do math and science, like, I'm gonna defend the humanities for my life, and things like that, like, I would just rather die for the Humanities, like, I swore off some - I didn't take one single STEM class at [college] because I'm like, I don't want to do that. And my also my advisor - is because at [college] they try to trap you with taking courses that you can't really transfer anywhere else. So that way, you can stay there and get your degree there.	Began as political science major [narrative] developing women [in vivo] preferred women's college initially [narrative] STEM sucks [in vivo] Defend humanities for my life [in vivo] no initial interest in STEM [narrative] trap you [in vivo] structures in place at college that prohibited transfer [narrative]

Note. In this excerpt (from Interview 1), Cassandra describes her initial experience in college and her reasons for pursuing a humanities degree.

Second Coding Cycle. Once researchers have conducted the First Cycle method (at least one round), Saldaña (2013) then encourages researchers to conduct a Second Cycle method. The primary goal in this phase of analysis is "to develop a sense of categorical, thematic, conceptual, and/or theoretical organization from your array of First Cycle codes" (Saldaña, 2013, p. 207). During this phase of analysis, Saldaña offers six Second Cycle coding methods: pattern, focused, axial, theoretical, elaborative, and longitudinal (see Figure 3).[135] Wanting to understand the similarities and differences both within and between participants' narratives, I decided to do focused coding (Charmaz, 2014), which codes data based on thematic or conceptual similarity.

There were two cycles of focused coding. The first cycle focused on individual participants as the goal was to understand their narrative and perceptions of success as individuals. I described this type of analysis as "the initial creation of narratives" in the next section. The second round of focused coding centered on categorical codes of each individual, which I then compared to other participants in the cross-case analysis. This phase of analysis is explained in the cross-case analysis section.

[135] Axial Coding, according to Saldaña (2013), "describes a category's properties and dimensions and explores how the categories and subcategories relate to each other. Theoretical Coding progresses toward discovering the central/core category that identifies the primary theme of the research. Elaborative Coding builds on a previous study's codes, categories, and themes while a current and related study is underway. Longitudinal Coding is the attribution of selected change processes to qualitative data collected and compared across time" (p. 209).

Initial Creation of Narratives. Using focus coding, I took the codes generated from the First Cycle and focused on the content of the codes (i.e., what the codes say) and then made comparisons between them (Charmaz, 2014). "One goal of focused coding is to determine the adequacy and conceptual strength of your initial codes" (Charmaz, 2014, p. 140). Assessing each of these codes and comparing them with other codes helped to create tentative categories. Throughout this process, I used Charmaz's list of questions as guidelines:

1. What do you find when you compare your initial codes?
2. In which ways might your initial codes reveal patterns?
3. Which of these codes best account for the data?
4. Have you raised these codes to focused codes?
5. What do your comparisons between codes indicate?
6. Do your focus codes reveal gaps in the data? (p. 142)

Analyzing the codes in this way was the beginning of my thematic analysis, by comparing "initial codes to sort, synthesize, integrate, and organize large amounts of data" (Charmaz, 2014, p. 113). I tried to think about how my first cycle codes related to each other and whether certain codes appeared more frequently or held more significance than other codes. To help me organize the codes, I wrote each of the first cycle codes on post-it notes[136] and then tried to categorize them based on the similarities and differences I saw between the codes. In constructing these codes and categories, I actively named the data and defined which seemed significant to me by describing what I thought was happening (Charmaz, 2014), all the while trying to remain open to other possibilities. During this first phase of the second coding cycle, I did not try to force codes to fit in a particular place. Codes that did not quite fit into the

[136] Note that a different colored post-it was used for each participant.

"categories" which I was creating at that time were left to the side until the next round of analysis. Some of these codes were the starting point to create new categories, while others were merged into categories that were renamed/redefined.

Although I tried to use participants' words (the in vivo codes) to describe what I was seeing in the data, I felt that these codes were not always capturing how I was interpreting the data. By focusing on the content, it helped me stay focused on what was happening rather than thinking about each participant and making "conceptual leaps and to adopt extant theories before [I had] …done the necessary analytic work" (Charmaz, 2014, p. 117). This process forced me to not only determine the strength of my codes but also required that I go back multiple times to my initial codes and rename/readjust them. Although presented as a linear process, this phase of analysis required multiple rounds of coding—sometimes jumping back and forth between the first and second cycles of coding. I questioned repeatedly whether the initial codes served their purpose, especially when trying to determine how the codes related to each other. Throughout this process, I had Charmaz's (2014) question in mind: "what kinds of theoretical categories do these codes indicate?" (p. 144). Comparing the codes allowed me to identify larger categories as well as identify how pieces fit together. Codes that appeared to be unrelated to other codes could be grouped together and allowed me to "see" other ways in which things could be connected.

Working with a single interview at a time, I then isolated and ordered relevant codes into a chronological, biographical account; thus, trying to keep each participant's stories intact (Riessman, 2008). During the interviews, many of the women would speak about their mathematics experiences "out of order." Viewing their narrative as a mini "biography," I wanted to group the episodes/events together within each interview to give a sense of a timeline of their life. For example, an episode could be "elementary school" to indicate their experiences as a young child learning mathematics. After this process was done for each interview for each participant, I then combined similar episodes together to represent their chronological life (rarely do participants provide their life stories in chronological order).

In addition to the transcripts, the identity map for each participant that was created in the first interview (and in some cases revised in the first and second interviews) was also used to aid in the creation of each of their narratives. For each mapping, analysis consisted of identifying the objects that were drawn and making sense of the connections between the objects (or concepts). Because the construction of the concept maps occurred during the interviews, the analysis was not limited to just the concept map they created. Excerpts of transcripts were coded[137] based on participants words and how it was initially constructed (and later revised).

Given that participants shared their personal narrative[138] accounts, I used thematic narrative analysis.[139] Through this strategy, the focus is on content within the story that might reveal the cultural and historical accounts that have influenced these women's perceptions over time while also keeping their stories intact. Using their stories to communicate their experiences, emotions, and meanings to the greater audience (within and outside the research community) can provide a rich understanding of how their perceptions of success has influenced their own lives. This type of narrative analysis helped identify a narrative theme across participants—a pattern

[137] A description of the coding process will be explained in the next section.

[138] Some may argue that these personal narratives are also a form of counter-storytelling. According to Soloranzo and Yasso (2001), counter-storytelling "is both a method of telling the story of those experiences that are not often told (i.e., those on the margins of society) and a tool for analyzing and challenging the stories of those in power and whose story is a natural part of the dominant discourse ± the majoritarian story" (p. 475).

[139] Recall that narrative analysis is an umbrella term for a variety of methods that focus on stories (Riessman, 2008). Thematic narrative analysis focuses on what is said—that is, the content of the story.

that is found through each of their stories.[140] Once the narratives for each woman was created, initial drafts of their stories were sent to each participant for review.[141]

Analyzing Concept Maps

Concept maps created during the interviews (and the iterations of them from the first interview to the last) are sources of data that were generated and analyzed. The analysis of concept maps occurred during, in between, and after all interviews were conducted. In the construction of the concept maps, for instance, the participant and I created the concept map together, with the participant first creating the initial map and then the two of us engaging in conversation with the map in focus. During the interview, I asked each participant to describe and elaborate on the concepts that she outlined in the map (and any relationships between them). The transcript, as another data source, provided a recording of the decisions that were made within the construction of the map during the time of the interview. Thus, the concept map and each corresponding transcript informed each other during the analysis phase (occurring at the same time and informed each other).

As a document, the concept map provided both details of the constructs themselves (those identified by participants as contributing to their success) as well as the relationships between them. There are a variety of ways in which to analyze concept maps. One method is "concept counting," that identifies which concepts were identified by participants and how often they were in the map.[142] But in understanding women's perceptions of success, I was drawn to

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[140] I highlight these "patterns" in Chapters 9 and 10.

[141] Note that three of the four participants chose to give feedback on this initial draft. Skylar, who chose not to participate in this part of the research simply stated that she trusted me with her story and did not feel the need to read it.

[142] Concept maps have typically been evaluated through a quantitative approach (i.e., looking at the "correctness" of the map or counting the number of linkages, constructs, and placements). In this study, however, "establishing a hierarchy among concepts and instituting validity between linkages may cause the researcher to overlook important

the placement of the concepts within the map and the connections made between them. Therefore, I did not follow this type of analysis of the concept maps. Prior (2002) claimed: "People think with things as well as with words. How they arrange and organize things in the world is important, not least because the organization of things provides insight into the most fundamental aspects of human culture" (p. 70). During analysis, I focused on the criteria that were used by participants to classify and organize concepts, made note of key ideas contained within each concept, located the organization of things in relation to the entire map (part to whole), and noted how the organization of the map guided the participant in thinking about her perceptions of success (Prior, 2002).

Cross Case Analysis

Cross case analysis within case study methodology can help identify and consider the multiple ways that power and knowledge operate throughout the data. Mohammed and colleagues (2015), for instance, were able to use case study methodology to analyze the practices of both patients, family members, and health professionals in finding a curative treatment for cancer. Within their study, they interviewed multiple people to obtain multiple perspectives of how their participants were looking for a curative treatment for cancer. As they analyzed the practices that patients took in searching for a cure, it appeared that patients participated in multiple discourses and that their multiple subjectivities were shaped by their participation within those discourses. This participation affected the way in which the patients conducted themselves, especially with doctors overseeing their treatment. Some patients, for example, resisted the authority of the doctor even though they still wanted to receive oncological

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ideas embedded within the map and minimizes the significance of the individual's perspective" (Wilson et al., 2016, p. 1152).

treatment.[143] The participants "did not necessarily view the knowledge obtained from health professionals as inherently more credible, but rather used self-obtained understandings to compare, confirm, and sometimes discredit the knowledge obtained in the clinical encounter" (Mohammed et al., 2015, p. 109).

From a postmodern feminism and intersectionality frame, I used case study methodology and cross-case analysis to understand the relationships and complexities within each individual case as well as across cases. Rather than merely using an interpretive frame during analysis, I considered the conceptual differences and similarities of the data between the women. Rather than searching for a unifying "truth," I looked critically at the differences in the things the women stated in their interviews or showed in their concept maps. The focused coding that was done for each participant gave me codes and categories that I used in this phase of analysis. Taking those codes and comparing them with other women in the group helped me generate larger categories, or themes, which are presented in Chapter 9.

Additionally, I critically analyzed the ways in which the women use their power, agency, and resistance to navigate the world of STEM to reach their understanding of success. With the creation of the identity and success maps, participants highlighted ways in which their identities influenced their perceptions of success. They also discussed how their perceptions and experiences with success have helped shape the way in which they view themselves. The actions they have taken to achieve their success highlights the discourses within STEM that may continue to affect their perceptions of success. Just as Foucault (1982) theorized about subjects

[143] The way in which participants resisted some of the doctor's advice surprised the researchers because they initially thought that patients would be too vulnerable or lack the knowledge to negotiate on their treatment (Mohammed et. al, 2015). This finding also highlighted how the subjectivities of the researcher can influence the research process; thus, providing a case for the need of reflexivity.

and power,[144] women within STEM may be participating in discourses that shape their “self,” which in turn could be shaping the discourses around them.

Analytic Memos

Throughout the process of coding the data, I kept notes in my journal that described the reasons why I chose to code in a particular way or how codes were forming. Saldaña (2013) called this method analytic memo writing, stating that this method allows the researcher to “to document and reflect on: [the researcher’s] …coding processes and code choices; how the process of inquiry is taking shape; and the emergent patterns, categories and subcategories, themes, and concepts in your data—all possibly leading toward theory” (p. 41). These analytic memos served as an additional code or categorizing method (Saldaña), as the memos allowed for reflection in helping make decisions about which codes would stay and which codes would collapse into concepts.

Member Checking

Just as the patients in Mohammed and colleague’s (2015) study participated in discourses that have influenced their behaviors and their aspects of the self, I believe that women in this study have also participated within discourses that have influenced their decision to continue pursuing a STEM degree. Thus, with a postmodern feminist and intersectionality theoretical perspective, I looked at how these participations within particular discourses have influenced their notions of success.

[144] Recall that Foucault (1976) suggests that power is relational and “comes from everywhere.” Because the self is composed of multiple subjectivities within an individual, the self can shift with changing social situations.

Understanding that my interpretation of the data may not "accurately"[145] portray how my participants perceive success, I asked participants to verify[146] my interpretations of their experiences and perceptions of success. As a researcher and a former ELL who has had mathematical success, I had to consider that my interpretations may not reflect how my participants think about these concepts. During data collection, I started my initial phase of formal analysis. Once I created their narratives, I emailed all four participants my progress and invited them to engage in conversations about my analysis.[147] All four participants were given access to my final draft of my analysis so that they could view how they are represented in my work. I gave a general description of who they are as individuals in addition to data that support how they perceive mathematics success. Portions of the interview as well as their concept maps were included to support the ways in which participants engaged in the concept map creation, thought about the experiences and how those experiences have influenced their perceptions of success, and their overall perceptions of mathematical success within the STEM environment within higher education. Of the four participants, I received feedback from three of them.[148]

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[145] Although I do want to ensure that I am representing how my participants think about success (and the potential influences that have altered their definition of success), I do also acknowledge that there is no one "Truth."

[146] I also acknowledge that participants may not agree with my analysis of the data. This lack of agreement is not to say that they are "wrong," but rather as humans, sometimes one cannot interpret or "see" aspects of our lives that others may be able to.

[147] Stinson (2008), in his study exploring the mathematics and academic success of African American male high school students, reported that he engaged in numerous telephone conversations throughout the study with his participants to discuss his analysis. In a similar manner, I invited my participants to engage in conversations with me (either by telephone, Zoom meeting, or in person) to discuss my initial findings.

[148] As noted earlier, Skylar was the only participant who chose not to take part in this part of the research. She responded simply stating that she just wanted to be a part of the study (to take part in something she thinks is "very important") and that she trusts that I will represent her and the other women "well." She declined to read or engage in conversations about the study but is still in contact with me still today.

Ethical Concerns

As a mathematics educator, I have begun to shift the way I have thought about research and how to conduct it. To put it simply, quantitative methodology and the ways in which research is conducted within that realm is very different than qualitative. Like many of the mathematics education researchers who shifted to doing qualitative research, I have had to think about the "rules" of ethics and its applications within this research. Foregrounding ethics as a philosophy (Stinson, 2017) in research requires ethical considerations at every step of the research process: purpose, informed consent, confidentiality, data use and interpretation, and so on. Ethics is at the center of education research (Stinson, 2017).

Regarding this study, I continue to think about whether the choices I have made (and will continue to make) will address the ethical issues of doing no harm through the way in which I choose to represent my participants, present the data, contribute to the mathematics education community, and so on. From a postmodern perspective, I am constantly reminded of Foucault (1983/1997) troubling the word "dangerous;" how not everything is not necessarily bad, but if we consider everything to be dangerous, then there is always an action to take. Thus, although I implemented the methodological procedures that have been shown to address the ethical nature of research, I also take action with myself and my researcher ethics.[149] As a mathematics education researcher, I am continually asking and challenging myself to think about the ethical decisions I continue to make. Understanding my own positionality and how it can affect the research and participants in the study is just one way to address some of my own ethical

[149] Stinson (2017) highlighted the work of Guillemin and Gillam, who identify two different dimensions of ethics in research as "procedural ethics and 'ethics in practice'" (p. 4). Procedural ethics addresses the concerns of the Institutional Review Board (IRB) in that it requires a step-by-step process of how ethical concerns will be addressed in the research study. Ethics in practice, however, are the ethical issues that a researcher might address on a day-to-day basis while conducting the research (and may not be foreseeable). Although I attempt to address the procedural ethics within the outline of my methodology, the ethics in practice was addressed through reflexivity throughout the research study.

concerns. Being a reflexive researcher and "by continuously and chaotically engaging my ethics through the research decision-making process" (Stinson, 2017, p. 5), I attempt to make ethics as my first philosophy in research.[150] The following sections address some of the methodological procedures of this study.

Researcher Background

One of the first ethical concerns to consider would be the site itself and my position of authority. Given that I am a faculty member and researcher in the same institution where participants have been former students, I had to ensure that participants do not feel pressure to participate in the study, especially if they do not want to take part in it.

Other ethical considerations are tied to who I am as an individual. Certain positions, such as my gender, ethnicity, and age can have an influence on the types of dialogues I have with participants. I identify as an Asian American woman who has also had to take a similar path as my participants. I, too, was successful in higher education, as evidenced in my participation in this degree program. In addition, although my first language was not English, my language (free of accents that would indicate that English was not my first language) could possibly affect whether students choose to share certain feelings or information. Language, as an identity marker, can also indicate one's position and the fact that my English skills are similar to that of a native speaker could potentially affect the way in which my participants view me (in regard to whether I am just like them or not). How my participants interpret my positioning can affect the type of data I may be provided in the interviews or in the construction of the concept maps.

[150] Stinson (2017), drawing on the work of Paul Ernest, supported the argument that ethics should be the first philosophy for mathematics education research and practice. As an individual who is guided by my own ethics and values, I too think that ethics should be at the forefront of any research.

In addition to understanding my position as a researcher, I also struggled during the analysis phase. Participants' use of language, for example, was a point of concern, especially when they spoke a few words in another language or had to look up words to convey what they were trying to say. Skylar, for instance, would often use her phone during the interviews to translate particular words that she did not know the English translation of. The process of starting with the in vivo coding was my first attempt to "capture" how these women were thinking. During the First Cycle of coding, however, I realized that the content of what they were saying were not necessarily portrayed by just those initial in-vivo codes.

As I continued to analyze the data, I also realized my interpretations of the data were shifting over time (Ezzy, 2002). It seemed like each time I looked at the data, my thoughts would change, or I would have other ideas that I would want to explore further. Because my research centers on students' perspectives/perceptions of mathematical success, it is important to ensure that my interpretations align as close as possible to theirs. Throughout this process, I consistently kept memos of my codes and thoughts about how I wanted to address certain aspects of my research. This additional form of data allowed me to go back to my data and code again and to check to see if there were any differences in how I was interpreting what I read.

Representation

Another potential risk could occur in how findings are portrayed in writing. I am conscious of my authority and power on how I represent these women to a broader audience. With their permission, each of the four women happily agreed to share their story. Thus, in Chapters 5 through 8, I provide a brief description of each participant and their journey to pursuing a STEM degree. To ensure that all participants were aware of how they are represented in this work, I sent a draft to "ask research participants to 'vet' or otherwise edit or approve data and even interpretations that involve them" (Preissle, 2007, p. 527). Although participants did not find any areas in which they disagreed with, I wanted to provide them all an opportunity to disagree with my conclusions and make any necessary comments or revisions. It is important to ensure that participants feel they are a part of the process in creating the finished product, rather than relying on the researcher's interpretations alone. Presenting both interpretations considers multiple perspectives of the same phenomenon.

As a feminist who also happens to be a woman who has had success within the field of mathematics, I am aware that my participants are current students who actively make the choice to continue to pursue a degree in STEM and their perceptions of success may be different from my own. Qualitative researchers, Tracy (2010) argued, "do not put words in members' mouths, but rather attend to viewpoints that diverge with those of the majority or with the author" (p. 844). Despite my good intentions, I must also recognize that my own practice may contribute to certain discourses that surround the success of undergraduate women pursuing a STEM degree. The intent is not to contribute to only a single discourse, but rather to open avenues for investigation. Presenting multiples narratives and representations of undergraduate women who have been successful allows additional explorations of research to exist (Tracy, 2010).

Other Dangerous Possibilities

There is potential danger in any research. Even though my research intends to highlight the successes of people with diverse backgrounds, people who come from a positivist frame might want to generalize my findings to a larger, overall population. Although generalization is not the intent of my research, I must be aware of how others might perceive these findings. In my research design, I chose methods with the goal of achieving an ethical study that highlights not only their success within STEM, but also how they have learned to define success for themselves. These findings do not suggest that certain “types” of people can or will be successful in mathematics nor does it imply that certain kinds of experiences can guarantee mathematics success for those who pursue STEM careers. This study simply offers another interpretation of what success might look like, how it has been perceived, and how that success has been achieved from a somewhat similar diverse group of students at a particular point in time and context.

Qualitative Reliability

Despite the amount of work done in qualitative research, there are still many who criticize the work due to its “lack of reliability and validity.” Yet, “applying traditional criteria like generalizability, objectivity, and reliability to qualitative research is illegitimate” (Tracy, 2010, p. 838). Coming from postmodern feminism and intersectionality frame, I view the researcher as the primary instrument for data collection and analysis. Understanding my own subjectivities before and during the study is an important facet of methodological rigor (see Manias & Street, 2001). For instance, before beginning this study, I had to reflect upon my own experiences within STEM and the intersectionality of all my subjectivities. I am not just a woman, whose first language was not English, but have been successful within STEM to become not only an undergraduate instructor of mathematics but also a mathematics education researcher.

Moreover, I must consider how my positioning could become blurred as I conduct the study as I am sure I will have some similar experiences with my participants. For example, in Mohammed and colleagues’ (2015) study, Shan Mohammed, as a former oncology nurse studying the perceptions of people who are terminally ill with cancer, had to consider how his past could influence the interview process. As a former oncology nurse, he wanted to protect his patients and was hesitant “to probe deeper about certain emotionally laden topics (for example, funeral preparations), despite the importance of these topics to the study aims" (p. 110). Although I have successfully completed a STEM degree, I am not in the process of completing it. My participants, however, will have a greater understanding of what their experience within STEM is like currently. As an instructor, I need to think about how my positioning has given me a different perspective and that I will need to probe deeper if I want to learn from the participants. I should not assume I know what they are talking about simply because I have been a STEM student myself. The context, time, and space are not the same as they are experiencing it now.

As a researcher and former instructor of some of these women, I must also acknowledge the power I have over these women. Being a former instructor could either open up new avenues for discourse within the interviews (as they may feel more comfortable with me due to familiarity) or it could potentially repress some of their thoughts because they may think I am judging them. Although the focus of the research is on their perceptions of mathematics success, participants may be hesitant in speaking about some of the challenges, especially if they feel I am too close or know people within the STEM community in which they refer to. To limit this possibility, I attempted to create an environment in which the participants felt that I was genuinely interested in what they think versus what is "true" or "right." Speaking to them individually in a space they choose to conduct the interview also help, I believe, them feel more comfortable and willing to share their ideas about their mathematics success.

Because qualitative case studies rely on the integrity and sensitivity of the researcher (as the researcher as seen as the primary instrument for data collection and analysis), the researcher and reader need to be aware of the biases that can affect the interpretation of data. Regardless of the type of research being conducted, however, "the question of subjectivism and bias toward verification applies to all methods, not just to the case study and other qualitative methods" (Flyvbjerg, 2006, p. 235). Presenting my epistemology and subjectivity statements as well as the reasons as to why I choose certain methods are some ways of controlling these effects.

Constant reflection and visiting the data throughout the research process is crucial in creating quality work (Bogdan & Biklen, 2016). Inserting concept maps during the interviews, for instance, requires the understanding that the concept maps are being co-constructed by both me and the participant. The concept mapping framework "recognizes that the construction of knowledge has multiple meanings and subjective realities" (Wilson et al., 2016, p. 1153). Given that each participant co-constructed a concept map that is socially, culturally, historically, and linguistically produced requires reflexivity of the researcher which needs to be implemented throughout the entire process (Creswell, 2003). Providing transparent methodological accounts of the research process as well as stating my own values and beliefs assist readers in understanding how I came to my conclusions (Creswell, 2003).

Being a reflexive researcher also means I must consider that my interpretation of success may not be representative of how my participants have come to view success. Throughout this process, I had to listen to and respect my participants' experiences and be aware of how my own personal values and preconceptions can affect the research (Lather, 1991). The way in which these women experience mathematics has been both similar and different to my own. Some of these experiences differed based on culture, context, and so on, and have affected the ways in which they perceive success. Therefore, I took time to continually review the multiple assumptions that I brought to the research process. For instance, understanding my previous assumptions about STEM culture while listening to their views and perceptions of the STEM field. Being a part of this study also meant I had to consider how the study has shaped and continue to shape my own self throughout the research process. Engaging in conversations about discourses that shaped my participants' view and attainment of success has also influenced the way in which I interpret and view the same discourses.

Moreover, because language (i.e., the words participants use) was sometimes a barrier in analyzing the transcripts,[151] going back to the participant using other forms of elicitation (such their concept maps) helped ensure that I was capturing their intended meanings. These "member reflections"[152] allowed me to share my initial findings with participants and provide opportunities for me to ask my participants questions while also obtaining their critique and feedback (Tracy, 2010). This process also allowed me to engage in deep reflection about what is being constructed from the data. Employing methods such as follow-up interviews, member checking, and journal memoing increased the likelihood that participants were co-constructors in the research and that the data/findings did not merely represent my interpretations alone, which in turn somewhat addressed the validity of my claims.

Although other researchers may try and attempt to replicate this research, I acknowledge that this study may not represent the feelings/interpretations/thoughts of other students who have had similar experiences. Given that "different constellations of interviewers and interviewees will result in different knowledge products" (Kvale & Brinkmann, 2009, p. 302), the data generated in this study may not be replicable. Methods typically used by researchers, such as making use of multiple researchers, data sources, methods, and so on, are often used as a form of

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[151] Of the four participants, one participant was not completely fluent in English. Although she was able to speak English conversationally, there were moments during the interviews when she would Google a particular word or phrase to try and convey meaning.

[152] Member reflections can take the "form of member checks, member validation, and host verification" where findings are brought back to participants for them to verify analyses (Tracy, 2010, p. 844). As one method of enhancing the qualitative credibility, it allows researchers to ensure "they got it right" while also providing opportunities to collaborate with participants and shed light for deeper analyses (Tracy, 2010).

triangulation.[153] Triangulation, however, assumes that a single reality exists (Tracy, 2010), which goes against the purpose of this study. The use of multiple types of data (i.e., concept maps and interviews) and different methods of analyses is intended to "allow different facets of problems to be explored, increases scope, deepens understanding, and encourages consistent (re) interpretation" (p. 843). Rather than triangulate the data to assume that a single reality exists, crystallization,[154] was employed as it allows the use of multiple types of data, methods, and theoretical frameworks to "open up a more complex, in-depth, but still thoroughly partial, understanding of the issue" (p. 844), allowing room for multiple voices to be heard and acknowledged. The multiple data sources, the input of both researcher and participants, as well as the theoretical lenses of postmodernism, feminism, and intersectionality were used to acknowledge and hear multiple voices surrounding the issue of mathematics success.

Lastly, I write my findings in a way that demonstrates the complexities and contradictions of the case (Flyvbjerg, 2006). Providing a narrative context allows voices of all participants involved to be captured and presented (Savin-Baden & Niekerk, 2007), while also highlighting their achievements. Using selected quotes to present my findings not only provided a space to specific ways in which my participants think about success (Kvale & Brinkmann, 2009), but also illustrated the multilayered complexity of the data.

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[153] Triangulation is often used in qualitative research and "assumes that if two or more sources of data, theoretical frameworks, types of data collected, or researchers converge on the same conclusions, then the conclusion is more credible" (Tracy, 2010, p. 843).

[154] Crystallization encourages researchers to gather multiple types of data and employ various methods, multiple researchers, and numerous theoretical frameworks. Different from triangulation, however, crystallization assumes that the aim of doing so is not to provide researchers with a more valid singular truth, but rather to allow more in-depth, multiple understandings of an issue (Tracy, 2010).

Concluding Thoughts

In this chapter, I described the research methodology that framed my study on the perceptions of women, whose first language is not English, about their mathematics success. I outlined my research design and the considerations I took to ensure that I conducted a sound and ethical study that not only offers new ways of thinking about success but also hopefully will promote new discussions in the STEM field. Many of the interviews conducted met for approximately 1.5 – 2 hours, as indicated in the IRB. Three of the four participants, however, often engaged in conversations with me for an additional 30 minutes to an hour outside the interview itself. While those conversations were not recorded, the relationships that were created during that time provided opportunities for me to reflect upon their individual uniqueness and how I want to portray these women in my work. Although I am interested in their perceptions of mathematics success, I was often reminded that their perceptions were linked to their history, their ways of knowing, and the way in which they engage with the world – their humanness. These components of the self cannot be ignored and can only strengthen this type of work.

As a collective case study, I present the data in such a way that first highlights each of these individuals and provide a detailed description of their individual case before "considering the emerging similarities and differences in cross-case comparisons" (Crowe et al., 2011, p. 6). Before sharing some of their ideas of what mathematics success looks like, for instance, I begin by providing information of how I have come to know these women and descriptions of my four participants (each with their own chapter[155]), in hopes that the reader can create an image of what these women look like, imagine and relate to some of the struggles they have faced (and continue

[155] As I was analyzing the data, I realized that each woman deserved to have her own chapter to highlight the complexities of who she is and the experiences she has had. To remain "fair" in the order of how they are presented, I simply went by alphabetical order of their pseudonyms. Thus, a description of Cassandra and her story will be presented in Chapter 5, Sasha in Chapter 6, Skylar in Chapter 7, and Wing-Yu in Chapter 8.

to face), and to provide a context to their stories and perceptions of success.[156] In addition, I share each woman's identity mapping[157] to highlight the ways in which these women organized their thoughts about themselves and the relationships between concepts that have had an impact on their lives. I then provide descriptions of the ways in which these women think about and conceive what mathematics success looks like and how they view themselves within these thoughts. I end each chapter with a description of how each woman describes her own personal journey and how she represented herself in the final construction of her maps.

In Chapters 9 and 10, I then consider the similarities and differences across these women and their experiences and provide some "answers" to the questions that guided this study. I hope the work done in this study will help propel STEM educators in thinking about how it is necessary to trouble what is the norm and to think about how just because structures currently exist (and have been "working" in the past for some) does not necessarily mean they are the best structures. And who better to hear from than those who are living through those structures currently?

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[156] Note that these descriptions are based on my own experiences with these individuals and can only reflect how I perceive them from my own theoretical standpoint. This is not to say that these descriptions are "not true," but as a postmodern feminist, I believe that this simply provides one way of knowing who these women are. Providing this context helps the reader understand how I came to my conclusions, as these are based on my own personal reflections.

[157] Recall that in the first interview, each participant was asked to create an "identity" concept map, which highlight the ways in which they view themselves and how they make connections to other aspects of their selves.

CHAPTER 5

CASSANDRA

Of the four women, Cassandra was the only participant whom I had never met before the study began.[158] Our initial conversations began over email, as we tried to find times to meet, and eventually led us to meet in person in May 2023. Upon meeting Cassandra, I noticed that she was a little bit taller than I (I am 5'5" on my best day) and had long, straight black hair. She was wearing jeans, sneakers, and a black tank top, which also matched the eye-frames she wore. She was carrying a backpack, which appeared to be heavy as she needed both straps.

As we sat down and began talking about the research and consent form, my initial reaction was that she appeared to be friendly but also a little shy. She seemed genuinely excited to be a part of this work and would often refer to this study as "amazing work" in conversations through text. We spent a lot of time outside of our interviews talking about my own desires and passions and how I intend to use this study to possibly make institutional changes in the future. Cassandra was always asking me questions about my work. I didn't realize it at the time, but her questions regarding how this work would be used aligns with her desire to implement change as a woman of color.[159] Her excitement in my work and her willingness to share some of her most intimate thoughts surrounding her experiences as a Hispanic woman in STEM made the time we met memorable and personal.

[158] During the recruitment phase, I reached out to other faculty at the institution inquiring if any of their students would be interested in participating in this study. Cassandra responded immediately, showing genuine excitement and interest in the study.

[159] More about Cassandra's desire to participate in advocacy work comes later.

Cassandra's Story

Cassandra was born and raised in the Atlanta area. Although her first language was Spanish, Cassandra can speak both English and Spanish. Both of her parents are Mexican and work together in their family business (painting and residential work). Her mother is Mexican American; having spent half her younger life in Mexico before moving to the United States and can speak both English and Spanish. Her father, who is also from Mexico, speaks primarily Spanish. Cassandra has a younger sister (ten years her minor) who is also bilingual.

Although Cassandra is bilingual, she shared that the journey to becoming bilingual was in large part due to attending school but also from her mother's decision to speak English at home. Cassandra grew up speaking Spanish first, but when she was in first grade, she was placed in an ESOL class. Her mother, fearing that her daughter would be separated from the rest of her classmates, decided to stop speaking Spanish at home and required Cassandra to only speak English in conversations with her.[160] Having one parent who spoke English and one parent who spoke Spanish allowed Cassandra to maintain both languages. This decision made by her mother seemed to help keep Cassandra out of the ESOL program as Cassandra stated that she no longer had to participate in the ESOL program after second grade.

Besides being placed in an ESOL class initially, Cassandra stated that her elementary school years were mostly "fun" (Interview 1). She loved her teachers and felt that they were overall good to her and her classmates. She remembered spending a lot of time reading English books (not just because English was required in school, but also because she did not think

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[160] Cassandra noted that although it was important to her mother that her children spoke Spanish, she was also aware of the possible actions the school would take to ensure Cassandra could speak English (i.e., placing her in ESOL classes). Knowing that she was the only one in the family who could speak both English and Spanish, Cassandra's mother decided it would be more beneficial to her daughter if she only spoke English to her at home. She did not perceive this as a sacrifice because Cassandra had other members of the family, such as her father and grandmother, who could speak Spanish to her.

Spanish books were available in her library to check out). She enjoyed reading so much that she would often engage in conversations around book series, such as *The Hunger Games*, with her peers. She continues to read as a hobby today.

It was not until middle school when Cassandra began to think that she was "advanced" in any of her schoolwork. Her passion for reading and the humanities in general helped her gain access to the higher-level courses, such as AP English and A.P. History. Mathematics, however, was never really on her radar as a strength. Cassandra stated that she doesn't particularly remember feeling weak or strong in math in elementary school but in eighth grade, Cassandra was placed into the advanced math track.[161] As an eighth grader, the school informed her that she would be taking ninth grade algebra:

> So, when I got to eighth grade, and I was in that algebra class, I was a little bit lost. And it was just kind of like I didn't really have much guidance, like I said, from my parents. I don't think my parents either understood the significance of taking that math course in eighth grade so I would come early for review sessions and get help from my teacher. But I think math just became less fun and less engaging than elementary school, so that's probably why I lost interest. (Interview 2)

At the time, Cassandra didn't understand the significance of that placement and "didn't take it as serious as other kids" (Interview 1) in her class.

In high school, Cassandra continued that track, having taken Geometry, Algebra II, and Precalculus. During her senior year, she had the opportunity to take AP Calculus, but chose to take the "regular calculus class" because she believed she could not do well in an AP mathematics course. Prior to the first day of classes, her AP Calculus teacher had given students

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[161] Cassandra was not sure how or why she was placed in this track. She believed that she did well in seventh grade, but also felt that the teacher recommended her to take this course.

a review sheet to prepare them for their first exam during the first week of school. The content on the review was mostly precalculus concepts. Cassandra stated that she did not study much from the review, believing that she knew most of the concepts because she had just taken precalculus the previous year. After doing poorly on the test, Cassandra decided it was in her best interest to move to a different mathematics course.

Yet high school was not a time when Cassandra focused primarily on grades. Although she always worked hard to earn at least a B in her classes, she described her time in high school as a time when she began to "see" how the world worked. For example, in the beginning of her junior year, Cassandra admitted that that was the first time she started thinking about going to college after high school. Despite being in a "good" school, Cassandra stated that her guidance counselors never mentioned college to her; instead, she learned about college from an outside organization called the Hispanic Organization Promoting Education (HoPe).[162] Because she did not know about the opportunities she could have, Cassandra began questioning why such an organization did not exist at her school given the increasing number of Hispanic students attending the school. Upon reaching out to "the only Latina teacher at the time" (Interview 1), Cassandra established a HoPe leadership chapter[163] at her school.

During her time in high school, Cassandra did not think she would ever pursue a STEM degree: "When I applied to all my colleges in the fall of 2018/spring 2019, my senior year of high school.... I was applying as a political science major because I wanted to be the next Stacey

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[162] HoPe is a non-profit organization that helps build communities for Hispanic/Latino populations. According to their website, one of their goals is to empower students to grow through leadership and educational opportunities while also helping students feel that they belong in school and other spaces they have traditionally been excluded from.

[163] HoPe leadership chapters are typically led by students and their chapter advisors to provide a space for students to strengthen their leadership skills, have access to educational guidance and resources, and participate in various community activities.

Abrams" (Interview 1). During that time in her life, she was heavily influenced by women of color in politics, such as Alexandria Ocasio-Cortez (AOC). Women in politics influenced Cassandra to enroll in a women's college with an "emphasis on leadership and developing women to girl bosses and things like that" (Interview 1).

When she began her college journey, Cassandra was determined to enter the world of policy. At that time, her interests were so focused on that path that she chose not to take any STEM courses within her first year of college. Instead, she focused primarily on getting her humanities credits completed and waited to take her required STEM courses later.[164] She excelled in her first semester in college, stating that she earned all As and was excited to return in the spring.

Spring semester of 2020, however, was when the pandemic changed the course of her life. Halfway through the semester (in March), Cassandra was told that she had to move off-campus, as students were no longer allowed to stay there due to the pandemic and social distancing. She finished the semester taking classes online and began to think about her purpose in going to school. Rather than continue her education the following fall semester, Cassandra chose to take a gap year to reassess her goals. Despite her academic advisor encouraging her to continue her education at the school, Cassandra knew she did not want to take online courses and felt "really guilty trying to pursue an education during that time because like…I just felt like the sky was falling" (Interview 1). She continued to work small jobs during the gap year but spent most of that time helping her grandmother who lived across the street and diving into random projects (crocheting, baking, etc.).

[164] Cassandra stated that she only had two STEM courses that were required for her degree so did not think it would affect her much to wait to take those courses.

During that time, Cassandra also read a lot about the global effect of the pandemic. The impact of COVID, for instance, was not just on humans, but also on the environment.[165] Seeing how climate change could affect people and the environment, Cassandra began to shift her interest from politics to environmental science. As she began to research more about climate change, Cassandra also began to see how "people of color are disproportionately affected by environmental injustice" (Interview 1). The current infrastructure of her county, for instance, has a lack of people of color "in rooms where they made these [types of] decisions" (Interview 1). Public policy, such as whether the public transit system should be extended to the suburbs of the city, can greatly affect who has access to certain resources. In pursuing a STEM degree, Cassandra stated,

> my biggest push to STEM in the first place was because if I do STEM, then I'll have the tools and knowledge to be able to have the data behind me so you can't really disagree with me. And use it as leverage—to combat environmental injustice. I felt like that was more conducive for change. (Interview 1)

Surprising even herself, Cassandra decided she needed to pursue a STEM degree so that she could begin to make positive changes in the world. Given that the college she was attending was primarily known for its humanities, Cassandra looked for alternative options: "So, at that point, I didn't really have a plan. But I knew that I wanted to do STEM" (Interview 1). Thus, after the gap year, she decided to enroll in a small public college (where she is currently) to work on the necessary classes she needs for this new major.

[165] Despite the negative effects COVID had on humans and human interaction, Verma and Prakash (2020) argued that the lockdown many countries had positively affected the environment. The lack of human activity, for example, lowered the amount of pollution in the air.

Construction of Cassandra's Identity Map

Before Cassandra started drawing her identity map, she began to describe herself as having a personality that is "intense" (Interview 1), as she is the type of person who will either invest her time wholeheartedly into a project or not at all. She then stated that by participating in this study, there was a purpose and good reason to get involved—her participation could help make institutional changes for others like her.[166]

Cassandra created her map by writing down aspects of herself as they came to her like a stream of consciousness without taking too much thought prior to writing. She began by writing her name in the center and drew an oval around it (as shown in Figure 4). She then proceeded to draw spokes from that center and started writing words and phrases she said described who she is as a person. The first spoke Casandra created connected with the word "college student," followed by "young adult." As Cassandra created each spoke from the center of her map to a word or phrase, she provided a brief description as to why she included it in her mapping. For example, when she wrote "crafty/resourceful," she stated that she thinks she can "make the best of any situation" and is always able to "play the hand" she has been dealt (Interview 1). Many of the words she used to describe herself either represented how she is seen by others (such as being charismatic, ambitious, crafty/resourceful) or ways in which she saw herself (such as a reader, a good pen pal, lifelong learner). Cassandra also included elements of her identity and her family structure, such as daughter, cousin, sister, and friend.

[166] During the interviews, Cassandra was always very focused on completing her mappings until they were "perfect." There were times when we would run out of time for the interview and Cassandra would continue writing and drawing until the very last minute. Even to this day, she will text me for updates on my work and is looking forward to reading the final product of this dissertation. I am grateful for her dedication and focus to this study and her wanting to ensure that she provided enough detail to her work.

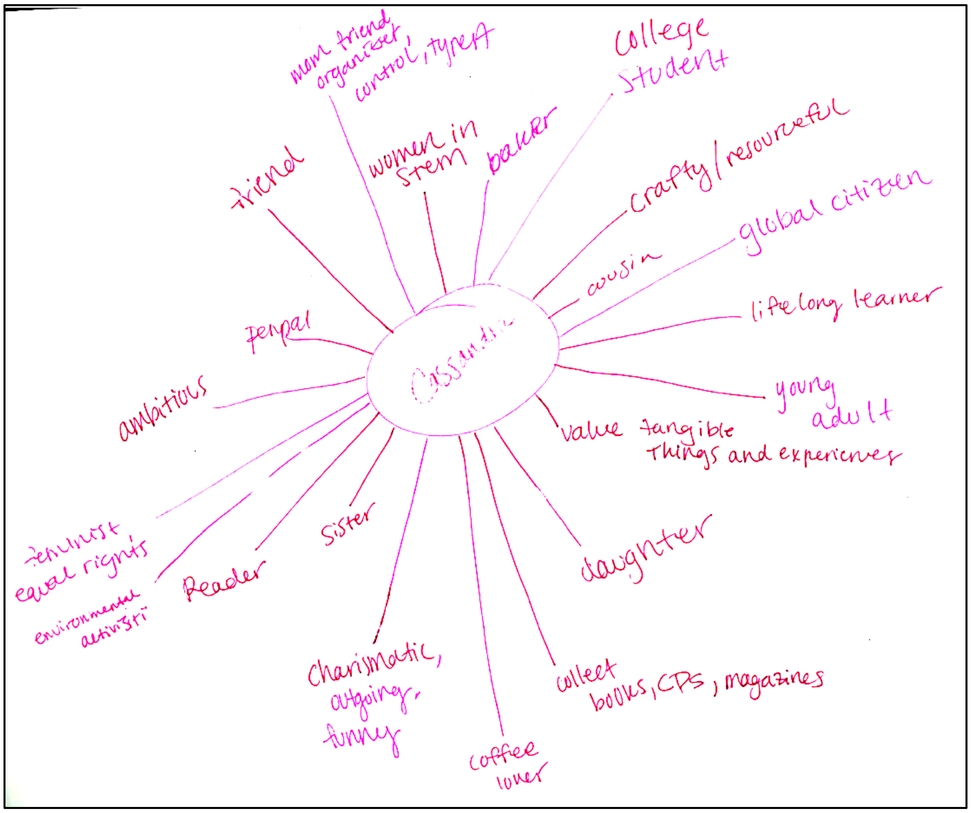

Figure 4. Cassandra's Identity Map.

Note. This concept map was created in Cassandra's first interview and represents some of the ways in which Cassandra described herself.

Connections Between Concepts

At first glance, the concept bubbles Cassandra made did not seem to have connections with one another—or at least it did not appear to have any more connections than being connected to the center. But in the second interview, when Cassandra was asked to show which concept bubbles she felt were the most important, it appeared that all the bubbles she felt more closely reflected her were interrelated with each other.

The second interview began by asking Cassandra to explain more about the placement of her bubbles in her original mapping. For instance, why were the spokes of different lengths? Cassandra responded that her primary concern when creating the map initially was to ensure she included all the ways in which she views herself. While she considers all the elements of her mapping to be "equally important" (Interview 2), she stated that some of them took up more time in her life and were thus significant. She differentiated these from the other words and phrases by highlighting them in green (see Figure 5). As she highlighted each word or phrase, she gave reasons as to why those descriptors were most prominent in her mind.

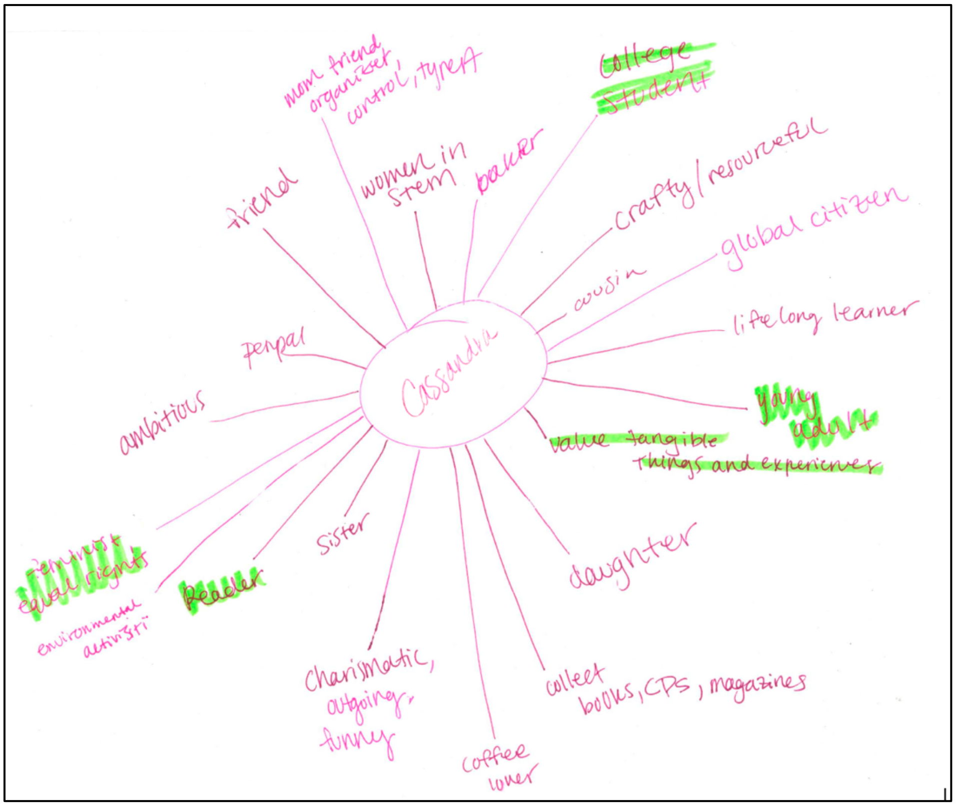

Figure 5. Revision of Cassandra's Initial Identity Map.

Note. This concept map was revised during the second interview. The highlighted words and phrases indicate those descriptors Cassandra felt most accurately portrayed herself at the time the interview was done.

The first phrase Cassandra highlighted was "value tangible things and experiences" because she really "values tangible things like mementos or memories, like in photos" (Interview 2). When asked to expand on that further, Cassandra stated that she perceives herself as being ambitious and someone who is always looking for opportunities. She described her many internships she has had over the years to provide evidence for her ambitious nature.[167] But although she values being able to experience different things, she stated that it is just as important to remember them because they "often inform other things I do" (Interview 2). Therefore, she often collects souvenirs to remind her of those experiences.

Cassandra then drew her attention to the phrases "young adult" and "college student" and highlighted them both. When asked why she highlighted those words, Cassandra stated that being a young adult in this current time is extremely important because those of her generation are the ones who can make the most impact and enact change. The phrase "college student," however, holds a different meaning as she views it as a "privilege" (Interview 2) given that she is the first in her family to go to college.[168] Although Cassandra views herself as being both a "young adult" and a "college student," her reasons for including both were distinctly different but also related to one another. Upon further elaboration, Cassandra stated that while both are important ways in which she describes herself, she does feel some pressure[169] within both realms. There is the pressure of her generation being the ones who can make a difference in the world and then there is the pressure of knowing that she does have the privilege of going to college and that she "should not waste it" (Interview 2). Both pressures seem to point to this idea that she is responsible in enacting some sort of change—in the family and in society.

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[167] Over the past few years, Cassandra has been active in trying to figure out what she "wants to do with her life" (Interview 1). She has applied and gotten many different internships, including working in a museum, working for the voting office to call people in the state of Georgia, and the National Park Service.

[168] Cassandra shared with me that her mother did complete a couple years at a community college but that her father did not complete his education beyond 5th grade. Even though her mother did attend a community college, Cassandra still defines herself as a first-generation student because her mother never attended a 4-year institution and never graduated.

[169] Throughout the interviews, Cassandra had a difficult time pinpointing where she thought the pressure was coming from. She stated numerous times that her family does not understand or value education in the ways she does and have often tried to encourage her not to go to school and instead work to earn money. She has pushed back on these encouragements and wants to continue with her education despite how her family seems to want a different path for her. She does feel there is a sense of responsibility placed on her for being a Hispanic woman in college.

Being a first-generation college student has helped her see "how important education is for society and especially for women" (Interview 2). As Cassandra described her experiences in college so far, she stated that her accessibility to higher education has been very important in helping her "engage in the intellectual and social challenges of our times"[170] (Interview 2).

Having gone to a women's college helped her learn more about the importance of feminism and encouraging women to become future leaders. Cassandra highlighted the phrase "feminist/equal rights" because her education will help her, and other women like her, "create a more fair environment for women and also their allies" (Interview 2). In addition to how she views how women are being treated in the world, Cassandra stated that feminism has mostly been "spearheaded by white women and only really concern themselves with their issues" (Interview 2). As a woman of color and a young adult, Cassandra has felt responsibility in making sure her voice and those who identify like her are heard:

> I'm just being a young adult and how our—our voice means a lot, especially when we vote. Like as a voting group, because of the issues that we care about, and how politically active we are. Because we probably have more time to do that type of stuff versus when you get older, and you have more responsibilities. And also, because we are going to be the generation that inherits a lot of problems. So, we have to rise up and fix them. (Interview 2)

Cassandra concluded her edits by highlighting the last phrase "reader" to indicate that with this sense of responsibility, there is a need for her to read. Although Cassandra says she enjoys reading for fun (and will often go to the teen section of the library), she spends a great deal of her

[170] Cassandra admitted that this phrase was the motto of the women's college she went to but that she has adapted it into her own life. "What's the point in education if it isn't to solve problems and learn ideas in how to make it better?" (Interview 2).

time following and reading “a lot of people in the environmental field that are academics that do research” (Interview 2). As someone who is looking to merge the humanities, STEM, and advocacy, Cassandra is interested in learning how others in field are addressing social issues.

Cassandra’s Perceptions of Her Own Mathematics Success

When speaking specifically about her mathematics experiences, Cassandra described them as being “okay for the most part… it was positive” (Interview 2). She recalled there being a transition in the way mathematics was taught, which affected the way she perceived mathematics as being fun or not. For instance, Cassandra enjoyed mathematics in elementary school because they were “using the tactile stuff—like the bears. The colorful bears for the ones and tens…And hundreds like those blue blocks. Those were fun” (Interview 2). While she enjoyed these activities in school, she did not feel as though she was prepared well for county or state exams. In describing her experiences around mathematics exams, Cassandra stated that she “always had anxiety for the testing part and was never prepared” (Interview 2).

Part of her struggle came from not being able to get help at home as her parents could not really help her with her homework. In addition, Cassandra stated she was a shy and timid kid and “never felt comfortable asking questions at school” (Interview 2). Without getting the help at home and not feeling comfortable enough to ask for help at school, Cassandra often did not feel prepared. In addition, Cassandra earned mostly Bs, which indicated to her that she was an average student:

> I think there was always room for improvement. I wouldn’t be struggling too much to have to get extra help. I think I was able to scrape by and just being average. I’m not necessarily like exceptional or like in math ahead of my grade or advanced or …anything like that. (Interview 2)

She proceeded to earn Bs throughout elementary and middle school, which meant that she wasn't excelling in mathematics but also meant she didn't need remediation. Nevertheless, Cassandra felt that although her grades were "average," she believed that her mathematics foundation was "a bit shaky" (Interview 2). So, when her teacher in eighth grade asked her if she wanted to earn high school credit and start with algebra (which would allow her to start with geometry as a freshman in high school), Cassandra was surprised. The opportunity to move into the algebra class, however, did not improve her perceptions of herself regarding mathematics. Cassandra ended her eighth-grade year with a B in her algebra course, which worried her because she now knew that her average starting high school was a 3.0. in her ninth-grade year, she decided she was going to "try harder" (Interview 2) and took advantage of every opportunity her teacher provided the class, such as test corrections or coming in for additional help. She was able to earn an A both semesters by remaining focused on her classes and surrounding herself with other students who took their coursework seriously.[171]

Cassandra continued to earn As in her mathematics courses her sophomore and junior year. When it came time to take AP Calculus her senior year, however, Cassandra began to struggle within the first couple of weeks. After taking her first exam in the course (which focused primarily on precalculus concepts), Cassandra did not feel she was capable to do well in the course, especially when comparing herself to other students.[172] She described the class as being "blended" because it consisted of seniors, juniors, and some sophomores. When she saw that some of the other students earned above a 100 on the first exam, Cassandra looked for other

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[171] Cassandra often spoke about meeting other students in the library to study and looking up to the students who did well in her classes.

[172] Cassandra did not state explicitly what her grade was on the test, but that she "did not do well" (Interview 2).

mathematics courses to take. She spoke to some of her previous mathematics teachers to seek advice and ultimately decided to take “a regular calculus class” (Interview 2).

Cassandra later admitted that this decision to move to another mathematics class was partly because she was intimidated by the other students in the class (especially the sophomores who “were the ones getting the highest grades” [Interview 2)) and it was her first time taking an AP STEM course.[173] Feeling intimated and ashamed to talk to her AP Calculus teacher, Cassandra instead decided to pull herself out of the course and enroll in the Calculus course. Although not as rigorous as AP Calculus, Cassandra stated that the calculus course she did take was a better fit for her. She was able to earn an A that first semester, but then her grade dropped to a C her second semester of her senior year. Cassandra explained that her grade dropping to a C was “her fault” (Interview 2) as she didn’t put the time and effort in the class. She developed senioritis and was late to school often.

When Cassandra went to college, she was set on earning a humanities degree. With the amount of time and effort it took her to do well in her STEM courses in high school, Cassandra did not perceive them as a strength. She applied to schools as a humanities major and was accepted into a women’s college. She took an internship the summer after her high school graduation with the Smithsonian and that experience solidified her reasons for not wanting to pursue a STEM career as her interest was more geared toward women’s studies.

When the pandemic hit and Cassandra was forced to leave campus, she became interested in environmental science as she began to see how people’s actions during the pandemic affected the climate. Her priorities began to shift, and she began to regret not having to take STEM

[173] Cassandra stated that in general she would “stay away from taking AP STEM courses” (Interview 2) because she would often hear from other students talk about how stressful those classes were. Rather, she took a couple AP humanities courses, such as AP English and AP World History.

courses her freshman year of college. During her gap year, Cassandra made the choice to take a couple courses at a nearby institution to see if she was ready to go back to school. Cassandra had a very positive experience that first semester and enjoyed all her courses, including the STEM courses. At the time, she took biochemistry and mathematics—making the pivot to pursuing a STEM degree. Feeling as though she "wasted" a year during her gap year, Cassandra stated, "I kind of just told myself like, well, you have to make this work. You can't change it" (Interview 2). Surprised by her experience at the school, she decided to make the switch and enrolled as a full-time student as a pre-engineering major, taking Chemistry II, Calculus I, and Environmental Science the following semester.

Yet, as Cassandra continued to take higher-level mathematics courses, she began to struggle again with learning the content. When she took Calculus II, for instance, Cassandra became overwhelmed with the large amount of work and began to do poorly on her unit exams. Although she had the support of her friend group, she stated that the entire group struggled through that course, often relying on YouTube videos and meeting regularly in the library. She began to lose confidence in herself and again began to doubt her choice to pursue a STEM degree. She completed that semester with a 72 as her overall grade in Calculus II and started to think that engineering might not be the best path for her. Rather than give up, Cassandra continued with her coursework because "people would say stuff like, you know there are engineers who aren't really that good at math" (Interview 2). In addition, during the time she took the STEM classes, Cassandra made a core group of friends – all of whom were pursuing an engineering degree and who were taking the same courses in the same order:

> So being in the same class with other people that you know kind of added like…Okay, I'm gonna do really well in the course because everyone else is in here and they are doing

> engineering. I’m also doing engineering so I’m going to get the same grade as they are. (Interview 2)

Not wanting to give up her friend group or degree just yet, Cassandra registered for Calculus III, Differential Equations, and Physics.

Yet Cassandra continued to struggle, especially in her Differential Equations class. Although she put in the time and effort and often went to help sessions offered by her professor, she stated that “even with a cheat sheet, I got a really, really bad grade” (Interview 2) on her first test. Focusing all her energy on one course and not seeing any benefits from her hard work, Cassandra decided to drop the course. She felt she disappointed her friend group because many of them decided to stay in the course (although later in the interview Cassandra did say two of her friends dropped the course near the withdraw deadline) and she would no longer be on the same path as them.

When Cassandra and I met in the Summer of 2023, she had just completed that semester (after having dropped her calculus course). She admitted that that semester had been extremely difficult for her and has made her question whether her choice to pursue a STEM degree was a wise one, especially because she also earned a D in Physics. Furthermore, some of her mathematics professors have repeatedly told her that she has not taken “a real mathematics class yet” (Interview 2). Cassandra stated,

> I don’t know if engineering is worth the effort. I can’t take this GPA. I don’t know…My expectations and grades have changed compared to when I was a humanities major. Like when you’re a humanities major, at least for me, I had a 4.0. …but now I probably have a 3.3. (Interview 2)

Despite the amount of time and work she has put into her studies, Cassandra stated that she has not seem much improvement in her grades. With such a difference in her GPA, as compared to when she was a humanities major, Cassandra is currently undecided about her plans and is nervous about staying in STEM: “To be honest with you, I don’t really see myself doing math as my career. I just can’t anymore. Like before…I was like, ‘oh, maybe I can do that.’ But now…” (Interview 2).

Cassandra’s Definition of Mathematics Success

Having struggled with mathematics for many years, Cassandra stated she had a few things already on her mind and was quick to start on this concept map. Just like with her identity map, she chose to talk through her thoughts as she drew pieces of her map. Cassandra began with the center of her concept map—she created the rectangle in the center and labeled it “mathematics success” (see Figure 6).

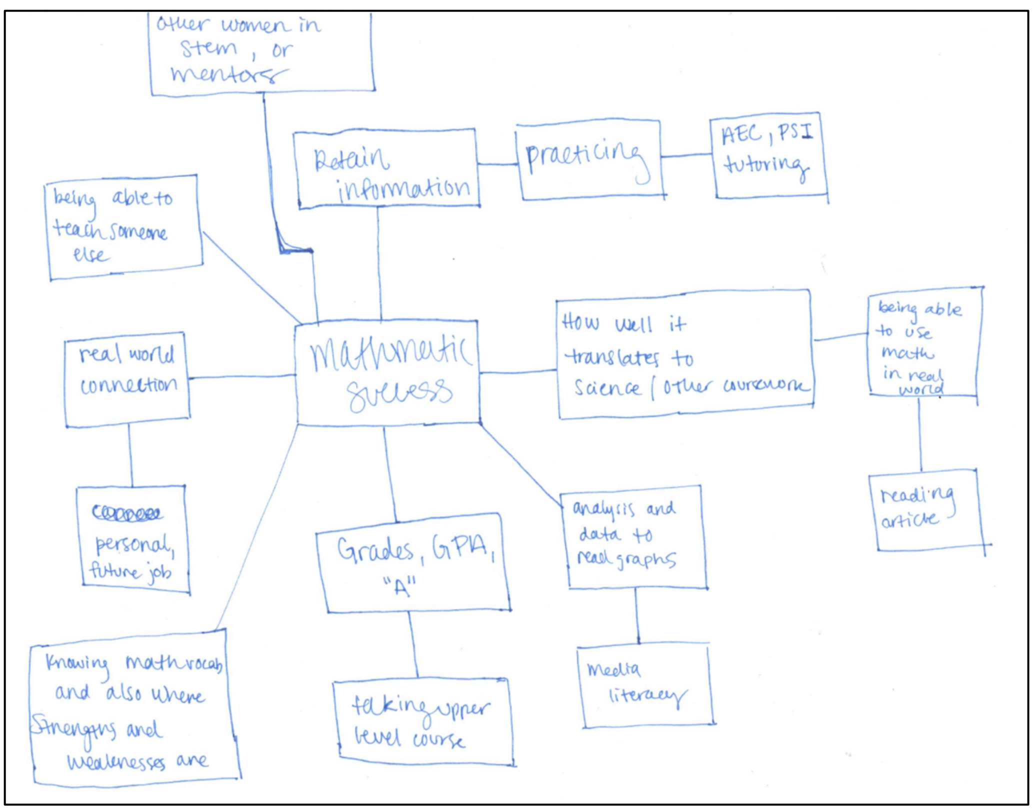

Figure 6. Cassandra's Initial Map of Mathematics Success.

For this concept map, Cassandra stated that she wanted each piece to be presented by a square or rectangle because they are more "stable and provide a good foundation" (Interview 2). She proceeded to tell me about her time taking Calculus II and how she had a really difficult time because she did not retain the information from her previous mathematics courses. She then created the concept bubble "retain" (above the "mathematics success" bubble in Figure 6) and proceed to draw extensions to that branch. She blamed herself and stated that she should have reinforced her knowledge through practice and seeking help by using the resources offered at the school, such as the tutoring center, Peer Supplemental Instruction, and tutoring.

Cassandra then shifted to the rectangle below "mathematics success" by stating that "grades define mathematics success" (Interview 2). To be successful, Cassandra stated that the goal would be to earn an A but then started telling stories of how grades do not necessarily reflect whether a student understands the material. For instance, Cassandra was upset to learn that many of her peers cheated on their mathematics exams during the pandemic. She said many of them admitted that they cheated by either using online resources or having an older sibling do the work for them. So, although Cassandra labeled the concept bubble as "grades, GPA, 'A,'" she revised her reason by stating, "I guess being able to walk away with not just a good grade but also like the learning experience of like…you really invested like information by practicing and going to tutors" (Interview 2). Cassandra continued that branch and stated that "following a track" and "continuing to take upper-level math courses" (Interview 2) were ways to determine mathematics success. She reasoned it was because all the courses are connected and if a person was able to move from one course to the next, then that person should get "closer" to knowing information needed for the specific career.

The courses students take on their path to pursuing a STEM degree should also mean that they are learning content that is relevant to the world. Cassandra stated that there should be a "real world connection" between the courses students take and the job they will eventually have. She stated that she is not sure what that looks like yet as her mathematics courses do not usually make those connections explicitly, but she felt that it could be because she hasn't taken a "real mathematics class yet" (Interview 2). A couple of her mathematics professors have told her that once she "take[s] the foundations course then everything will come together" (Interview 2). Cassandra stated that she did not know what that meant but hoped it would help her make clear connections to her personal life or future job.

Another indicator of mathematics success is being able to make connections to other disciplines, like science. Cassandra then drew the rectangle to the right of "mathematics success" to portray that the math a person learns should "translate" to other areas. If people can begin to see the connections to other disciplines, then it should also be easier for people to "use math in the real world" (Interview 2). According to Cassandra, there are different "levels" of the type of connections people should be able to make, beginning with simple calculations, "like working in a retail job" (Interview 2). As an employee of a retail store, Cassandra stated that she is always amazed at how people cannot seem to do "simple" calculations: "When things are on sale…people can't even do 50% off. I understand that you gotta meet people where they are, but it's like people older than me. And then they ask me, 'how much is that'?" (Interview 2).

Another way to see how mathematics is used in the real world would be to read scientific articles and journals (she wrote "reading article" as she said this). When asked why she thought it was important to read articles, Cassandra stated that being able to understand scientific articles and journals was another indicator of success: "A marker of being successful is being able to have those analytic skills…. like being able to read graphs and understand how scientists model data" (Interview 2). As Cassandra continued to talk about why it was important for people to read and understand these articles, she said she realized that it was more than just reading. She then went back to the "mathematics success" bubble and created another branch and wrote "analysis and data to read graphs" (positioned bottom right from the "mathematics success" bubble in Figure 6) to indicate that people also need to be critical about what they read: "If you have a basic understanding of math…. then this type of information or whatever you are reading may not be true. You can't assume that what you are reading is true. Take it with a grain of salt" (Interview 2). Cassandra stated she didn't know what this type of behavior or characteristic should be called but stated that she would just call it "media literacy."

Cassandra then shifted to other ways people can determine whether they have a solid understanding of the mathematics. She reflected on her own learning experiences and stated that whenever she was able to teach other people, she could perceive herself as knowing the content well (then drew the top-left bubble from "mathematics success"). She admitted that these moments did not happen often, which, for her, indicated that she did not have a strong foundation: "Sometimes I don't really trust myself to explain the concepts to somebody because it's like, well…. I'm not too sure. I didn't know it myself. But being able to teach someone else can help" (Interview 2). Cassandra then stated that one of the best ways to teach another person is to show steps that correlate with the way that person was thinking about the problem.

Reflecting on her most recent experience in taking Calculus II, Cassandra then stated that she wished she knew what she knew and what she didn't know. In other words, she felt that she was unable to pinpoint what she didn't know, which affected her ability in asking for help. She stated that it would help to know the "math vocab" to help her know what her strengths and weaknesses are (see bottom left concept bubble of Figure 6).

At this point, Cassandra appeared to be done with her concept map, as she put down her pen. She stated that she didn't really have anything else come to mind when trying to figure out what to draw on her map. When asked if there was anything we did not get a chance to talk about or if she wanted to add something to the map, Cassandra asked, "What about barriers to succeeding in math?" (Interview 2). I encouraged her to explain her thoughts and she began to talk about her own experiences as being a woman in the educational system:

> Like an emphasis on women in STEM or things like that growing up versus what I got later exposed to like in high school or maybe college? It's just really different…. I think like integrating more examples of like women in STEM….and it kinda make me think about how like success is also being able to see other people in your field who look like you. Like you feel like you have a place in math. I don't know—I guess just more support especially if you come from like a family where, like I said—like if your parents aren't able to help you with homework…. then you're approaching these subjects—like it doesn't have to be that way. If you have more support…. like more programs to…. bring in maybe students that have that support—like not all of us have like educators as parents. There's some of us that….so just because we don't have that access doesn't mean we shouldn't be…. like everyone should have access to resources like that. And just being able to have people that look like you—or see other people like women in STEM. At least for me…. or people who can be like mentors to you. So yeah…. just like barriers…. more support for math. Also, the stigma that math has…like OMG I hate math. It doesn't have to be scary… It doesn't have to be scary. (Interview 3)

Cassandra stated that she thought these ideas were important but was not sure where to put them on her mathematics success map. Not wanting it to be eliminated completely, she drew her final concept bubble (seen at the very top of her map in Figure 6) and wrote “other women in STEM or mentors.” She added that she had never considered STEM in high school because she never thought it was a viable option. No one brought it to her attention or made her feel as though it was something attainable. As a woman pursuing a STEM degree currently, she stated that it would have been nice to have people come talk to her and her classmates about the value of math, what options there would be if they were to pursue mathematics, and just be available as mentors for support and help.

Revisions to the Mathematics Success Map

Before making revision to her mathematics success map,[174] Cassandra said she wanted to clarify one thing about her current map. She elaborated on the concept bubble, “knowing math vocab and also where strengths and weaknesses are.” Although she initially wrote that concept bubble regarding her own experience of not knowing the proper vocabulary and not being able to communicate where she needed help, she stated that she also believes people tend to categorize all of mathematics, especially when they have had a bad experience. For example,

> people often say, ‘oh, I just hate math.’ And it’s like, ‘well, why do you hate it?’ When you realize they just struggle with fractions, then it’s like, okay. That’s one part of math. You can still be good at other math concepts. (Interview 3)

Cassandra continued her example by stating that many people base their opinions about mathematics from a very early experience, like third grade: “Having a bad experience with one small topic does not mean you can’t move forward” (Interview 3). She stated it’s a “stigma” that

[174] Before the final interview started, Cassandra stated that she had been thinking about her map and wanted to make a couple changes to it.

people tend to have about mathematics and did not realize it until she recently switched to STEM.

Another concern Cassandra had about her previous map was how to reflect "grades" and "GPA." As a self-proclaimed "perfectionist," she has a hard time accepting grades that are not As (something she has had to get used to since making the switch to STEM from humanities). Cassandra stated that many people have told her that "a lot of engineers are bad at math" and that she "should not care about getting Bs and Cs" (Interview 3). These statements have been a source of conflict for her because while she understands why people tell her this (to make her feel better), she does not think it is helpful to make it appear as though grades do not matter. She stated, "GPA is eternal" (Interview 3), as she considers it as part of her permanent record. In addition, she is concerned about her current scholarships and whether her GPA will prevent her from continuing her education if she chooses to take that path in the future. She stated that she wished grades were not considered a large indicator of success but did not know what else could be "normed and accepted" (Interview 3) across institutions.

Branching off from "grades, GPA, 'A'" and "taking upper-level courses," Cassandra added a concept bubble called, "proceed with caution" (see Figure 7). Cassandra clarified by stating, "proceed taking the upper-level mathematics courses with caution if you're getting Bs and Cs" (Interview 3). She began to question whether "just moving forward" from a class after earning a C was a good choice to make. Although a C is considered passing, Cassandra said she began to doubt whether a person should move forward because earning a C means the person met the minimum requirements and does not have a solid foundation of the concepts. Cassandra further stated that earning Bs and Cs would mean "you have to dedicate a lot of time and practice every day" (Interview 3) in the next course, which may or may not be possible depending on the circumstances of the person. Cassandra also stated that there is some “wiggle room” (another concept bubble branched off from “proceed with caution” in Figure 7), in the sense that moving forward only requires grades above a D. Knowing that she can earn an A, B, or C in a course does help a little bit with her anxiety because it means she has more of a chance to move on to the next course.

The “wiggle room” also refers to grades, as earning a C in one course means there is less “wiggle room” to earn another C. Cassandra has tried to “balance” her grades to ensure that she can maintain her scholarships.[175] But there were times when Cassandra had to drop a course for her sanity as well as her GPA. In Spring 2023, for instance, Cassandra admitted to having to drop her Differential Equations course because she had difficulties understanding the content. She also felt she could not put in the time that course needed while also taking Physics. The decision to drop the course was “devastating and was a blow to the ego” (Interview 3). In addition, having to drop the course made her question whether she belonged in STEM. She wanted to show the professors that she could improve and “solidify [her] title as a STEM student” (Interview 3). When asked what would help her feel like she belonged in STEM, Cassandra stated that grades were a large part but also “supplementary experiences, like internships and research during your undergrad” (Interview 3) and currently believes that “other people probably think I’m horrible at math” (Interview 3). So, although Cassandra has been a STEM major for at least a year, she stated that she doesn’t feel like she really belongs in STEM or has shown others that she belongs partly because she has had limited opportunities to show what she knows: “Besides taking the coursework, I haven’t had the opportunity to do STEM things…with the knowledge I already know” (Interview 3). Cassandra acknowledged that part of this is “her fault” as she does not

[175] Cassandra stated that when she first transferred to this institution, her overall GPA was a 3.8. Her GPA has since gone down to a 3.4, “only because I still get my As from my electives and other courses” (Interview 3).

actively pursue STEM internships as she has done with other internships[176] due to her lack of confidence and not knowing what to expect from a STEM internship.

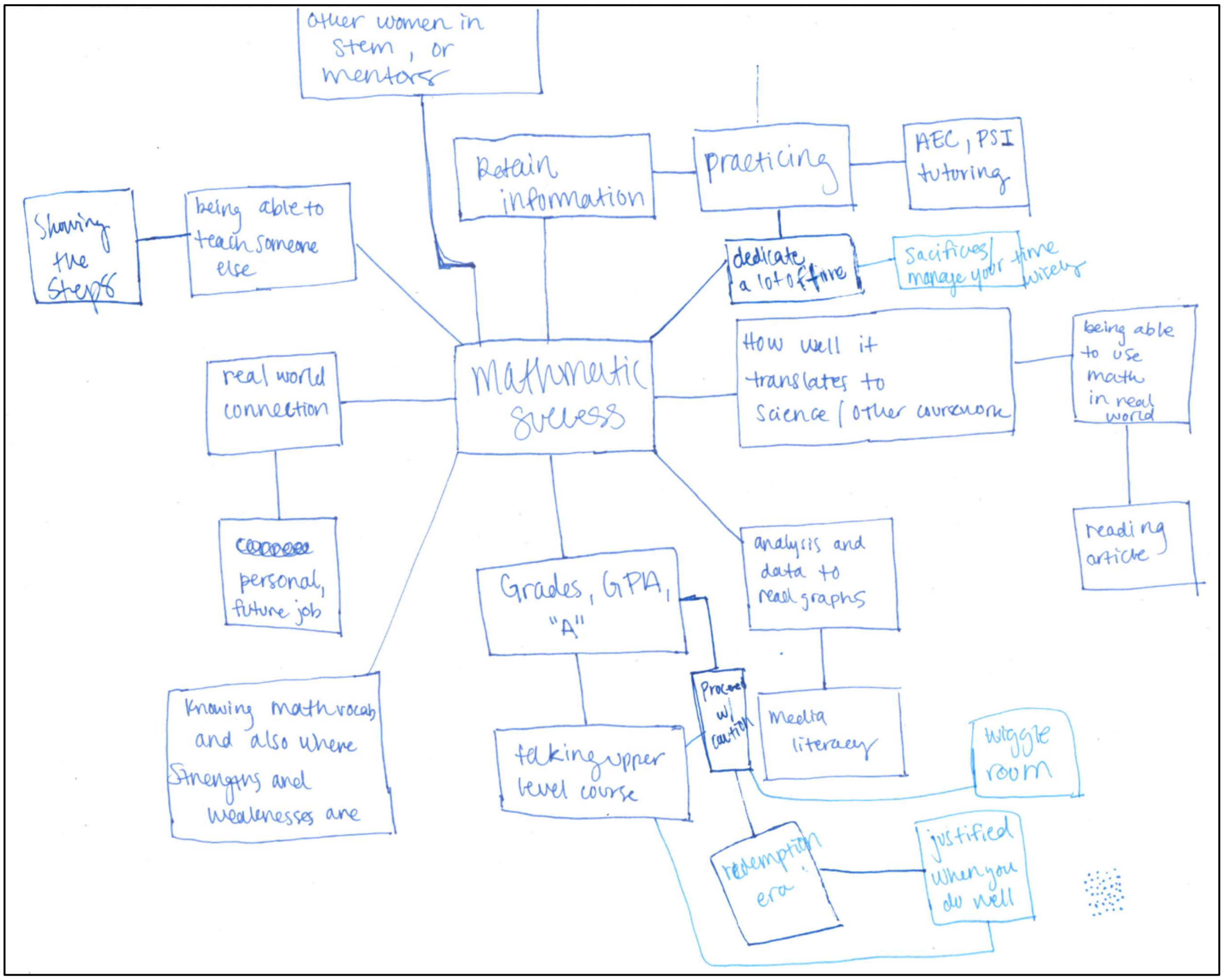

Figure 7. Cassandra's Revised Map of Mathematics Success.

From her experience, Cassandra has felt that whenever she has earned a C in a mathematics course, she would have to "redeem herself" (Interview 3) in the next course by making sure to earn a higher grade. This "redemption era" also meant she had to really

[176] It is interesting to note that Cassandra has participated in many different activities outside of school, including at least three different internships. Every summer, Cassandra has applied and has gotten accepted to various internships, including her time working in the museum and her internship at the time of the interview working with an environmental agency.

understand the content, which required her to put in more time, effort, and some sacrifices.[177] Her advice to others is to "proceed with caution because it can be so frustrating…I put in so much effort and time in math and I barely pass…but when I do well, it kinda justifies" (Interview 3). If she was able to dedicate the time into a course and do well, then it provided further justification to her that she should proceed to the next upper-level course. Cassandra, however, stated she was in the "redemption era every semester" (Interview 3) and it has begun to make her question whether she should stay on the engineering track.

She further stated that she feels "math can be kinda isolating" (Interview 3) because to learn mathematics content, it must be "one-on-one with you and the material" (Interview 3). She has gone to tutoring sessions, watched videos, and has met with friends to try and learn the content, but could only grasp it when she practiced problems on her own. While writing the last two concept bubbles "dedicate a lot of time" and "sacrifices/manage your time wisely," Cassandra described the times when she would force herself to take the time to put in the practice, which has made her make sacrifices to her family, her social life, and even other courses. Prioritizing her mathematics courses has demanded more time that have been taken away from other things she enjoys.

Cassandra's Final Concept Map

Unlike the first two maps, Cassandra did not start drawing her last map right away. She stated she was not sure how to draw this final concept map because she hasn't really thought about her own success or felt she has been successful:

> I think it's hard to think about success or like acknowledge the good things I've been doing when I take a little bit longer than my counterparts to finish the degree. I'm still

[177] Cassandra admitted that she had to cut back on her work hours at the retail store to dedicate more time to her mathematics courses.

> unsure about the path that I'm taking…it's hard for me to really enjoy my success or like to see myself being successful to really enjoy my experience because I'm constantly having to…I feel like I'm playing this catch-up game. And I'm actually really exhausted of operating mentally because I want to be someone that just enjoys a semester for what it is and taking coursework that you like…not having to play catch up having to redeem yourself. (Interview 3)

In addition, Cassandra stated that mathematics success is "a healthy balance between…earning the grades that you are wanting…what academic goal you set out for yourself in terms of how you want your grades but also actually enjoying the coursework" (Interview 3). She has been unable to find the balance of what she would consider mathematics success for herself. She further clarified that those who are successful in mathematics have the "initiative to pursue other opportunities related to the major" (Interview 3), such as internships or finding other ways to use their knowledge. Cassandra did not feel confident in saying that she has been successful in mathematics because she has "not been able to find that balance in STEM" (Interview 3). As a humanities major, she felt she was given more flexibility—being able to explore her options and make mistakes without having it "ruin" her chances for the future. In STEM, however, "you gotta have a little bit more of your ducks in a row" (Interview 3).

The time she has spent on her coursework has not been rewarding, as she has not earned As in all her courses and has not always enjoy her time learning the content. Her focus has been primarily on getting good grades that she has not been able to think beyond her coursework. In addition, she has not been able to see how the mathematics she is learning is connected to her area of interest. As a self-proclaimed "interdisciplinary person," Cassandra stated that a "true measure of success" is being able to synthesize all the information from coursework and making connections to other fields: “Eventually everything you learn should all be informing each other and like using all of those skills to learn more things” (Interview 3).

Cassandra also began to talk about her experiences in the classroom and how she has tried to navigate the STEM terrain. Compared to the humanities, Cassandra stated that she does not feel as welcomed in STEM by her classmates and is continuously “hav[ing] to play catch up” (Interview 3). Unable to earn the high grades she was accustomed to at her other institution as a humanities major, she has begun to question the actions of those in her program and classes. For example, she wondered why she had a difficult time making connections to the men in her classes or why people often felt they needed to “gatekeep information” (Interview 3). Being in STEM has felt “isolating” (Interview 3) for Cassandra despite her efforts to form study groups and create friendships.[178]

Although Cassandra did not think she had reached that level of success in mathematics, she began to draw her map (see Figure 8), stating that she has had “some form of success” (Interview 3). She began by describing the things that have helped her along the way of pursing a STEM degree, by first starting with the center concept bubble, labeled “Cassandra’s Mathematics Success,” and having branches stem from that center.[179]

[178] Cassandra spent a large amount of time discussing her experiences as a woman in STEM and often compared these experiences as a STEM major to that of her experiences as a humanities major. Because Cassandra was not the only person in this study to raise similar questions/issues, I discuss that issue in further detail in Chapter 9.

[179] Although Cassandra drew each concept bubble as if they were separate entities, her description of the bubbles in the interview makes it appear as though they are all interconnected. In addition, when asked if there were any concept bubbles that were more or less important than another, Cassandra stated that they were “all equally weighted” (Interview 3).

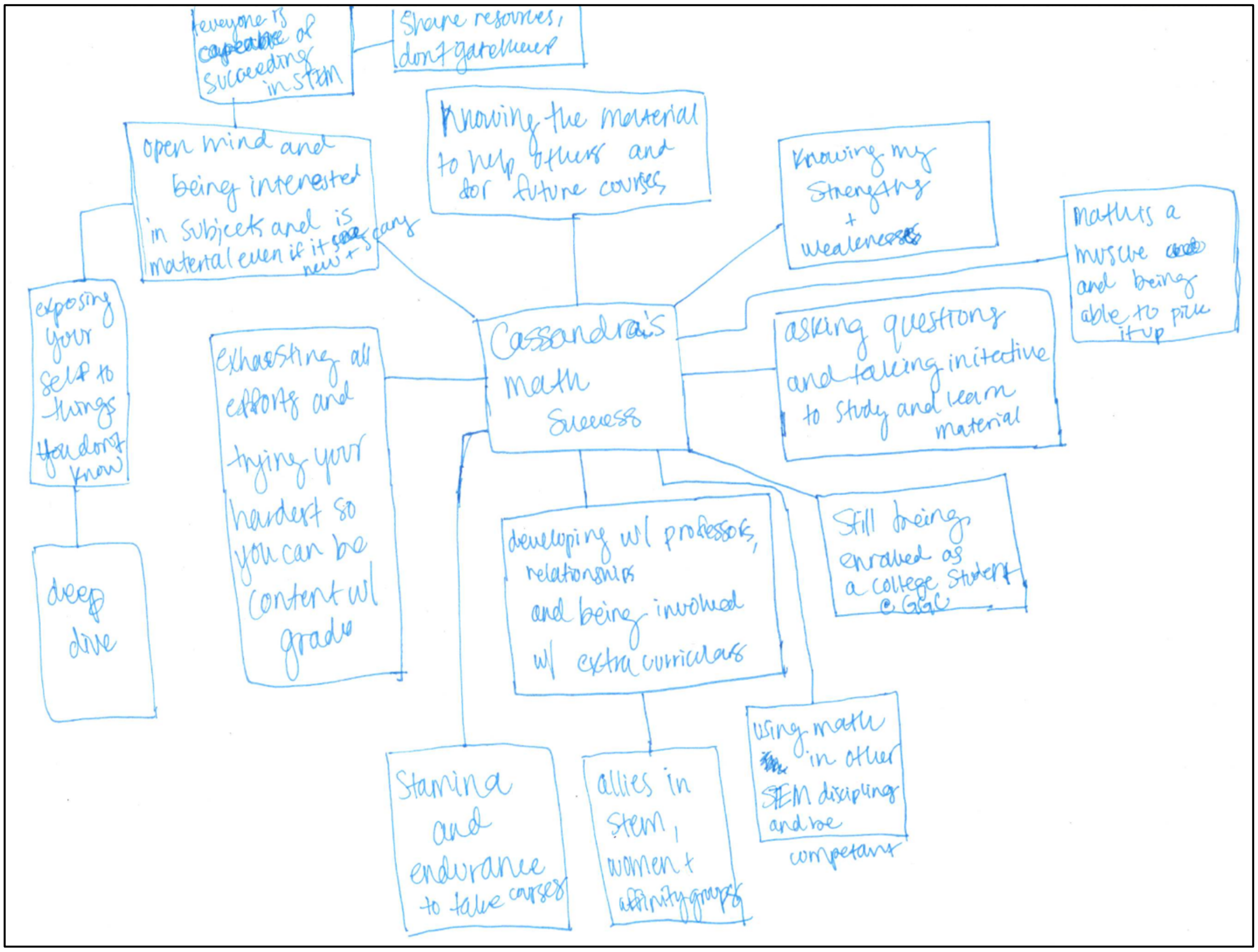

Figure 8. Cassandra's Final Concept Map.

Because she has struggled and continues to struggle in her mathematics courses, Cassandra stated that being able to "take the initiative and ask questions" (Interview 3) has helped her study and learn the content of her courses (see concept bubble to the right of the center bubble in Figure 8). Through the process of asking questions, she has been able to form good relationships with her professors, which have also helped her to become involved in some extracurricular activities (as some of her mathematics professors were also advisors to student groups on campus, such as the engineering club).[180]

[180] Note that although Cassandra created a separate branch and concept bubbles to represent her relationships with professors and other members of extracurricular groups, she stated in the interview that they were related to one another.

Cassandra then stated that grades were another thing that determines her success. Although she has conflicted feelings about grades, she stated that she always tries her best to get the best possible grade; exhausting all possible effort (see concept bubble to the left of "Cassandra's Mathematics Success" bubble in Figure 8). It is only when she has tried her best that she has felt some form of success—even when the grade was not as high as she wanted it to be. It has been difficult for Cassandra to accepts grades like Bs and Cs but knowing that she worked hard to get them has made her more "comfortable" with the idea that sometimes grades "don't really matter" (Interview 3).[181] All the time, effort, and dedication she has put into her coursework has required "stamina and endurance" for her to keep moving forward (which also describes the concept bubble to the left of "developing relationships with professors" in Figure 8).

Another indicator of mathematics success for Cassandra is being able to know the material well enough to be able to help other students, especially "without having to refer back to my notes" (Interview 3). Because her STEM experience has often felt so isolating, Cassandra stated that she would often try and reach out to other women in her classes to form study groups. During the times when the group met, she would be able to "test" her knowledge by explaining concepts to others (and helping her determine what her weaknesses are) while, at the same time, she could talk to other women about their experiences. Through these engagements, Cassandra learned, for instance, that other women in her classes also felt alone and unsupported. She started to create bonds with other women and made it a goal to help and encourage other women to be

[181] Cassandra often contradicted herself about grades as she continues to progress through the program. Although she stated that she would be "content" with her grades, she would often state at different times throughout the interviews how she was not happy about them too.

successful. She wrote “everyone is capable of succeeding in STEM” and “share resources, don’t gatekeep” to indicate that with support, other people like her could be successful in STEM.

Reflecting on her own experiences, Cassandra stated that is why she feels she is successful because she is still enrolled in school. Being enrolled as a college student makes her proud but also nervous at the same time. While she understands it is a privilege for her to be in school, she also feels the pressure of being a representative “woman of color in STEM” (Interview 3). Having to learn what to do to be successful in STEM has been stressful. Although professors have offered suggestions of what she needs to do to be successful in STEM (such as stating that “math is like a muscle that you need to exercise all the time” [Interview 3]), Cassandra stated that there are “things” that continue to be in the way for people to be successful, such as the competitiveness of STEM and how people “gatekeep information.” She continued by stating that it is important to look at the work done by underrepresented scholars and to—

> value their contributions because I think STEM has historically been like very exclusionary for underrepresented people. In order to change, though, you have to be committed to change that. So that way you can be successful and other people can be successful—especially those who have been underrepresented…. There’s room for everybody to be successful and for everybody to know them. It’s not impossible for people to learn. You can meet them where they are, and they can get there. Everyone’s capable of succeeding in STEM—it’s just gonna look different for everyone. (Interview 3)

Having come from a non-STEM track and being a woman of color, Cassandra said she has been able to be more “open” to listening to and learning from others. These experiences and conversations with others have often led her to go into “deep dives” as she is always thinking about ways to change the narrative around STEM and who can be considered successful. Drawing in the last concept bubbles on her map, Cassandra concluded the interview by stating that when it comes to her own personal success, she is still unsure of where her path will lead her:

> Am I going to solve matrices as an engineer? It's been kinda hard to see the bigger picture these last couple of years. Doing all these STEM courses to get access to engineering upper-level courses. It's been kinda like…I'm just staying on for the ride because that's what everyone else is doing. But like, I don't know…Is this really worth it? Because I don't really see the light at the end of the tunnel. (Interview 2)

CHAPTER 6

SASHA

I have known Sasha since fall semester 2022; she was one my College Algebra students that semester. I remember her coming into the classroom on the first day and choosing a seat in the very first row. She wore jeans, sneakers, and a T-shirt and wore her thick, curly hair up in a bun on the top of her head. Her friend, Julia,[182] sat next to her and they began speaking in Spanish. I could tell from their engagement that they knew each other well and were excited to see each other in class.

As I began the class, Sasha and Julia immediately stopped talking and focused all their attention on me. While going over the syllabus, I could tell Sasha was serious about her studies and wanted to do well. This seriousness was evident in not only her choice in sitting in the first row but also by her expressions as she was listening to me and the notes she was taking in her notebook; she was paying close attention to details and requirements of the course. She did not waver from looking at me and did not get distracted by her peers around her. In addition, her notes, which are always neat and color-coded, were also the focus of her attention (when not on me).

As the semester progressed, I came to know Sasha as a young woman with a vibrant personality. Although she is a serious student, she is also friendly and social. She would often engage in conversations with her peers surrounding her—especially with Julia and a couple other women who also happened to sit in the front row. She was quiet during class but would often ask questions whenever she got stuck on a problem or wanted to verify her answer. When thinking

[182] Pseudonym. I later learned that Julia is a close friend of Sasha's when she lived in the Dominican Republic and reunited with her when attending college.

about who to ask to participate in my study, Sasha was one of the first students who came to mind.

Sasha's Story

Sasha was born and raised in the Dominican Republic (DR),[183] where she lived with her mother, grandmother, and younger brother. Sasha's first language was Spanish, as that was the primary language spoken in her country and is the language her entire family speaks. During her childhood, her Dominican father, who is also a U.S. citizen, was living in North Carolina as he and Sasha's mother were not together. Although separated by distance, Sasha stated her father would visit Sasha and her family in the DR frequently.

Sasha spent most of her youth in the DR, where she attended private school, as public schools were "not good" (Interview 1). When describing the difference between the schools in the Dominican Republic and the United States, Sasha stated that the public schools within the United States are "way better than private schools in the Dominican Republic" (Interview 1). Thus, Sasha's mom paid for her and her brother to attend a private school. Unlike the elementary schools in the United States, Sasha stated that her private school was very small but was a time when she really bonded with her peers as students often grew up together. She described her community as being close and friendly; people often seeing each other inside and outside the classroom. She was with the same group of students from her elementary school years up through ninth grade. She felt so close to this group of peers that she often referred to them as family.

Sasha did not learn English until she came to the United States when she was 15 years old (a month before starting her sophomore year). Her decision to move to the United States was

[183] When speaking about the Dominican Republic, Sasha often used the phrase "DR." Although not standard APA style, I use DR to mean Dominican Republic because that is the language she preferred to use.

greatly influenced by her father, who encouraged her to move for the educational and career opportunities she would have: “It was his way to ensure that I had a good future” (Interview 1).[184] Despite not really wanting to move, Sasha felt the responsibility to come to America for herself and her family: “I made the impression on friends that I was okay with coming because I knew—I felt I didn’t have an option. I had to come anyway” (Interview 1). Despite being worried and scared to travel to the United States, Sasha stated she has never been the type of person to show her real emotions, especially to her parents. She felt the responsibility to take the lead in this new life and embraced it.

As a 15-year-old student, Sasha stated that being in school in the United States was extremely difficult. Not only was she trying to learn English to communicate with others in the school, but there was also no sense of normalcy. After having experienced being with the same group of students every year throughout elementary and middle school, Sasha found it extremely difficult to make friends or establish a core group who could help her navigate this new world: “I left my family in school too” (Interview 1). When moving to the United States, for instance, Sasha was surprised to learn that students had to move from one classroom to another. Conversely, students in the DR would stay in one class and the teachers would move (including her ninth-grade year). Having to move from one classroom to another and seeing a different group of faces in each class was overwhelming in the beginning. Sasha had a difficult time making bonds and friendships with all the new changes.

[184] According to Sasha, the DR is a “poor country” with limited upward mobility for those who want to pursue a career. Her family thought it would be best for her to leave the DR and pursue an education in the United States.

When Sasha entered high school in Georgia, she stated that she was placed into a class for those who could not speak English for a few months:[185]

> Well, most of the students were—their first language was English. So, all my English class we were all on the same place…didn't know English.... In my biology class, these are my first classes ever in the United States. There were—it was mixed too. So, I feel like the only place where I had people.... like every student be like me was in that English class. All my other classes.... I was in classes with other students that had English as a first language—especially math. (Interview 1)

Understanding that her English class was clearly different from her other classes, Sasha was determined to learn English and excel in school. To do that, she spent most of her time watching American television shows with Spanish captions, listening to music, and studying the English language. She also credits her English teacher for working with her in learning the language and culture. Over time, she was able to speak English "well" —being able to hold conversations with others and said, "after three months, they took me out" (Interview 1).

Her experience in these English classes were not necessarily negative, but Sasha knew that being in these classes meant that she was different. Although Sasha was proud to state that she was able to transition out of the English class she was originally placed in, she has stated that she tries to avoid taking English classes altogether. While she is confident in her oral communication skills in English, her fear is that her academic English (reading and writing) are still weaknesses that she may not be able to overcome. Her fear of not being able to do well in English has prevented her from taking the necessary English requirements at the college. As a

[185] I'm assuming that the class she was placed into was an ESOL class, as Sasha often spoke about students in the class not being able to speak English. Sasha, however, never actually said this was the case even when asked if this was the placement. Rather than impose my own interpretations or putting a label on her experiences, I have left the wording here to represent how Sasha described it.

junior, Sasha has yet to take her core English classes.[186] Although she passed and earned good grades in English in high school, she feels her English skills are still weak.

On the other hand, Sasha considers mathematics as her strength. Yet, when speaking about her experiences in her mathematics classes, Sasha was quick to state, “I hear a lot of people saying like.... math is like universal; you don’t really need to know the language. That is a lie. That is a lie!” (Interview 1). She elaborated further by stating that learning mathematics requires some form of communication because “you have to understand what they tell you” (Interview 1). As an English learner in a mathematics classroom where the teacher only spoke English, Sasha quickly learned that to do well in mathematics, she would also have to strengthen her English skills.

As Sasha became more acclimated to the school system in the United States, she quickly learned how to be successful. She was able to maintain the high grades she always had prior to coming to the United States. Her next step was to figure out what to do beyond high school:

> So, my plan after high school was to just jump straight into college. I didn’t want to waste my time. And then I had a time in my senior year when I didn’t know if I was gonna go to college in general. But I had the pressure of my family. That’s the main reason why my dad wanted me here—for college. (Interview 1)

In preparing to go to college, Sasha applied to a few colleges in the area. Her heart, though, was set on going to one specific college because it was the only college in the area that offered a software engineering degree.

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[186] At the time of the interview, Sasha did not yet take her core English class but has taken the first core English class since the interview was conducted. I have been in contact with Sasha throughout fall 2023 semester (seeing her about two to three times a week as she often visits my office) and Sasha did earn an A in the course. Her confidence in her ability, however, remains low and she is preparing to take her second core English class in spring 2024.

Sasha quickly learned, however, that the college required her to live on campus in a dorm her freshman year. While she was comfortable with the idea of living on campus, her family did not approve: "I knew that was the school I wanted to graduate from…but I have to dorm there. We don't dorm in the Dominican Republic. So that was a big deal for my family" (Interview 1). After many arguments and discussions with her family, Sasha ultimately decided not to attend that college and instead took a gap year. She regrets that decision today, but at the time, she stated that she did not want to upset her family.

During her gap year, Sasha worked. After about a year, her family started putting pressure on her again about going to college. Knowing that her family was still not okay with her living on campus, she chose to apply to colleges in the area that would allow her to commute to school. She is currently a student at a small public college, where she and I met. Her dream, however, of attending her first choice is not completely lost. Although she is a student at this current institution, Sasha has plans to transfer once her core classes are completed. A potential barrier, as stated earlier, is whether Sasha will take her core English classes.[187]

When asked what her goals and aspirations are, Sasha stated that she would love to go back to the DR and live there with her family. Knowing that the DR has limited opportunities for growth in her career, Sasha stated that she would like to establish her career in the United States first. The ideal situation would be to work for a major technology company, such as Google, and to work remotely in the DR so that she could "have the best of both worlds" (Interview 1). To this day, Sasha continues to be motivated to finish her degree so that she can attain the goals she has set out for herself. Although Sasha is currently pursuing an Information Technology degree, her main goal is to become a software engineer. As her current school does not provide that

[187] Sasha is aware that she cannot escape from taking these courses but have dreaded taking them. She did enroll in an English class in Spring 2023 but dropped from the class shortly after the semester started.

degree, she has chosen IT as she awaits to transfer to another institution that can offer the degree she wants to pursue.

Construction of Sasha's Identity Map

When asked to construct her identity map, Sasha began by drawing a bubble that represents her life in the DR; a school with students (as represented by the stick figures) to highlight the ways in which she experienced schooling before coming to the United States (see Figure 9). In constructing this part of the map, Sasha explained that as a child in the DR, her time in school was one of her fondest memories. Being in a small school with the same group of students throughout her elementary and middle school years were valuable as students bonded with one another. One reason for this bond was the amount of time she and her peers spent with one another throughout their educational journey because "you literally grow up with this people in the school" (Interview 1).

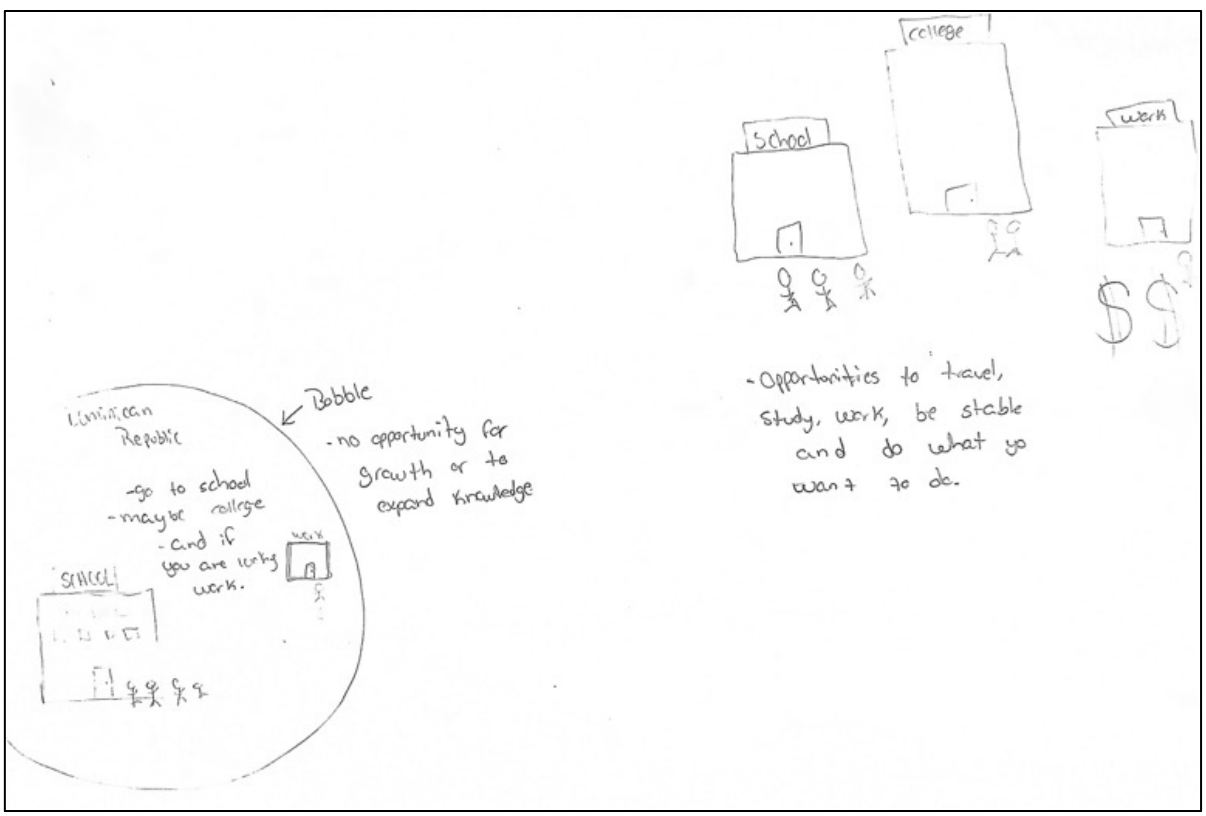

Figure 9. Sasha's Identity Map.

Note. This concept map was created in Sasha's first interview and represents some of the ways in which Sasha described herself and her experiences.

Despite the good times Sasha had in her younger years, she quickly stated that the educational system in the DR could not provide her the necessary room for growth. Although students can go to college after graduating high school, they will still have a difficult time getting a well-paid job and will be "stuck": "I feel like if I were to stay in the DR, I wouldn't be able right now to have the car that I have or drive myself wherever I want to go or have a job or just be.... independent" (Interview 1). She emphasized this aspiration by writing next to the school "go to school, maybe college, and if you are lucky—work" (see left hand bubble in Figure 9). In addition, the bubble that surrounds the people and the school represents how people who stay in the DR will remain trapped because there is little room for economic mobility or independence. Sasha then wrote that there is "no opportunity for growth or to expand knowledge" as an explanation for that part of her mapping.

The United States, however, is seen as "a different world" (Interview 1) to Sasha; the land of opportunity and only requires hard work[188] and motivation of the individual to get to where they want to be:

> Here, there's more opportunities.... or whatever you want to do. When you're in the United States, especially when you're a citizen. You can do whatever you want. Just got to work hard for it. But with the guarantee that if you stay focused, you're gonna get there. In DR, there is not much that you can work for, or towards, you know what I mean? Like here being a citizen... if you work hard enough to save money, you can go travel the world. Traveling the world is giving you an insight of how everybody lives

[188] During the second interview, Sasha was clear about how she viewed the United States as being a place for her to be successful: "It's just United States. Opportunities. That's what United States is for me. Opportunities. That's it. (laughs). I mean, I can get my degree. I can go to work and make money."

> different cultures different.... You know, it's just like different worlds. People in DR - that's all they know. That's all they ever get to know. (Interview 1)

Therefore, the United States is not constricted with a bubble because more opportunities are provided to those who want it, whether they decide to go to college, work, travel, and so on.

When asked why the DR and the United States were so far from each other in her concept map, Sasha stated that she didn't necessarily see any connections between the two worlds, which made it "so hard" for her. As a person standing in the middle—the space between the bubble represented as the Dominican Republic and the top right-hand corner of the map—Sasha believes that she cannot be in both places, as they don't provide all that she needs or wants in her life:[189]

> In the middle. I'm still here [Dominican Republic] because... this is my like... this is my country. My family's here, my friends are here. My childhood is here. But this [United States] is where I'm at, like, I'm focused here. I gotta get through school. And I gotta be successful. So, I'm right in the middle. And I keep pulling from one to the other, one to the other. And I don't—I can't say there are any links. It's just so different, like, both are so different from each other. And I feel like that's what makes it hard being away from my country. For my future, because I'm not completely here and I'm not completely here if that makes any sense.... This [Dominican Republic] is where I want to be, but this [United States] is where I need to be for my future. (Interview 2)

Sasha continued to describe the feeling of being torn by stating that she often must fight between her desires (i.e., being back in the DR) with that of having "the responsibility to be someone" (i.e., staying in the United States): "Outside of career and education, this [pointing to the

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[189] It was not clear that Sasha perceived herself as being in the center between the two worlds until Interview 2 when she stated, "if you look at.... I'm standing in the middle."

Dominican Republic part of the map] is my heart. Everything that I love is here" (Interview 2). Although Sasha's heart continues to lie in the DR, she kept describing how staying in the DR would prevent her from being successful. It wasn't easy for Sasha to see this limiting success initially, but over time she has come to understand what she needs to do to provide for herself and her family:

> Maybe when I came, I didn't see it. Because I was more.... I was thinking more of.... what I was leaving behind with the people that I had instead of the opportunity that was being given to me to see another world. (Interview 2)

This sense of responsibility stems from the pressure she places on herself[190] as well as from her family who wants her to finish school and get a good job.

As the oldest child, Sasha recognized that her family relies on her to be able to provide herself (and them) a successful future. Despite having a younger brother, for instance, she is aware that this tremendous responsibility still resides only on her. Although her family wants her brother to pursue a similar path as Sasha (i.e., go to school in the United States, go to college, and have a successful career), she sees how they treat him differently in their expectations of him. For instance, he has been living in the United States for less than a year and has already been given the option (from their parents) to go back to the DR before the end of the year. Sasha, who also came to the United States as a teenager, was not given the same choice leading her to believe that she had to stay to accomplish her goals:

> And, I mean, they still say, like, ya know, we want you to go to school and do something, but it's not.... They're not for—I'm gonna say, forcing him on him. You know what I mean? And I don't like that. And I was gonna say, like, when I came, there was never a

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[190] Sasha stated numerous times that the pressure she feels was not placed on her solely because of her family. She, too, has expectations set for herself to be successful for both her and her family.

> choice of going back to the Dominican Republic. It was one option only—finish high school and then go to college. But they're even giving him that option. (Interview 2)

Sasha attributed this difference due to their varying personalities; describing herself as being an outgoing person, someone who "loves to get new knowledge" (Interview 2), and someone who can remain focused on her goal. On the contrary, her brother is shy and isn't willing to put in the additional effort to speak or learn English.[191] Despite her wanting to go back, Sasha continues to believe that the United States is the best place to be for her and her brother so that they can accomplish their goals. Thus, with high expectations for Sasha from her family and herself, the responsibility to become successful outweighs her desires to go back to the DR too soon.

Connections Between Concepts

In the construction of her identity map, Sasha would often state that there were no connections between what her heart desires (being in the DR) and what her sense of responsibility lies for herself and her family (being in the United States). Despite this claim, Sasha often spoke about some of the cultural differences that she wished could exist in the DR (and vice versa) and how aspects of herself seem to fit better in the United States. Although she placed herself in the middle of her map (between the DR and the United States), Sasha admitted that she is "a little bit more on this [United States] side" (Interview 2). Having lived in the United States for about five years, she has recognized that there are aspects of herself that have changed, and she has been able to form stronger connections with people in her life currently. Yet, these connections sometimes conflict with some of her cultural values or the values of her family.

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[191] Throughout our conversations together, Sasha insists that to learn the language well, one must be able to put themselves "out there" (Interview 2); engaging in activities outside of school (such as watching American television) and be willing to make mistakes ("just say it however it came out").

One strong connection she has formed is the one with her current boyfriend; an African American who speaks English, is "not Hispanic" (Interview 2), and who has not yet earned his degree.[192] Although Sasha states that her family has not outright expressed their concerns about Sasha being in a relationship with him, her mom has had conversations with her about losing her cultural values:

> I wouldn't say a concern but it's definitely an....observation. And my mom said, like, they love him. But my mom's.... she still says to this day, like.... you know, a parent, like will always want you to stay in your culture. (Interview 2)

As her relationship has become more serious (they have been dating for about two years now), Sasha says her boyfriend does recognize her family's concerns and has made attempts to learn more about and become involved in the Dominican culture. His willingness to learn of the family's cultural values has helped in their acceptance of their relationship, but Sasha is also aware that although "they never made it too obvious, I still knew how they feel" (Interview 2).

Although Sasha's family may have some concerns or reservations about Sasha's relationship with her boyfriend, Sasha has expressed some concerns of her own; about how living in the United States has changed her and the ways in which others in the DR see her. Sasha, for instance, has struggled with feeling a sense of belonging ever since she moved to the United States as a teenager. While adjusting to a whole new culture and trying to do well in school, she felt like a Dominican. The problem, however, is that very few Dominicans live near her, and she has not been able to make strong connections to those who have had a similar background. After living in the United States for two years, she felt like she "didn't belong

[192] Sasha has stated that he is currently working and is taking online courses to earn a computer science online degree. Although he is making strides to earn his degree, she says the focus for them as a couple is on her completing her degree first. He helps to support her financially so that she can focus on school.

anywhere" (Interview 2). Despite going back to the DR to visit, Sasha has noted that she can feel a difference in the "connection with people" (Interview 2). She could not pinpoint what was different but continued to say that she could "feel" a difference in the way she was being viewed by those who live there year-round:

> And that's what's hard when I go there. Because I feel like I'm a resident. I mean, I'm Dominican. This is where I grew up. I got—I still have that sense of.... what do you call it? Like I'm proud of this, like, this is who I am. I'm always gonna go back and I gotta go back almost every year. But....I don't know.... there are—there have been a few times where I feel more like a visitor and that makes it horrible because I'm not. (Interview 2)

As Sasha continues to live in the United States, she is aware that this separation between her and those who live in the DR will probably widen. Nevertheless, she still wishes that "all my connections to the Dominican Republic were still strong. But....it's hard being... having strong connections in two different places at the same time" (Interview 2).

Another connection Sasha has established in her time here in the United States is the connection with the United States. Despite having an end goal of returning to the DR,[193] she is also currently working on getting citizenship in the United States. Having dual citizenship would allow her to travel freely between both countries and potentially meet both her desires and professional goals to be successful.

Sasha's Perceptions of Her Own Mathematics Success

When speaking about her mathematics experiences, Sasha often distinguished her experiences in the Dominican Republic to those in the United States. As a young child in the DR, Sasha spoke of her strengths in mathematics as mathematics often came easily to her: "I've

[193] Sasha intends to move back to the Dominican Republic once she has established her career. Her goal is to find a job in the United States that would allow her to work remotely.

always been good with math, like I've always, like you explain me something one time or two times, and I'll get it. I'll really understand that…I never struggled with math" (Interview 2). Sasha explains that one reason she has been able to do well is because she has always been self-disciplined and had the motivation to want to do well in school. She not only completed her homework but also would read ahead to prepare for the next lesson. According to Sasha, her grades were "always above 90" (Interview 2). In addition, unlike the boys in her classroom, Sasha often described the girls as being more serious about learning the mathematics as the boys would often "joke or play around the classroom" (Interview 2).

Sasha attributes her ability to do mathematics well not just to her innate abilities, but also because of the teachers she had in school. She often spoke fondly about her fourth- and fifth-grade teachers, as they encouraged her to do well and challenged her in the classroom. Her fifth-grade teacher, for instance, would invite her to come to the board multiple times to explain mathematics concepts or to solve a problem in front of the class. In addition, mathematics was a source of comfort for Sasha. Whenever Sasha was stressed, she would "do math problems to get [her] anger out" (Interview 2). Mathematics allowed her to focus her energy on solving a problem and provided a way to calm herself.

These experiences in her primary school years were a stark contrast to the experiences she had once she came to the United States. Upon arrival, Sasha was placed in the ESOL program for the first 3 months. During that time, she took courses alongside other students who did not speak English and described how they would often rely on each other to learn the content of their classes. As an independent woman who has always been able to learn content easily, this new way of learning was a struggle for Sasha.

Although Sasha felt she was "good"[194] at mathematics, it was hard to showcase her mathematics ability due to the language barrier, resulting in her earning her first "low B" in a mathematics course. When describing the struggles she had to overcome in her mathematics class, she described how difficult it was to understand her teacher, as her teacher only spoke in English. Despite having a couple of other students in the class speak Spanish, Sasha became frustrated with her teacher because she felt that the teacher could have taken additional actions to ensure that her students were understanding the content:

> In general, when she was explaining something, I couldn't 100% understand. So maybe... I don't know. I mean, it's high school. She had a lot of other students, but maybe focusing more…on me. When it came to doing a problem, you know, come explain [to] me again. Let me see if I really understand because when she was teaching over there, it was fast paced. And I remember I told her this one time, like… . Can you slow down? Because I'm not understanding what your—I mean, you're gonna have to understand that. It's not numbers. We're not only talking numbers. In order for you to teach, you have to explain what you're doing with the numbers. She will teach us how to solve the equation. But did I really understand? No, because she was speaking in English. That's why I said math is not universal. The numbers are. Like the number one, number two, but…you will still have to explain it. Like if we are in Calculus next semester and you're teaching me something and I don't know English—is that gonna work? It's not gonna work. Because I don't understand what you're saying (Interview 2).

Although it would have been ideal if she had a teacher who could also speak Spanish, Sasha stated multiple times that that was not necessarily a requirement. Her expectations however of

[194] Although Sasha often excelled in mathematics (earning at least 90's in all her courses), she only ever used the word "good" to describe her performance in her mathematics class.

what teachers should do to help their students always goes back to the actions they need to take to ensure students understand the material, such as providing guidance, checking in on students, and offering more help sessions.

Other struggles with English included aspects of the curriculum, such as word problems. Understanding that English is needed to comprehend the word problem before being able to answer it brought some stress and anxiety to Sasha because it would further "prove" that she was not capable of doing the mathematics:

> And I'm still struggling to this day. That's why I don't like word problems in math. Because to do a word problem in math, you have to really understand what is being given to you. And what they're asking. That requires English, you know, like, you really have to know what you're reading to be able to understand the problem to be able to do the solution (Interview 2).

Word problems were not an issue for Sasha in the DR, as she would solve them in Spanish. In the United States, however, she often discussed how important it was for her to know English and the lengths she would go to learn the language.[195] "First semester was horrible. So, I knew I had to do something. That same thing when I came. That's why I learned English so fast. Because being a straight A student…I wasn't gonna let English give me Cs or Bs. I still wanted my As" (Interview 2). Her desire to prove herself and do well in school motivated her to take this extra measure to learn English.

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[195] As Sasha viewed her academic career "in danger" (Interview 2) due to the language barrier, she would often engage in activities outside of school to help her learn English quickly. These activities include watching American television shows, listening to American music, and speaking in English as much as she could outside the classroom. Sasha explained that her personality of "not being a shy person" (Interview 2) helped her learn English at a quicker pace than her peers.

After that first semester, Sasha stated that she had "good" mathematics teachers but did not think that having good teachers were the reasons why she was improving in her mathematics courses. She attributed her success in these courses to knowing "more English" (Interview 2). Although many of her teachers often encouraged her in school, she described how the experiences she had in her first semester affected her confidence in being able to do mathematics:

> I'm good at math, but I'm not as confident as I was before I came. I like math. I still have that love for it. But.... when we're talking about the confidence of knowing that I can, it's not 100% the same. (Interview 2)

Other factors, such as her placement in mathematics courses also contributed to how Sasha began to see her mathematics ability. Although she was placed into the "accelerated track,"[196] Sasha began to see differences between herself and others in her class. For example, being in a small classroom in the DR and then having to move to a much larger STEM school in the United States put into perspective the competitiveness with STEM: "I was around nerds. I wasn't top one anymore. (laughs). So that played a part into it" (Interview 2). These experiences and having to compare herself to others diminished her confidence in mathematics by "35–40%" (Interview 2), especially when she recognized that other students in her class were freshman (and she was a junior at the time).

The COVID era was also another factor in the way Sasha began to see herself differently as a student and the impact of her mathematics success. During that time, Sasha and her family (which consisted of her grandparents, her aunt, and her cousin) were forced to live in a one-

[196] Sasha could not recall what the "tracks" in the school were–only that she was able to take the accelerated precalculus class her junior year of high school. She was aware that her placement was not at the top of the class, but she also was not considered part of the bottom.

bedroom apartment. Unable to focus at home, Sasha began to lose the motivation to want to succeed, stating that she did not want to do homework and she felt “burnt” all the time. Rather than earning the As she was accustomed to, Sasha earned “bad” grades (mostly Bs). One class included her online AP Calculus class, which required her to learn most of the content from watching videos her instructor posted online. Not feeling prepared to take the AP exam, Sasha opted out of taking the exam; knowing that she would have to retake the course in college. It was not until about 10 months later did Sasha and her family move into a house that provided the space she needed to focus on school.

Despite the struggles Sasha had in high school, Sasha still considers mathematics as one of her strengths: “I always say there’s history and language arts people and then there’s math people. I’m a math person” (Interview 2). Her belief in her capabilities in mathematics stems from her passion of doing mathematics. Sasha is clear in stating that she still enjoys learning mathematics: “I like math. I mean – that don’t mean that I’m perfect at it or that I don’t struggle, but I enjoy it” (Interview 2).

Sasha’s Definition of Mathematics Success

When asked to create her concept map of how she viewed mathematics success, Sasha chose to talk through her thoughts as she wrote them down (see Figure 10). She began by stating that mathematics success required a “good amount of knowledge” (Interview 2) and stated that knowledge accumulates over time and begins with school:[197] “I can always compare what I know now from two years ago when I didn’t know what I know now” (Interview 2). This first step, the

[197] Sasha noted that although people can learn mathematics before they start school, school provides the foundation of what mathematics is and how to communicate ideas to others. Learning numbers, for instance, is not necessarily learning mathematics, but the required components so that a person can learn math.

accumulation of knowledge, would occur during your K–12 experience, as school provides the knowledge a person needs to build the foundation.

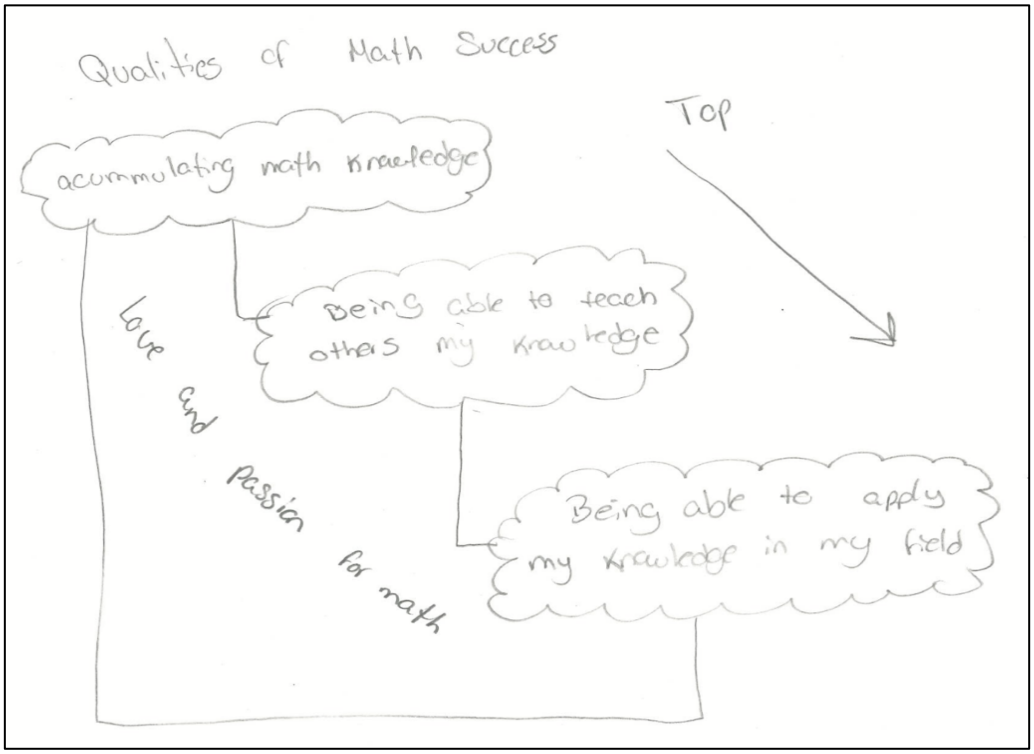

Figure 10. Sasha's Initial Map of Mathematics Success.

Note. This image represents the initial mapping Sasha created that highlights the qualities of mathematics success. In creating this map, Sasha started at the top with "accumulating math knowledge" and then continued with other qualities of mathematics success moving in the downward direction (as she indicated with the word "top" in the top right corner with an arrow).

To demonstrate the amount of knowledge a person can have, Sasha then stated that a person should be able to "teach it correctly to other people" (Interview 2) and then apply it in the field. As an IT major, Sasha indicated that mathematics is necessary because mathematics is the building block needed to create programs. This second "step" —the ability to teach content to others—is perceived as the most difficult step to Sasha as it requires some form of communication to share knowledge with others:

> When you're sharing your knowledge with other people in math, you have to know how you're doing it. And you have to do it in a way where the other person will understand it.

> You know what I mean? Like, I have, this is better in my head. Anything is better in my head than how I'm communicating. So that's hard for me. (Interview 2)

Thus, according to Sasha, if a person can communicate their knowledge to another person, then that quantifies as being successful. When asked if this step was more important than the last step she outlined in her map (i.e., the application of knowledge in the field), Sasha responded by stating that her map was not "completely accurate" because the second step is the most important of the three that she outlined. Understanding and applying the content in the field, although valued, were not considered as the primary component of mathematics success. Communication of knowledge, through language and other forms,[198] is what constitutes being successful in mathematics for Sasha.

According to Sasha, the path to mathematics success is a "journey" (Interview 2), one that requires love and passion. Mathematics may not be the end destination (as her major is not specific to mathematics) but is a necessary component in obtaining a STEM degree and for being successful in the field. The "love and passion" (Interview 2) Sasha refers to is a necessary component that is needed throughout the journey:

> I definitely think if I don't want—that love from math from the beginning, I wouldn't be here. Or wouldn't even get to here or here [points to the second and third steps]. I mean, I could have chosen a major that required me to take algebra and that's it. You know what I mean? I want it. I want to learn more. So…I do what I want—combined the things that I like—technology and math. (Interview 2)

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[198] During the interview, Sasha indicated that the use of language, such as English and Spanish, would be the primary way people would communicate, but she did not want to limit herself to just language alone. She indicated that other forms of communication, such as drawings and subtle cues from the teacher (such as a head nod or when a teacher checks in with a student) are other ways in which knowledge can be shared.

Revisions to the Mathematics Success Map

In revisiting the map in the third interview, Sasha still believed that the three steps she outlined previously are important qualities that demonstrate mathematics success. Sasha indicated however that the steps did not necessarily have to go in the order that she outlined. She recognized, for instance, that if a person was able to accumulate knowledge and then apply the knowledge in the field (or life), then that could indicate the person is successful in mathematics. Nonetheless, she stated that she would not recommend "skipping steps" because being able to communicate knowledge to others is what is valued in society.

In addition, Sasha was unhappy about the initial way she created the map because the map made it appear that the "order" of the steps required a person to walk down the steps (rather than up).[199] Sasha also stated that in between interviews, she thought more deeply about our conversations about mathematics success and wanted to add in details for each "step." For example, within and between each step, there also exists many smaller steps that can help a person move from one step to the next. Thus, Sasha outlined additional, smaller steps (see Figure 11) to highlight some of the ways a person can move between steps.

[199] In the third interview, Sasha indicates that the way to read this revised map is to start on the "bottom step" (shown in Figure 11) and work "your way to the top."

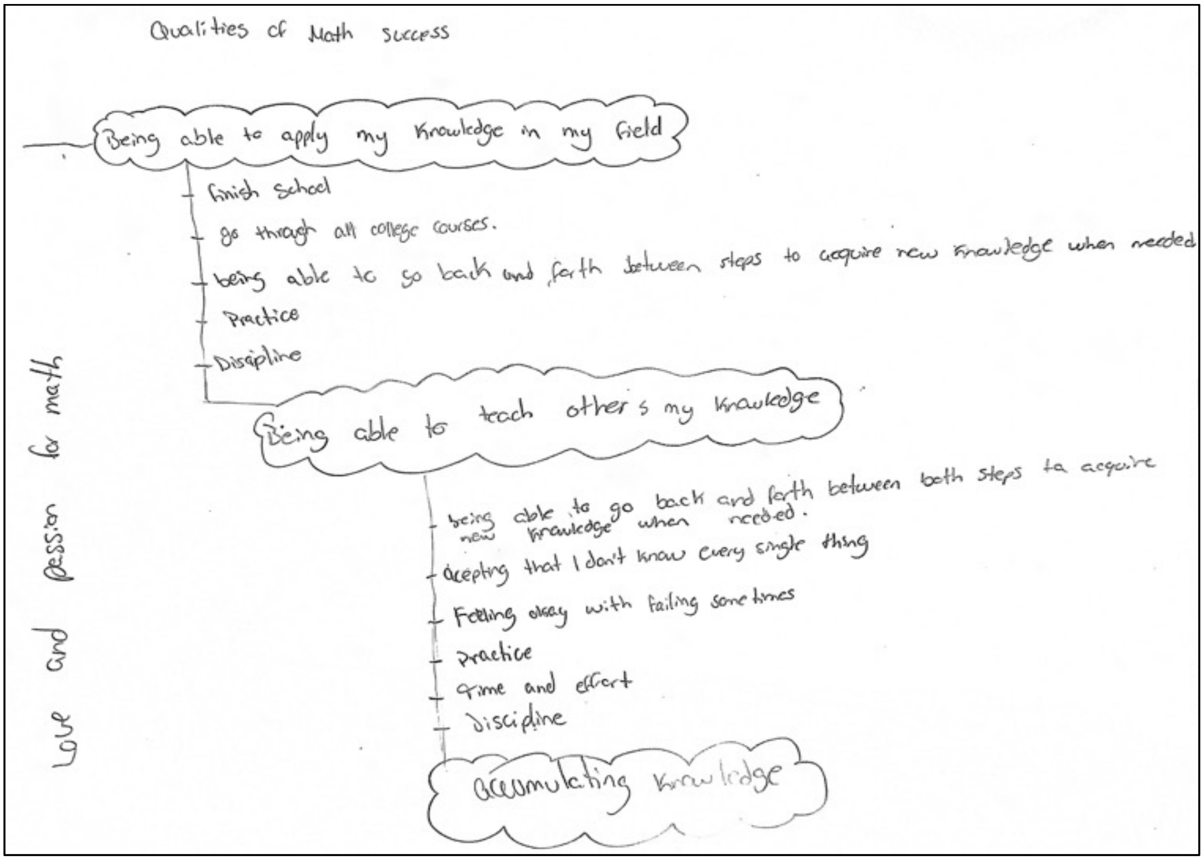

Figure 11. Sasha's Revised Map of Mathematics Success.

Note. Sasha's revised map of the qualities of mathematics success includes more details within each "stage."

In the process of detailing the smaller steps in her revised map, Sasha began to realize the cyclical nature of this path to success and often stated that a person could go back to any of the steps while on this journey:

> That happens from when you first start learning. And then, one of the reasons why I put here [points to the smaller step beneath the second step] being able to go back and forth between both steps to acquire knowledge when needed, I put in both because, I mean, I could be here [pointing to the third step], and then there's something I don't know. So, I can go back. You know what I mean? And then I could be here [pointing to the second step], and there's something I don't know. And then I can go back. (Interview 3)

Throughout this process, Sasha kept referring to how grades, the feedback from a teacher, or "life experiences" could determine whether a person would need to go back to a previous step. From her own experience, when she earned a "bad" grade (such as a B in her first mathematics course in the United States),[200] she had to accept that she didn't accumulate enough knowledge or was not capable of communicating what she knew and thus, had to go back "to the beginning to figure out how to move forward again" (Interview 3). Sasha stated that these "failures" along the way was necessary to help her improve upon her own abilities or to help her reassess where she was on the path to success. These smaller steps, such as "accepting that I don't know every single thing" and "feeling okay with failing sometimes" had to be combined with practice, discipline, and time and effort for Sasha to move beyond the struggles she was facing.

Sasha's Final Concept Map

Drawing from both her identity map and her mathematics success map, Sasha struggled to combine the ideas discussed in those mappings into one final concept map because of the struggles she continues to have about her own identity and the ways in which she sees herself as a Dominican and as a woman in STEM. Sasha often stated that she has often heard people say, "that pretty much all majors in STEM are a man's job, but [she] never let that get to me at all" (Interview 3).[201] In addition, the tremendous responsibility she has felt about being successful from both herself and her family has affected the way she views her own journey to success. Sasha ultimately decided to try and combine the necessary components she feels has contributed to her success so far and the ways she defines success within her own life (see Figure 12).

[200] In the third interview, Sasha stated that "everybody got a different definition for failing," but for her, earning a B as her overall grade in a course is considered as "entering the failing zone."

[201] I describe more about how Sasha describes her viewpoint on women in STEM in Chapter 9, as this topic also came up in interviews with other women in the study.

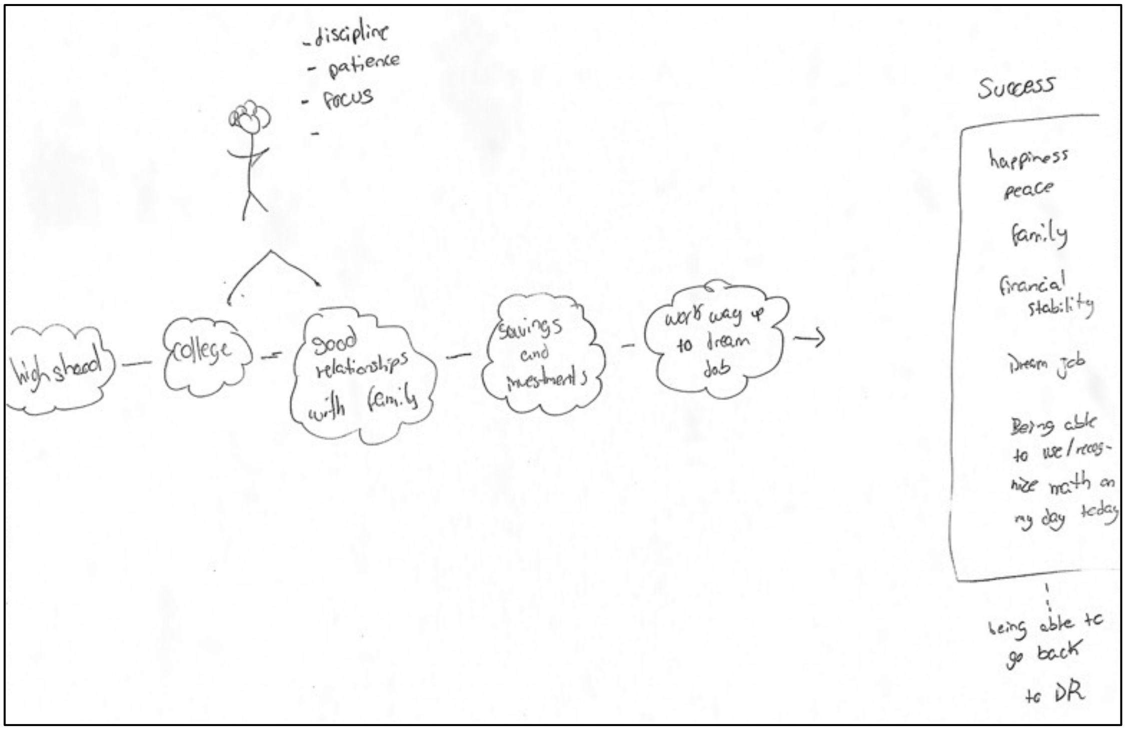

Figure 12. Sasha's Final Concept Map.

Note. Sasha's final drawing highlights the path (starting on the left-hand side of her map) Sasha currently views herself in trying to obtain her goals (or what she deems as being successful).

Unlike her mathematics success concept map, Sasha began by drawing her own path in a linear fashion, starting with the concept bubble titled, "high school." When asked why her mapping started with high school and not with her primary school years, Sasha indicated that it was not until high school that she began to "doubt" her capabilities to obtain the success she had always set out for herself. High school created challenges she did not fully anticipate, such as being able to earn her As while also learning a new language. In addition, the conflict she had with her family[202] and the competition she had with other students in school affected the way in which she saw her path to her success. Sasha did not doubt that she would be successful, but that

[202] Sasha noted that although her family has always desired for her to go to college, they also created "barriers" for her. For example, her living situation in high school during COVID presented challenges that affected her ability to focus on school.

her path to that success had to be alter based on the challenges she faced (essentially extending her timeline for when she would be able to achieve her success).

Above the “college” and “relationships with family” bubbles, Sasha drew a stick figure of herself to indicate that that is where she is currently. As she continues in this part of her journey, Sasha stated that some of the qualities (such as “discipline, patience, and focus”) have been necessary for her to remain on this course and to help her continue to earn her As in her college courses. Although not outlined in her concept map, Sasha indicated that her second mapping (where she outlines the necessary steps to be successful in mathematics) is really “seen throughout” (Interview 3); indicating that the learning process is occurring at all stages of her life and will contribute to her success as an IT major.

Sasha however continues to struggle with her relationships with her family members. Not only does she continue to feel the pressure from her family to be successful but also she stated that her family has not provided the necessary support she feels she needs to achieve her success. As the first member of her family to go to college, her family has been unable to help her navigate college life and relies on her financially as Sasha also helps to pay for rent, food, and so on. Sasha has learned to “rely on herself” (Interview 3) when it comes to school as her family does not have the knowledge or skills to help her navigate the educational part of her life.

In defining success for herself, Sasha’s primary goals have remained the same throughout all the interviews: to become financially stable, find a good job in the technology field (where she says she must be successful in mathematics to be able to do that), and go back to the DR where her heart lies (as shown on the right-hand column of her map). When defining whether her life has been successful,[203] Sasha stated that she feels a need to also give back to society by being "able to make a change" (Interview 3). Sasha elaborated by stating,

> If I helped a group of people or something like I can do back in my country…to help the people over there…something that will make me, you know, when I'm old like, and can look back, I can be proud. (Interview 3)

Although these goals will help her achieve "happiness and peace" (Interview 3) for herself, Sasha stated that her personal success should also somehow contribute to the success of others.

[203] As Sasha continued to talk about success when describing the components of her mapping, I noticed that she was describing success in multiple ways. As we continued our conversation, Sasha began to outline how she views her life as "being successful" in two different ways: her personal success that the concept map focused on but also a person's life can be viewed as being successful based on how the life lived has contributed to the greater society.

CHAPTER 7

SKYLAR

My first encounter with Skylar was in August 2022. At that time, Skylar was enrolled in my course for the school's Peer Supplemental Instruction (PSI) program.[204] As a PSI faculty instructor, I was responsible in making sure our PSI leaders got the support they needed to be able to create lesson plans for their sessions,[205] hold and conduct PSI sessions for students on campus, ensure that they met with their content-specific faculty mentors, and engaged in the PSI community by participating in training and social events throughout the semester. As part of the program, PSI leaders are normally required to attend a 3-day training at the beginning of the semester with other leaders across disciplines. It was through this training that I was able to first meet and speak with Skylar.

Skylar, along with three other students in the course, met with me on a Saturday morning to participate in PSI training. Skylar was one of the first students who arrived. She came into the classroom wearing baggy jeans, a t-shirt, a long-sleeved shirt, and carrying a backpack. Before seeing her, I knew she was probably Vietnamese (given her last name and my experience with students at the school). She has a round face, short black hair (falling at shoulder-length) with some blonde highlights) and was wearing black-framed glasses.

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[204] The Peer Supplemental Instruction program was established and created by STEM faculty at our institution. Although there are other schools in the country who implement the Supplemental Instruction (SI) program, PSI slightly deviates from SI in that our PSI leaders conduct sessions that serve students across multiple courses. Rather than pairing one PSI leader to one instructor/class, for instance, our leaders hold PSI sessions for students from any class/instructor. As part of the professional development of our leaders, they can choose to receive research credit by enrolling in our research class or they can be paid as a student worker.

[205] As part of the PSI program, PSI leaders are responsible in creating lesson plans for students who come to their sessions. Skylar, as an Information Technology (IT) leader, was responsible in creating sessions for students taking the first IT course.

My first impression of Skylar was that she was very shy and self-conscious about her English.[206] Upon first meeting her, Skylar introduced herself but then became silent. Unlike the other girls who were also there for the training, Skylar often just sat and listened, seemingly not really participating in conversations or group work. At first, this behavior concerned me because as a PSI leader, students are required to lead and facilitate discussions with other students during their sessions. With it being the first day, however, I tried not to show my concern until I could see what her sessions would look like.

I quickly learned that Skylar was self-conscious about her language abilities. Yet, her willingness to participate in the PSI program, especially as a leader who is expected to conduct and facilitate sessions, indicated to both me and her PSI content-specific faculty mentor that she was dedicated to improving her language skills[207] while also helping those who struggle with IT concepts. Throughout the semester, I continued to work with Skylar on her sessions, observed her sessions and provided feedback, and tried to provide the support she needed to be successful in the program. Unlike tutoring, the PSI program encourages leaders to facilitate discussions amongst students in their sessions; encouraging students to help one another working through problems. This role was difficult for Skylar, as most of her prior experiences have been similar to what a typical tutoring session would look like.[208] Although she struggled with implementing

[206] It is difficult to describe how I know this self-consciousness to be the case, but as a person whose first language is not English, there are signs that indicate English language ability as an insecurity. For instance, those who are self-conscious about their language abilities are often soft-spoken, will say a phrase or word as a question (rather than a statement), and are often silent—spending more time listening how others speak rather than speaking themselves. In addition, Skylar often hesitates when she speaks—pausing when she reaches a word that she is unsure of.

[207] To be clear, I have never felt that Skylar particularly needed to work on her communication skills. Although she has a strong accent, I never had trouble understanding her when she spoke. Skylar however stated improving her communication skills as a particular goal for herself during the semester I had her as a student as well as in conversations we have had for this study.

[208] Skylar often spoke about how her experiences in Vietnam as a student and how it differed greatly from what she was expected to do as PSI leader. In addition, in interviews for this study, she elaborated stating that "teachers will

sessions as a facilitator (and not a tutor), Skylar accepted the challenge and continued to work closely with both me and her content-specific mentor. She finished the semester successfully (providing several PSI sessions for students) but did ultimately decide not to continue with the program in Spring 2023.

Given the difficult semester Skylar had with the program, I was surprised to hear she wanted to participate in the study. Although we had a good relationship, I did not think to include Skylar in my initial list of students during the recruitment phase. Like Cassandra, Skylar had heard about my work from another faculty member and reached out to me about her possible participation in the study. After having a conversation about what the study was going to be about, Skylar decided to participate, stating that she felt she could provide some information about women in STEM.

Skylar's Story

Skylar was born and raised in Vietnam and speaks both Cantonese and Vietnamese. Although she identifies as a Vietnamese woman, Skylar also has roots in China. Her mother is Chinese and encouraged her children (Skylar and her younger brother) to speak Cantonese. Skylar indicated that the primary language spoken at home was Vietnamese (as her father is also Vietnamese), but given her mother's ties to China, her mother insisted that Cantonese be spoken. As Skylar stated, her mother "can speak Vietnamese but she doesn't want us to speak Vietnamese at home" (Interview 1). Thus, Skylar and her brother grew up in a bilingual household.

explain everything on the board, they will write with a whiteboard and chalk" (Interview 2). Thus, Skylar had some difficulty with the PSI training because it often conflicted with how she thought her role would be in her PSI sessions.

Skylar spent her childhood in Vietnam, where she attended primary school up through college. When describing her experiences in school, Skylar spoke about the rigor and time spent on excelling in her studies. Education was (and continues to be) an important aspect of her life and culture. According to Skylar, many families in Vietnam not only sent their children to school during the day but also used their resources to provide opportunities for their children after school and on weekends (such as tutoring, extra courses, etc.). Her family was no different: they provided these additional resources to help Skylar prepare and perform well on educational exams that often determined the course in which she would take in her life.

Skylar indicated that neither of her parents pursued STEM as a career and "stopped in high school" (Interview 2). Despite not going to university, Skylar's parents have been able to pay for her schooling and have been financially supportive of Skylar in her educational journey. Skylar's mother and her aunt owned a business creating personal banners for their customers and her father was a personal driver for "a person of high status" (Interview 1).

Skylar described her time in Vietnam as "stressful," as the primary concern for her and her parents were her studies at school. Not only was she required to take courses during the day, which included English courses, she was also required to take extra courses outside of school. Skylar's family required her to take additional math and literature courses throughout the week and English courses on the weekends. These extra courses were determined by her interests and the career path she chose to take. For example, when she was younger, she was initially interested in becoming an architect and so her parents enrolled her in an art class after school.[209]

Like Sasha's experience with primary school, Skylar also stated that she was with the same group of children in her classes; they would stay together from one year to the next. This

[209] Although Skylar has always been interested in house designs, she changed her career path to IT because she is "not good at drawing" (Interview 1).

group of students would stick together until the end of fifth grade, when they would take a test to determine which school they would attend next. Skylar stated that children would take another exam at the end of middle school to determine their “path,” as test results were used to determine which high school they would attend.

According to Skylar, moving from middle school to high school was a “big change” (Interview 1) because the tests were harder and would determine what type of high school (and career path) a child would be able to attend:

> Every time you change the school, you need to take the test. From grade nine to grade 10, to middle school to high school and take the first test and then high school to college. You need to take a test—like a big exam. If you don't have enough brains—your brain is not high enough, then you cannot go to the…you know, good school. (Interview 1)

There was a significant amount of pressure for students to perform well on these exams because the results could also send them to a “lower school” (Interview 1). If a child needed or wanted to retake the exam, the school would make them wait a year. Although Skylar often spoke about how difficult these exams were, she was extremely successful. She earned a first prize in physics in middle school, and she tested well enough to get into the high school for the gifted, also known as “the best high school in the country” (Interview 2).[210]

When Skylar attended high school, she spoke primarily about the courses she was required to take, which aligned with the career path she was working towards. In addition to taking these academic courses, Skylar participated in what she described as “volunteer activities” (Interview 2) in school. These activities included preparing and serving food at a local restaurant or visiting an orphanage. While not a requirement, Skylar indicated that the gifted school she

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[210] When speaking about this school, Skylar indicated that the high school she attended was the “dream school” (Interview 2) for most students in Vietnam. The school was “famous because it’s really hard to get in” (Interview 1).

was enrolled in wanted their students to "experience a lot of things. For example, like not just academic, but we also have to practice soft skill" (Interview 2). Students engaged in a wide variety of activities and clubs that focused on particular "soft skills," such as teamwork, how to plan, and speaking conversational English.

Skylar continued to excel in school, focusing on a STEM path. Although she had other passions and interests, Skylar's primary concern has always been to do well in school and to pursue a career in software development. When it came time to choosing a college, Skylar and her family decided that she would study in Vietnam for two years and then continue her education abroad; hoping she would have access to more opportunities in another country.[211] Skylar spent the first year and a half in Vietnam in a "bridge" program where she was required to take courses in English. Although her professors were Vietnamese, they were required to speak English when they taught their courses. Skylar described this time as being extremely difficult for her. Although she had been learning English all through her primary, middle school, and high school years, she found herself having a difficult time learning the content:

> I'm not judging their knowledge or their accent in… I'm just saying that I have problem listen to the explanation—in math and coding. I know they're like, really good professor. They all have a PhD in America that they come back to teach us that which means they are extremely, extremely intelligent. But maybe their style of teaching is not matching with me. Style like…they also explain materials, giving example giving homework, but I don't know why it's hard to…Maybe different is the languages. (Interview 2)

[211] Skylar stated that her family wanted her to study either in the United States or Australia. Skylar chose to study in the United States because some members of her family have lived in the United States and could provide guidance for her.

When asked why she thought she had a hard time understanding her professors in class given her history of learning English, Skylar elaborated further by stating that the English she learned in school was different: “But those are just English, not English in math” (Interview 2). Skylar noticed a difference in how the English language was being used in a mathematics classroom and how it differed from her general understanding of the language.

After spending a year and a half at the university in Vietnam, Skylar came to the United States in 2019 to continue her studies in New York, right before the pandemic. At that time, she was 20 years old and believed that coming to the United States would give her access to more opportunities for her career. Yet, her experiences in New York were short-lived, as the pandemic changed her education path dramatically. Skylar was required to move off campus to meet the social distancing guidelines. Unable to stay on college campus, Skylar left New York and moved to Georgia. Unsure of when the school would reopen and not wanting to move back to Vietnam, Skylar thought the best decision would be to live with her cousin. Skylar then decided to enroll in a small public college in Georgia (that she currently attends) to try and finish her degree.

Transferring her credits from Vietnam and New York to Georgia however has been problematic because not all of Skylar’s credits transferred. Although Skylar has taken several mathematics courses, at both the institutions in Vietnam and New York, the college in Georgia required her to take the mathematics courses again.[212] Still, Skylar is not upset about having to take these courses again, because “it’s better because I got a higher grade” (Interview 2). So, although Skylar had the potential to graduate early (with only having one year left if she stayed in New York), Skylar is content in taking multiple courses again to earn a higher GPA. She

[212] It was a little unclear as to why the credits did not transfer. Skylar indicated that she took most of her math courses in Vietnam, so that could be the reason why some of the credits did not transfer over (given that it is hard to determine whether courses are similar overseas).

currently has one more year left of her program to graduate with a dual major of IT and applied mathematics.

Construction of Skylar's Identity Map

When asked to create her identity map, Skylar requested that I leave the room as she thought about how she wanted to organize her map. After about 10 minutes, I came back to find Skylar using her phone to find specific images that she wanted to incorporate into her map (see Figure 13), such as the Chinese flag.[213]

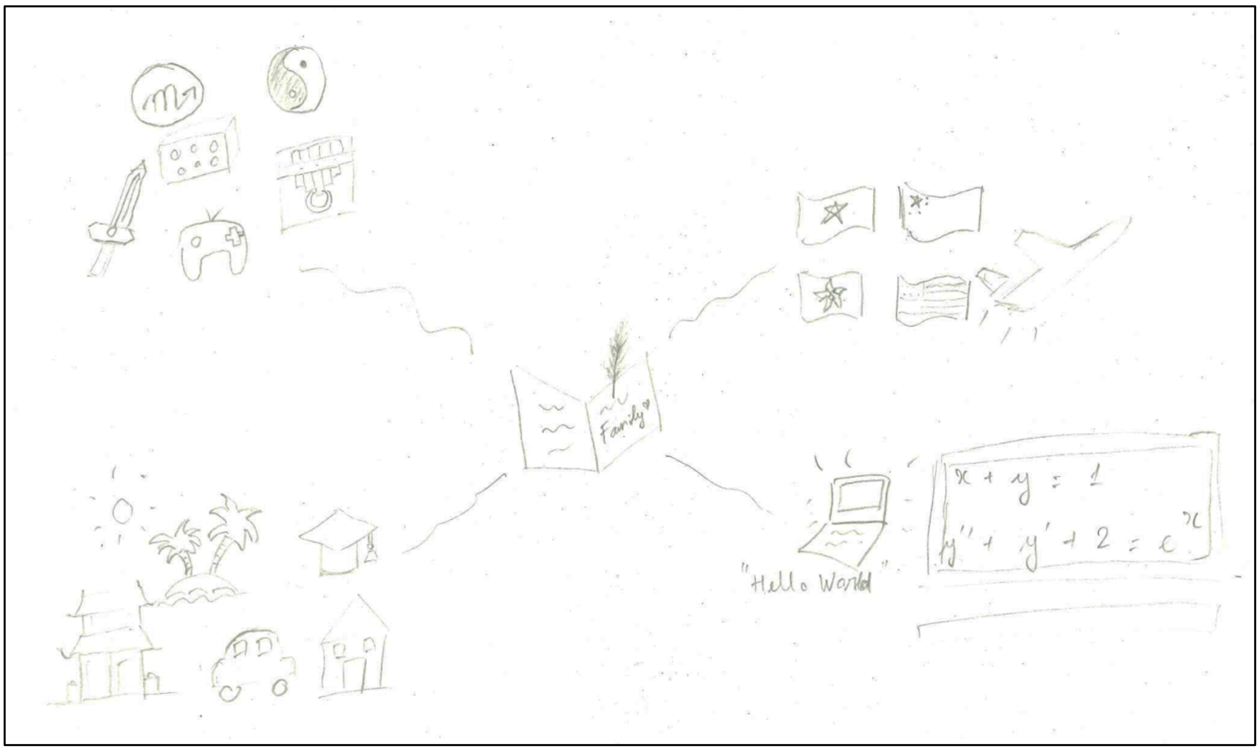

Figure 13. Skylar's Identity Map.

Note. This concept map was created in Skylar's first interview and represents some of the ways in which Skylar described herself.

[213] I include this request made by Skylar to highlight how nervous Skylar was about "drawing" her map. Although I did explain that her map did not necessarily need to have images, she felt compelled to include images because she felt it would better portray what she was thinking rather than having to write it all out in English. Knowing that her first language is not English and that she has voiced concerns in the past about her English skills, I did not discourage her from using her phone as an aid.

Skylar began by describing the book in the center, stating that the book represents how she likes to study and the feather next to the book represents her. When asked why she chose to use a feather to represent her, she stated that her "Chinese name[214] is related to a feather" (Interview 1). The book in the center of her map has the word "Family" with a heart, because "family is the most important" (Interview 1). Although Skylar is aware that the term "family" normally includes other "related people," she identified her family only includes her parents and her younger brother.

Skylar then moved to the upper right part of her map, stating that the core (the book) can help her travel the world. Although Skylar intends to graduate in IT and applied mathematics, she also loves to study languages. Skylar took a few Mandarin courses in high school and then continued her study of Mandarin on her own. She currently knows Vietnamese, Mandarin, Cantonese, and English (which are represented by the flags of Vietnam, China, and the United States),[215] but is also interested in learning other languages, as there are more countries she wants to visit (as indicated by the airplane [the image next to the flags] as well as the images she included in the lower left of the concept map).

The upper left and lower right components of her map highlight her interests in and out of school. Skylar enjoys playing online role-playing games, building structures using Legos, playing the kalimba, learning other languages and studying, and maintaining a balanced life. Her

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[214] Upon further questioning, I also learned that Skylar chose her own Chinese name and based the name on a character in a game. In addition, when she plays in an online game, she uses the feather as her signature.

[215] Although there are only three countries listed here, Skylar drew four flags. Because languages are important to Skylar, she wanted to make sure she included the flags of China that represented the geographical regions of that spoken language. Thus, Vietnamese is represented by the flag of Vietnam (as represented by the star in the center); Mandarin is represented by the national flag of the People's Republic of China (as represented a large star in the upper left corner with 4 smaller stars around it); Cantonese is represented by the Kapok flag, which was used by the Cantonese nationalist movement and represents the Cantonese people of southern China (as represented by the Kapok flower in the center); and English (as represented by the American flag).

hobbies and passions have all lead to her goal of pursuing a STEM degree in software development. As an IT and math major, Skylar used images of a computer and a chalkboard with mathematics equations respectively. “Hello World” indicates the “programming language you need to study” (Interview 1) and is often the first words you see when opening a new program. Skylar also indicated that she has recently become interested in learning more about astrology, but it is not yet a current passion.

To represent her goals, Skylar included images of palm trees, a Chinese structure (representing her desire to travel and her love of going to the beach), a graduation cap (representing her dream to earn a master’s degree or a PhD), and a car and house (representing part of her success). When asked what she intended to do after she graduated, she indicated that she intends to continue her education by earning a master’s degree and then “continue with career and job” (Interview1). In addition to being successful in her career, she intends to use her income to travel.

Connections Between Concepts

In the creation of her identity map, Skylar found it difficult to portray how she viewed components of herself and the relationship between the components. For instance, when Skylar initially constructed her map, she had family (as represented by the book and feather) in the center, and then all other concepts stemming from that with approximately equal distance. When asked if there was a reason for the equal distance from the center, Skylar stated that she wanted to portray “balance” across all four realms.

In describing her mapping however Skylar would often go back to languages, having stated that language is one of the four main elements she used to define herself (and potentially have equal weighting). When asked if language was one of the key components of her mapping, Skylar responded, “I’m not saying like languages is like the most important thing…but maybe because my family is like multi language?” (Interview 2). While Skylar recognizes the importance of language in her mapping, she also seems to attribute that to language being a foundation in her family unit. Her mother, for example, insisted that her children learn Cantonese, despite living in Vietnam where most of their daily interactions did not require speaking Cantonese. In addition, Skylar grew up in a country where learning English was valued and required.

Skylar often spoke about the importance of language in helping her achieve her goals in life. Not knowing another language could potentially limit the types of opportunities she would have in the future: “Language is kind of like the most important I think” (Interview 2). She would emphasize how language is what connects all the pieces of her map together, as if it is an implicit requirement:

> If I want to study in America, then I’ve got [to go] back to the languages, right? If I want to be traveling around the world, I will go back to languages again…. But I still think they’re equal because if I study language, I will notice I would like to play games or I want to play games. … I’ll go to traveling like that. See…link so maybe I’ll do something like just make it into a circle because I think they have link. (Interview 2)

Skylar seemed to recognize that knowing multiple languages can be perceived as a benefit as language is important in being able to travel. “If I want to be traveling the world, I will go back to languages again” (Interview 2). Learning English, for example, has helped her travel to the United States, providing the opportunity to earn her degree. In addition, if she wants to travel to other countries, she finds it necessary to learn those languages as well. Skylar however also noted that there are places she wishes she can travel to, such as China and language is a way to help her achieve that goal.

Recognizing that the link she was referring to in our conversation was not highlighted in her current mapping, Skylar then revised her map (see Figure 14) by drawing additional segments between the realms, stating that “there’s kind of like four different things connected, but they also connect to each other” (Interview 2).

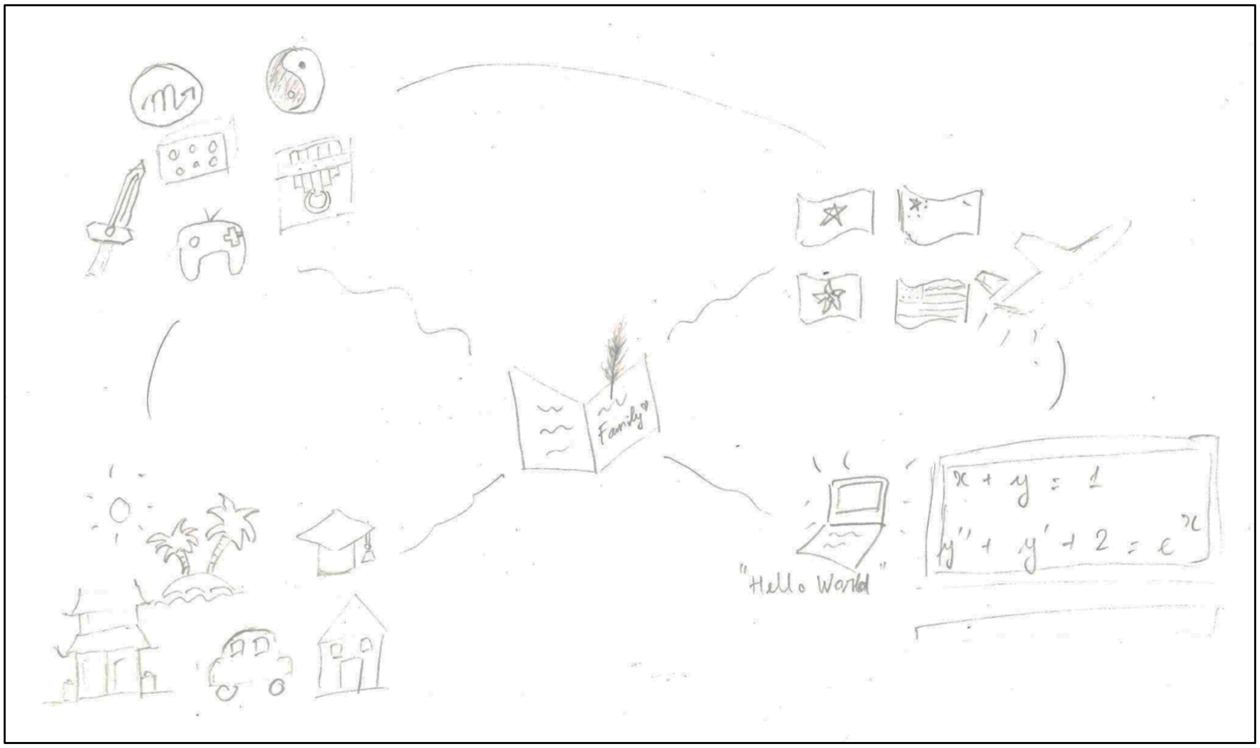

Figure 14. Revision of Skylar’s Identity Map.

Note. The only difference between this mapping and Skylar’s original mapping is how she made connections between each group (by drawing a curve between each of the four components).

Skyler’s Perceptions of Her Own Mathematics Success

Before having Skylar construct her perceptions of mathematics success with another concept map, Skylar and I had a long conversation about her experiences in Vietnam and the journey she took to come to the United States. As mentioned in her story, Skylar indicated that her parents played a large role in her success; primarily accepting her interests in the STEM field and then providing her opportunities that catered to her interests. For example, when Skylar was in middle school, she told her parents she was interested in architecture and so they enrolled her in an art class. This type of behavior may not seem unusual to some, but to Skylar, it indicated that her parents were willing to support her regardless of how others in society thought about women pursuing a STEM degree. One experience stood out to Skylar because her friend had a similar interest in IT but was not given the same opportunities as Skylar:

> And next is when… when I tried to choose my career, and I said like—I like computer or something like that—they [Skylar's parents] just support me just like that. Because my friends…she also said that she wants to go into computer engineering, but their parents said like, 'No, this career is only for men. If you follow this, it's hard for you to find a job in Vietnam'…stuff like that. 'And you cannot beat those men.' (Interview 2)

When asked why her parents were supportive despite how women were perceived in Vietnam, Skylar simply stated that she had already "proven herself" (Interview 2) to her parents by earning high grades in school and winning a physics prize in middle school. Although Skylar stated that it was not unusual to see girls win the prize (given the nature of the school she attended), the prize itself seemed to represent that "those who has won the award have the ability to follow that [a STEM degree]" (Interview 2).

With the additional classes after school, Skylar "did not have much trouble" (Interview 2) with any of the subjects in school, including mathematics. When asked if she ever struggled with mathematics specifically, Skylar could only recall having some trouble with division in primary school—primarily because her grade on an assignment/test was not a perfect 10.[216] In response

[216] Skylar described the grading system in primary school to use a scale of 1–10 (with 10 being the highest grade a student could earn).

to her struggles, Skylar's parents enrolled her in an additional math class after school. Having gone to school from seven in the morning till four in the afternoon and then taking additional classes in the evenings (typically from four o'clock to eight o'clock) three days a week and English classes on the weekends, Skylar credits most of her success to the times she spent in the classroom.

On the other hand, middle school was the most stressful time of Skylar's educational journey. The additional classes she was required to take in primary school primarily focused on mathematics and English. When she was in middle school however, she started taking courses that focused on the sciences, such as chemistry and physics. Unlike primary school, Skylar was not forced to take these courses by her parents. Instead, she asked her parents to enroll her in these additional courses so that she could be better prepared and win the physics award. The added pressure of doing well in school (because her goal was to get into the prestigious STEM high school) created a much more stressful time for Skylar. Although she earned extremely high grades, she was always aware of the possibility of not being accepted into the STEM school. By winning such an award, Skylar indicated that it would help her "get into the high school for the gifted" (Interview 2), while also earning recognition from family and friends.

Interestingly, Skylar was not as motivated to try and win the mathematics award that was also offered to students at the school. When asked why she did not pursue that award, she simply stated that—

> Math is harder at that time. In Vietnam math, they want us to prove something, for example, that gives you a theory or something like that. And they want you to prove it. But I don't have that much knowledge and materials to prove that. (Interview 2)

Despite earning high grades in mathematics, Skylar still perceived herself as “not capable” of winning the mathematics award. Part of the reason for this decision is because she felt that the potential physics content for the award covered a specific range of content. Mathematics, however, was not as clearly defined, as the questions in mathematics could cover geometry, statistics, algebra, and so on. Skylar did not think she could study or prepare for an award when she did not know what specific content to focus on. In addition, her mathematics scores in middle school ranged from eight to ten, which indicated to her that she was not as strong in mathematics as she was in physics. Skylar admitted that although she was taking additional courses to help prepare her in science, she often volunteered to do additional practice in mathematics whenever her teachers offered them in school.

Skylar stated that the time spent in middle school and the additional courses she took outside of school prepared her well for high school. Although the content in high school did get “harder” and she continued to take additional courses after school until 9 pm, Skylar enjoyed high school more because she was able to give herself time to “play.” The high school offered opportunities for students to volunteer in the community, such as preparing food for a restaurant or visiting an orphanage. Skylar enjoyed these activities but also saw them as opportunities to learn the “soft skills” the high school encouraged students to learn.

By the time Skylar entered college, she felt she would be well-prepared to succeed. She however “did really bad, like I did worse in those math” (Interview 2). When asked to describe how “bad”[217] her mathematics courses were, Skylar stated that she felt the language barrier was the primary issue: “I don’t know why. But I think one of the problems was the language barrier. Because I started English program in my college in Vietnam. And sometimes I cannot

[217] Skylar stated that “bad” meant she was now earning Bs in all her courses—something she was not accustomed to up until this point in her life.

understand what my teachers is talking about" (Interview 2). The bridge program of the college required her to learn in English, to prepare her to take courses in the United States. With this new change, Skylar began to see a dip in her grades, even in courses such as coding, mathematics, and physics, which she had always done well in. In response to her low grades, Skylar used methods that she had previously used in middle school and high school and started putting in extra time outside of class—re-reading the textbooks, searching for answers online, and studying with a group of friends. Despite having trouble in her courses, Skylar admitted that she never went to her professors for help because she knew they would speak in English, and she did not think that would help her learn the content. Skylar did not think her professors were a good resource to learn the content of her courses because she would "just listen to them again. And I still don't understand" (Interview 2).

Skylar's confidence in her understanding of mathematics was somewhat diminished the first 2 years of college. Yet, her insecurities in mathematics changed when she came to the United States. In her third year, Skylar moved to New York, where she enrolled in linear algebra and experienced the same type of success she had in high school. Skylar could not explain why, but she stated that the course was "easy" and "boring" but that she was able to earn an A. During the pandemic however Skylar was forced to move out of the dorms and then moved to Georgia to live near her cousin. She is now enrolled in a small public school, where she has been retaking several of her mathematics courses.[218] Rather than be upset about having to take her mathematics courses again, Skylar stated that the courses are very easy and "it's better because I got a higher grade" (Interview 2). Her concerns of having a low GPA from the courses she took back in

[218] Recall that many of her courses from Vietnam and New York did not transfer over to her current institution.

Vietnam are slowly being erased because she can earn the high grades she was used to growing up.

Skyler's Definition of Mathematics Success

Just like when Skylar drew her first map, she requested I leave her alone in the room for about 10 minutes. When I came back, Skylar provided her map (see Figure 15) and stated that "success is kind of like the path, but if you want like higher….so I draw stairs" (Interview 2).

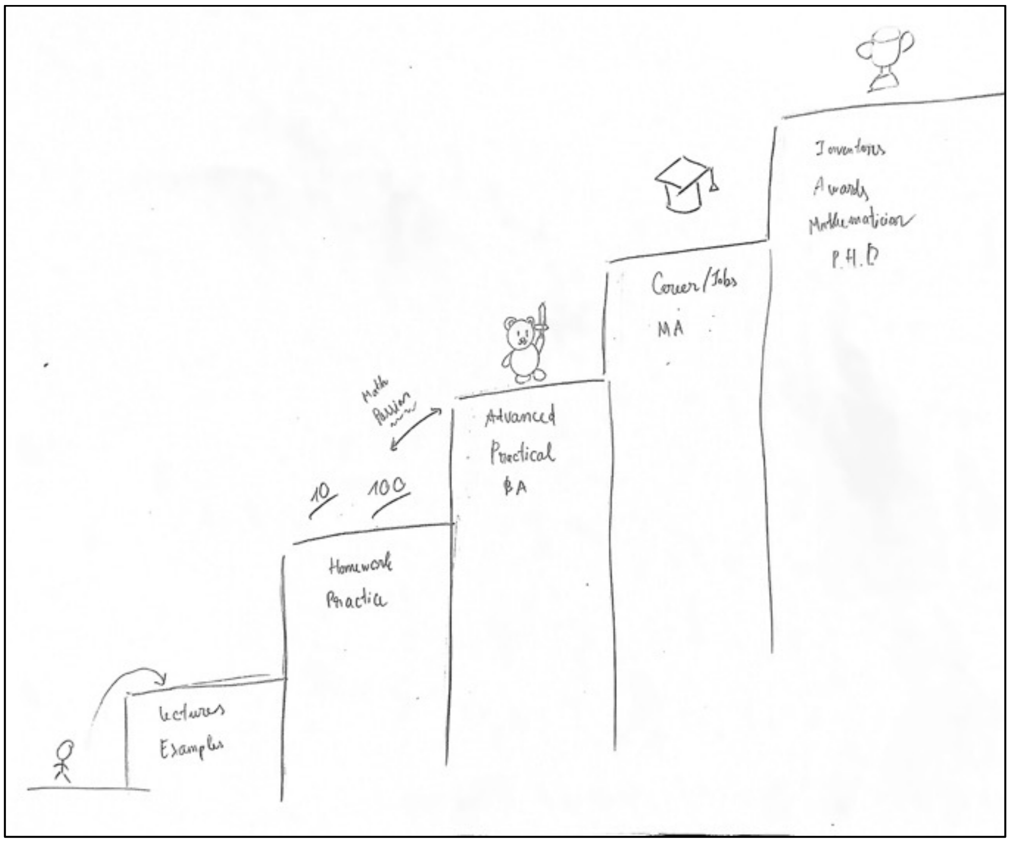

Figure 15. Skylar's Initial Map of Mathematics Success.

On this journey of mathematics success, Skylar stated that every person needs to start by "doing math" (Interview 2). To "do math," Skylar emphasized the importance of being exposed to lectures and examples, which is provided by schools. But simply being exposed to lectures and examples is not enough to be able to move up the stairs, as "doing math" means there is a sense of responsibility on the person to put in time and effort. The second step, "homework and practice," requires a person to engage with the mathematics through "a lot of practice and exercise" (Interview 2). Through this engagement, a person should be able to recognize her "success" by the grades earned (as indicated by the "10" and "100" that is shown on top of the second step in Skylar's map).

According to Skylar, it is at this second step where most people stop on their mathematics journey. For those who "want to challenge themselves more" (Interview 2), Skylar stated that they need to have the motivation and passion (Skylar indicated this need in her map by writing "math passion" with a bidirectional arrow in between the second and third steps) to want to continue and broaden their knowledge by gaining "access more harder materials" (Interview 2).

People who choose to move to the third step are those who want to engage in the "advanced and practical mathematics" (Interview 2) in their lives. To Skylar, this meant they are pursuing a bachelor's degree (as represented by "BA" in the third step) that is in the field of mathematics or in a field that is dependent upon mathematics. The drawing of the bear on the third step represents Skylar—an image she chose to represent herself because the word "bear" in Vietnamese was a nickname she had as a child. This third step represents accumulation of knowledge that is needed to be successful in the field or in one's career.

People who move on to the fourth step use mathematics in the field (in their job or career) or are continuing their education by working toward a master's degree. Those who move beyond the fourth step and into the fifth step are considered "mathematicians. …like genius!" (Interview 2). These mathematicians are those who not only go on to get their Ph.D. in mathematics but also make contributions to the field of mathematics with their inventions and awards. When asked what type of people Skylar would consider being at this step, she stated "people like Thomas Edison or Pythagoras" (Interview 2). Skylar also stated that while she does not think the fifth step is unattainable for her, she does perceive is as being "kinda far" (Interview 2) and would only consider pursuing that path if she had some kind of "sponsor"[219] or support.

Revisions to the Mathematics Success Map

During the third interview, Skylar stated that there were elements of her map that she was "not happy with" because she could not figure out how to represent some of her ideas in a drawing. Between the second and third interviews, she thought about how she could represent some of these ideas but still could not figure out how to do it. When asked what elements of the map she would like to change, Skylar began by stating that the map she created only represents "one type of math" (Interview 3). For each "branch" of mathematics, a person would have to start at the first step again. For example, when she started learning about differential equations, she found herself going back to the first step—watching videos and examples online to help her learn the material.

Skylar also stated that the steps, although drawn to be equal in size, may not actually be equal depending on the person moving along the path. For instance, "some people just need more or less access. …and less exercise to get higher grade because they're smarter" (Interview 3). The steps would thus shift depending on the needs of the individual. Skylar emphasized however that a person's ability is not the only factor to consider. For example, a person who is "smart but also lazy" (Interview 3) may not be able to move easily between the steps: "Because, if you're smart, because you understand those materials it's faster than others… . But when you don't

[219] During all three interviews, Skylar mentioned multiple times that she is only able to continue her education because of the "support" she can receive from the schools financially. Although her parents do provide financial support for Skylar while in school (i.e., cost of living and spending money), her goal is to earn scholarships so that her parents do not have to pay for her education. Her reasoning is because she knows that her parents have already paid "a lot of money" (Interview 1) already for all the additional classes they enrolled her in throughout her childhood.

practice a lot then, you know, you couldn't get a higher grade, if you don't practice" (Interview 3). Skylar struggled with determining whether a person's ability or work ethic would determine whether one would be able to move between the steps more easily. By the end of the interview, Skylar stated, "right now, I feel like the abilities is not important because if you practice a lot, you can still improve" (Interview 3). To indicate that the steps could shift depending on the person, Skylar then added three bidirectional arrows to the third, fourth, and fifth steps of her map (see Figure 16).

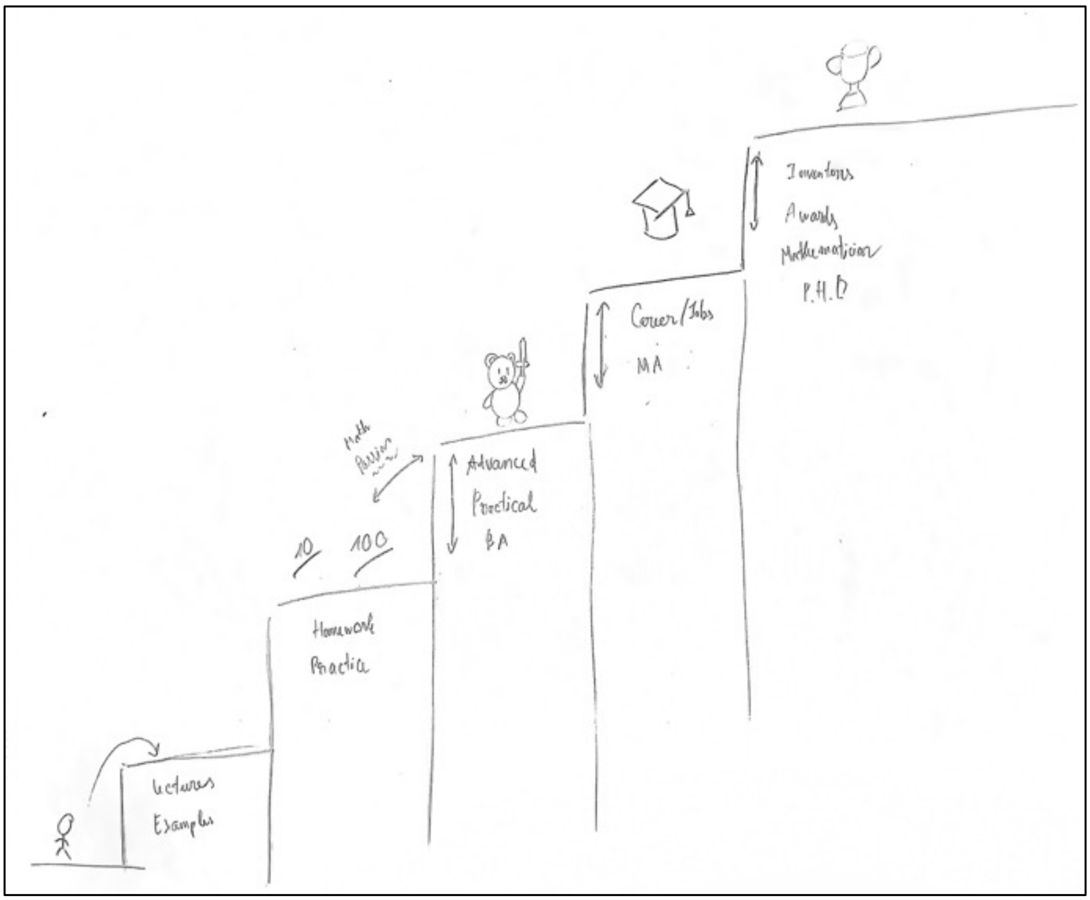

Figure 16. Skylar's Revised Map of Mathematics Success.

Note. The only difference between Skylar's first map of mathematics success and this revised version are the three arrows Skylar added on to the third, fourth and fifth steps.

Once Skylar drew the bidirectional arrows, she also emphasized that there could be other potential factors that could affect the shifting of the steps, such as the amount of passion a person has for mathematics. According to Skylar, if a person is not passionate about mathematics, then the possibility of that person moving to another step in the map would be low. The passion essentially is what would drive a person to continue this path and is necessary to move beyond the third step (and affects the shifting of the fourth and fifth steps).[220]

Skyler's Final Concept Map

In the final interview, when Skylar was asked to create her final concept map to represent a combination of her first two mappings, she indicated that she began to see her own journey like climbing a mountain rather than climbing stairs (see Figure 17) because climbing stairs is "not as hard as climbing [a] mountain" (Interview 3).

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[220] Skylar was still not entirely happy with her concept map as she couldn't figure out how to represent these ideas in her drawing. Additionally, she recognized that she probably did not "get it all" (Interview 3) when describing what factors would make the steps shift.

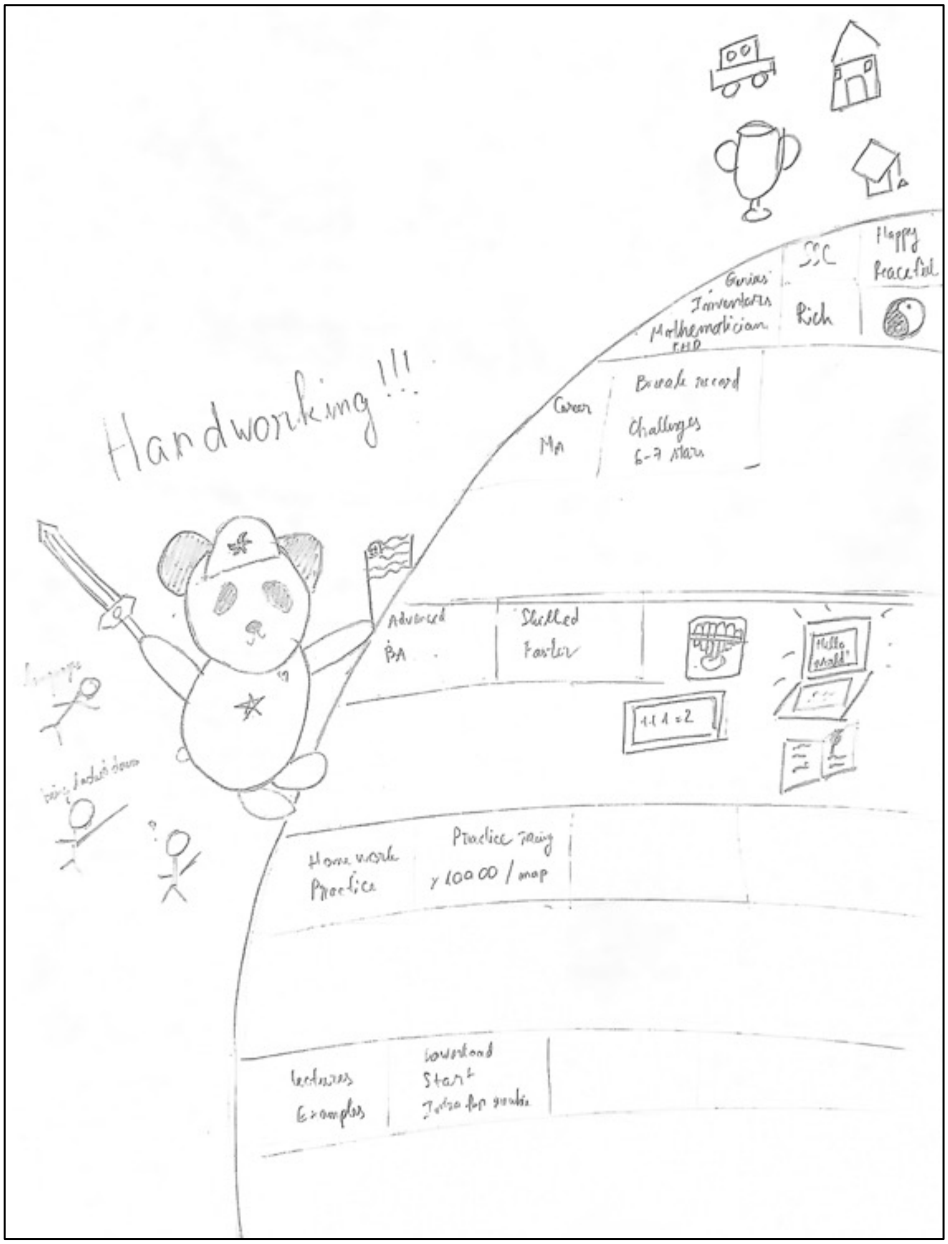

Figure 17. Skylar's Final Concept Map.

Skylar was very intentional in how she portrayed herself in this drawing. Although "bear" was her nickname in primary school, she also wanted to highlight aspects of herself that relate to her heritage. Skylar therefore portrayed herself as a panda bear (to represent her family heritage from China) wearing a hat (to represent Hong Kong because she can speak Cantonese),[221] with a star on the bear's chest (to represent growing up in Vietnam). She then drew the American flag (the object the bear is holding as she climbs up the mountain) to represent "opportunity" (Interview 3); recognizing that being in America is a big and necessary part of her life, as the United States can provide opportunities for her that she cannot get in Vietnam. The sword in the drawing represents her hobby in playing video games, a necessary component because playing video games provided an outlet for her; representing the importance of balance in her life because playing video games has helped her maintain her mental health. In addition, the games she played provided opportunities for mental challenges as well, as many of the games she participated in required playing against other people in the world.

After drawing the panda climbing the mountain, Skylar began to think about how the challenges the mountain was supposed to represent: "Because this one is not only…like, success in math—what you want, you need to do success in math, but this mountain has different things in…different stuff" (Interview 3). Like her second concept map, Skylar stated that she too had to go on a similar path, starting with accumulating knowledge through lectures and examples. In the technology world, that would be like "downloading a program and then starting it" (Interview 3). Next to the phrase "lectures" and "examples" at the bottom of the mountain, Skylar wrote "download," "start," and "intro for newbie."

The next "step" of the mountain is where "homework" and "practice" lie—indicating that Skylar has had to practice ("x 10,000" as shown in her map) to get to where she is now. The panda bear is holding on to the side of the mountain that represents her current place in this journey; working on her bachelor's degree and fine tuning her skills (as she has "gotten faster"),

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[221] Skylar initially drew the hat with a Vietnamese flag on it, but then changed it because she thinks "Vietnamese should be in my heart" (Interview 3).

such as coding and doing mathematics. Skylar also included images she used in her first concept map, such as the kalimba, the computer, the chalkboard with mathematics on it, and the book with the feather pen.

The "final steps" of the mountain are towards the top. Skylar noted that although she intends to reach the top of the mountain, she is not sure what lies in those phases of her life. She plans to go to graduate school to obtain her master's degree and eventually have a career in IT. She is currently pursuing a dual degree in IT and applied math. Although IT is her main goal, she considers mathematics as a necessary component in her IT success:

> I think my main goal is still IT/math. It just kind of like support my IT… . But maybe I can do something with math if I couldn't find a job with IT. But at the end of the day, I think…I'm thinking right now I'll come back to IT. (Interview 2)

If she were to pursue a Ph.D. in mathematics or IT, she would then be close to the top of the mountain because she would be considered successful in her field. Pursuing a Ph.D. however is not at the very top, because ultimately Skylar wishes to lead a "happy and balanced life" (Interview 3) that includes being financially stable and being able to engage in activities that bring her joy (such as traveling, earning accolades, etc.).

After Skylar completed her drawing, Skylar stated that her journey has not been particularly easy for her. The initial steepness of the mountain, for example, represents her having to work hard—going to school, taking additional courses, and maintaining high grades so that she can get on this current path to success. According to Skylar, "everything is hard when you start" (Interview 3) and she had to be "hardworking" to overcome the initial steepness of the mountain. She emphasizes this by writing the word "hardworking!!!" above the bear, as she attributes a large part of her success thus far to her work ethic.

Skylar also recognized that her parents had a large part in her success but stated that there were “enemies” that tried to prevent her from going on this path to earning a STEM degree. When asked what she meant by “enemies,” Skylar stated they were “obstacles,” such as “languages, woman, and being looked down” (Interview 3). Not knowing English, for example, has been a challenge for Skylar, especially when she first started college in Vietnam in the bridge program. She continues to be self-conscious about her English skills and stated that she needs to “keep practicing English” (Interview 2). In addition, being seen as a woman in STEM hasn’t necessarily been hard for Skylar directly, but she has seen how her friends have been denied opportunities because of their gender. Nevertheless, Skylar does note that she would love to go back to Vietnam but understands that being a woman makes it more difficult for her to pursue her dreams in her native country.

To represent these ideas in her drawing, Skylar proceeded to draw stick figures that surround the bear and labeled two of the stick figures with “language” and “being looked down” (as seen in the far left of her concept map). She then placed a question mark above the third stick figure, stating that she “sense[s] there is something else” (Interview 3), but could not identify what else to write.

CHAPTER 8

WING-YU

My first encounter with Wing-Yu was in my Calculus I class in Spring 2022. I had gone to the classroom about fifteen minutes before class to set up the technology, when I noticed a young Asian woman sitting in the front row. She was wearing jeans and a T-shirt and was looking at something on her iPhone; her shoulder-length black hair disrupting my view of what she was looking at. Wing-Yu was also wearing a mask, which made it difficult for me to see her face.

When I walked into the classroom, I greeted her and asked for her name. She gladly gave it to me and stated that she was excited to take the course. She had heard about me from one of her closest friends (who happened to take my College Algebra course the previous semester). Based on his recommendation, she enrolled in my Calculus I class as a dual enrollment student.[222]

I asked Wing-Yu a few more questions (such as "where do you go to school?" and "Have you taken dual enrollment courses before?") as I was setting up the technology and other students started to trickle into the classroom. Although Wing-Yu answered my questions, I could tell that she was a little shy and noticed that as more students walked into the room, she became quiet. [223]

[222] At the time, I was aware that she was a dual enrollment student because she freely gave me that information on the first day of class. Normally, instructors are not given this information and are expected to treat dual enrollment students just like other college students.

[223] During our first interview, Wing-Yu did state that this type of behavior is typical for her as she sees herself as being very "reserved" and struggles with connecting with other people. At the time, I did not think she was socially awkward; I just assumed that given how people were responding to COVID, that Wing-Yu wanted to just distance herself to protect herself and others.

As the semester progressed, I noticed that Wing-Yu kept to herself. This behavior was not surprising given that we were all trying to navigate the new norms of COVID. For the safety of myself and others, I did not have students engage with one another as I had done before the pandemic. Students were asked to continue social distancing from one another and were encouraged to wear masks.[224] With limited physical opportunities to bond with one another, students often kept to themselves during class. Despite the organization of this class, Wing-Yu did very well, earning an A in the class for that semester.

When I reached out to Wing-Yu through email to see if she would want to participate in the study, I was a little surprised with her quick "yes." Although she was a great student in my class, I did not feel as though we had bonded that much that semester.[225] We would have conversations before class started (about 5 minutes), but she was often very quiet and kept to herself. The most I knew about her was that she was a dual enrollment student at the time, and she loved to draw (and was very good at it!). Her passion for drawing was evident as I would often find her artwork on her name tent.[226] At the end of each class period, when Wing-Yu would return her name tent to me, I would often see new drawings that decorated her name. So,

[224] At this time during the pandemic, there were no requirements for faculty or students to wear a mask at our institution. Social distancing and mask wearing were encouraged but was not a requirement. Due to the changing conditions of the pandemic and trying to navigate this new form of education, I did not conduct class as I had prior to the pandemic. Normally, students in my Calculus classes are arranged in groups and work through activities to learn content (similar to flipped learning, where the instructor is a facilitator of students' learning). During the pandemic, however, I went back to the "lecture style" of teaching while in person and tried to incorporate group work using technology.

[225] During the pandemic, I often felt I didn't do a good job in getting to know my students. Not being able to see them in person or seeing their faces (due to the mask wearing), made it difficult for me to associate them with things they would tell me about themselves. While I was still able to engage in conversations with students, I never felt that I built strong bonds with them.

[226] Over the last few years, I have started asking students to write their preferred names on name tents. I would use these tents to not only learn students' names, but also for attendance purposes. I personally hand out the name tents to each student as they walk into the classroom, greeting them by their name at the beginning of each class. I then ask students to return the tents to me at the end of class. This method has helped me learn students' names but has also helped them learn more about each other. Students have said to me that they appreciate seeing the name tents because they have also helped them learn their peers' names and personalities.

when Wing-Yu agreed to meet with me at the start of this study, it was the first time I was able to see her entire face. We met at a coffee shop and spent some time getting reacquainted; catching up on each other's lives after not seeing or talking to each other for a year.

Wing-Yu's Story

Wing-Yu was born in the United States. Although both of her parents are from China (her mother from a rural area of China and her father from Hong Kong), they met in California. Wing-Yu's mom had family members who lived in San Francisco and so, with her family's support, they decided to stay in California, where Wing-Yu was born.

Despite having family in the same area, Wing-Yu describes the area she lived in California as "not the best place to live" (Interview 1) and the houses as being "run down." Due to the living costs of San Francisco, Wing-Yu's parents struggled to afford to buy their own home. While living in California, her mother was a seamstress, and her father did some indoor construction/electrical work. Thus, Wing-Yu and her parents were forced to live in the "basement of someone else's home" (Interview 1). In addition to providing a safe space for their child, Wing-Yu's parents were also concerned about Wing-Yu's asthma. The air quality in California seemed to have affected Wing-Yu's ability to breathe. Rather than try and find a home in California, Wing-Yu's parents saved their money over time and eventually bought a house in Georgia. Wing-Yu's asthma condition and the fact that her parents had family members who also lived in Georgia helped motivate them to leave California. When Wing-Yu was about 6 years old, she and her parents moved to Georgia.

Wing-Yu's parents, not knowing much English themselves, spoke primarily Cantonese at home. Living in the United States however provided Wing-Yu opportunities to learn English, which helped her become bilingual. She attended daycare as a small child and was around people who spoke primarily English. At that time, she remembers feeling "confident" in her English skills because she was able to communicate with people she wanted to communicate with. When Wing-Yu came to Georgia and started first grade, Wing-Yu admits that she "struggled with English" (Interview 1) because speaking English was only a part of knowing the language. She continues to struggle, for instance, with using "bigger" words and correct grammar.[227] As a bilingual student, Wing-Yu has been able to maintain her Cantonese (as her parents "only speak like basic English" [Interview 1]) at home while also learning English in school.

Conversely, Wing-Yu has always felt mathematics was a strength she had since she was in daycare in California. Not only did she enjoy doing mathematics, but she also excelled at it at a very early age. Her earliest memory was when she was in PreK and was asked to solve some addition and subtraction problems. Timed mathematics quizzes, such as the Big 20,[228] did not create any source of anxiety for Wing-Yu; instead, she enjoyed doing them and often noticed she would finish before most other students in her classroom:

> I like doing these and I'm good at, and I remember being good at this. I remember liking doing it because I guess it was a superiority complex too, because all the other kids who didn't do as well as me. (Interview 2)

Time spent in school was mostly enjoyable to Wing-Yu—especially in elementary school. Even though Wing-Yu acknowledged the struggles she has had learning English, she has good core memories that mostly center around her friend group. Although she described herself as being "socially awkward," she continues to be close to this peer group. The bonds she was

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[227] I discuss later in the chapter some of the different types of struggles Wing-Yu has had as compared to some of the struggles other participants of the study also had with the English language.

[228] The "Big 20" is an assessment some schools use to measure students' computational skills, such as addition, subtraction, multiplication, and division. The goal for students is to complete all 20 questions within a specific time frame (depending on the content that is being assessed). Wing-Yu's experience of the Big 20 included being able to recall her multiplication facts within 2 to 3 minutes.

able to create with these people from elementary school has carried with her up until now. Although many of them do not attend the same college, they often communicate through online games.

This friend group was especially influential in school—not only at recess but also how Wing-Yu would think about placement and how she was being seen by teachers and other students. In elementary school, Wing-Yu indicated that she was tested for gifted but did not get into the gifted program. This denial at first confused her because she felt that was just as capable as her peers. She viewed school as being “pretty easy” (Interview 1); often completing assignments in school and not having any homework to do at home:

> But then I specifically remember there was like a gifted program or something. And basically, like people will be tested for gifted. And I would see like my friends—they would leave to go to like this FOCUS[229] class. And I remember like thinking like, oh, why couldn’t I go? What are they doing? I didn’t know. But I remember they tested me in like third…third grade or fourth grade and or fifth grade. I remember like for the test, apparently, I was like one point off being like included and they were like debating whether it actually be let in. Ultimately, I wasn’t. I remember just thinking like, why wasn’t I let it in? Because when you’re in elementary school you don’t really care about what you’re learning. You more care about, like, you know, your friends, the fun classes, …you know? I just remember thinking like, why can’t I go with them? Because I remember the only time I went to a FOCUS class was when like, they told us, ‘Hey, you

[229] In her school district, the gifted program is called FOCUS (Fostering, Originality, Creativity, Understanding, and Self-Awareness) in elementary school. When students move into middle and high school, the gifted programs are known as PROBE (Problem-Solvers, Researchers, Observers, Brainstormers, Evaluators) and QUEST (Querying Unusual Extended Study Topics), respectively. In this program, students are pulled out of classes for a part of the school day to “receive additional instruction in higher-level thinking.”

> can bring one of your friends as a partner to like dissect a brain' or something. One of my friends was in the FOCUS group and she invited me. And that's like, the only time I've ever went. And I just remember thinking like, why wasn't I invited? You know? Or like, why? Why can't I be in here? I apparently was like one point off when they did test me. So that was like, kinda frustrating. (Interview 1)

While this experience was a source of frustration for Wing-Yu, she did say that ultimately being tested and not being placed into FOCUS was not a barrier to her participation in the same courses as her peers. As she worked through school, her teachers realized her potential and would advise her to be put into accelerated courses. She did eventually get tested again in middle school and was accepted into the gifted program. Yet, Wing-Yu did not see much of a difference in her day-to-day life in school because she was already in the accelerated courses.

In middle school, she indicated that there were three teams (A, B, and C), with C team being considered as the "accelerated" group. Along with most of her peers, Wing-Yu was included in the C team. The creation of the teams created a negative discourse amongst students, as students in A and B teams were hostile toward the C team. Wing-Yu stated that those A and B teams viewed the C team group as being "superior" (Interview 1) because they were in the accelerated group. Although she is aware that the accelerated courses covered more material, she did not think there was much difference between the teams, claiming that the courses "really weren't that different" (Interview 1).

Yet, being in the accelerated group did not always mean she was immune to other pressures of middle school. Wing-Yu described herself as being "super depressed" in middle school due to the fear of her sexuality[230] coming out in school. During a time when she felt she

[230] During the interview, Wing-Yu proudly stated that she is "bi" and is open to sharing this information. Although she was open about this part of herself during the interview, Wing-Yu did state that she has yet to tell her parents.

needed to figure out who she was and how to deal with the emotions she was feeling, she had to also deal with how others were perceiving her and her relationships with her peers. Most members of her peer group however were supportive and did not pass judgement. By the time she got to high school, Wing-Yu no longer cared what others in the school might think.

High school was a time when Wing-Yu had to learn how to navigate in many ways, as COVID hit the end of her sophomore year. Going into junior year fully online put a tremendous amount of stress on Wing-Yu, especially given that she was taking multiple AP courses at once.[231] This period of time was the first time in her academic career where she really struggled learning content in her courses.[232] Many of her teachers, for instance, would provide notes and recorded videos, but would expect students to mostly follow the schedule on their own time. Although the modality was like a hybrid class, Wing-Yu stated that most teachers would use Zoom just to answer questions, rather than teach content. Taking challenging courses online, having to learn most of the content on her own, and not being able to interact with her friends took a toll on her mental health. Wing-Yu stated that being home all the time affected her in ways that she is still working on today.

For her senior year of high school, it was a little better for Wing-Yu because she was able to become a full-time dual enrollment student at a local college, where she and I met. Compared

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Given her parents "conservative nature" (Interview 1), she is not sure how her parents will respond to this news and is waiting to tell them once she is able to support herself and moves out of the house. In addition, having heard about some of her friends' experiences of when they told their parents, she feels it might be better to wait until she has become independent and can support herself. More details about her relationship with her parents will be discussed later in Chapter 9.

[231] During her junior year, Wing-Yu reported taking five AP classes, which included AP Language Arts and AP Calculus.

[232] Apart from English, Wing-Yu stated that she always felt school was easy for her up until high school. Her struggle with English in elementary school was primarily focused on grammar and writing. Her conversational skills however were good enough for her because she was able to communicate with her teachers and friends. Wing-Yu does separate the different "types" of English, which is discussed later in Chapter 9.

to her AP courses, Wing-Yu felt the coursework was not as demanding, the workload was more manageable, and it allowed her to get out of the house (because many of the courses were hybrid). She also happily stated that her senior year was the last time she had to take an English class, which is a prerequisite for many other courses in her major.

Wing-Yu is now currently a student at another institution, where she is pursuing a computer science degree (focusing specifically on intelligence and media). Due to her ability to take college courses as a dual enrollment student, she has enough credits to be counted as a junior even though this is her second year in college. When asked to describe her college experience so far, she simply replied that "it's like high school plus, like the plus that matters" (Interview 1). Although she has been struggling with some of her mathematics and computer science courses, she indicated that being able to meet people like her (i.e., those who are also a little reserved and like to play online games) and making her own schedule makes college a happier place for her. She spends most of her time with three other women (a diverse group consisting of one Hispanic woman, one White woman, and one Southeast Asian woman).

Construction of Wing-Yu's Identity Map

When asked to create her identity map, Wing-Yu chose to share her thoughts as she was drawing components of her map. As Wing-Yu began to create her map, she stated that she thought about herself and her life like what one would see in a game (as shown in Figure 18). Just like a game, there are "different levels or worlds" (Interview 1), with each one representing a phase in her life.

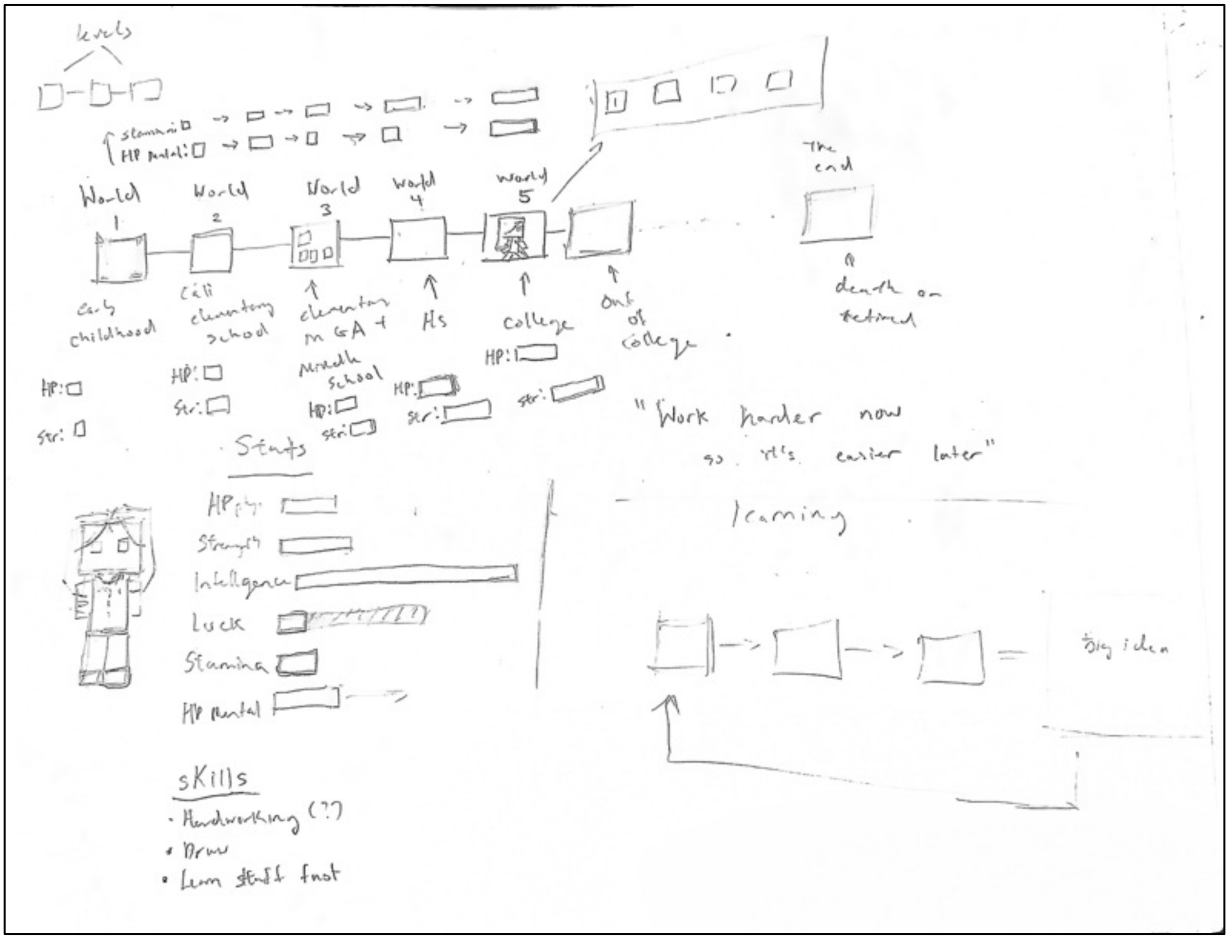

Figure 18. Wing-Yu's Identity Map.

Note. This concept map was created in Wing-Yu's first interview and represents some of the ways in which Wing-Yu described herself.

Wing-Yu began drawing these worlds in the top left corner of her map, detailing each world as a phase of her life (see Figure 18). World 1, for example, represents her early childhood and within that world there are multiple levels that she has had to work through to move on from that world to World 2, which represents her time in elementary school in California. In all, Wing-Yu constructed "seven"[233] worlds in a linear sequence:

[233] Although seven worlds were drawn, Wing-Yu said she did not know what lied beyond her years in college (what the worlds would be or how many of them she would have to venture through) and thus, represented those worlds with just "a bunch of dots." You can see those dots in her drawing between World 6 (labeled as "out of college") and the world labeled as "the end." She does propose that some of those worlds could include getting married or

1. early childhood,
2. elementary school in California,
3. elementary and middle school in Georgia,
4. high school,
5. college,
6. out of college, and
7. the end (death or retired).

She then proceeded to draw a representation of herself in the World 5 box to indicate that she is currently in that world as a college student.

Additionally, in every game where there is a main character, the game often provides a summary of the character's strengths and weaknesses, known as the character "stats" (Interview 1). The "stats" Wing-Yu chose to highlight in her identity map (see bottom left corner of Figure 18) include potential strengths and weaknesses, such as HP,[234] strength, intelligence, luck, and so on and are represented by different bars. Her stats include (a) HP physical, which represents her overall health or "daily energy"; (b) strength, which represents her physical strength; (c) intelligence, which represents her ability to learn content easily; (d) luck, which represents how lucky she is in specific situations; (e) stamina, which represents her energy level, and (f) HP mental, which represents "how burnt out" she is. Wing-Yu acknowledged that her intelligence bar was the biggest because normally she does learn things quickly in school, but she had just completed a tough semester where she felt she put a lot of energy into trying to do well in her courses. As a result of that semester (and college in general), Wing-Yu felt that her physical and

having children but has not really planned for any of those events to occur and has left that space open to all kinds of possibilities.

[234] Typically, in role-playing games, HP stands for "Hit Points"—or the total number of hits it would take to defeat that player. It's a visual many gamers use to determine how "healthy" their character is and whether they need to acquire more strength.

mental health has taken a toll. All the other stats therefore have low bars in comparison to the intelligence bar.[235]

When asked if Wing-Yu believed she could change the status of the bars herself, she responded that she probably could. In terms of strength, she spoke about how she could incorporate some exercise in her daily routine or go outside more. Other stats, however, such as HP mental and stamina seem to be more reliant on environmental factors. For instance, Wing-Yu described how her mental health was low because she felt she "studied too much" and at some point, she really needs "to take a break" (Interview 1). Due to the pressures of school, she feels it has overall affected her mental health and stamina—"feeling really burnt out physically and mentally" (Interview 1).

Despite having low stats in some of these areas, Wing-Yu acknowledged that she does possess some good character traits, such as being a hardworking person, knowing how to draw, and having the ability to learn fast (shown in her map under "skills"). She has often stated that she can stay "hyper focused" on things, which has helped her do well in school. If she finds something interesting, for example, she will want to learn everything about the subject and will not move on until she does.

Still, Wing-Yu worries that these skills may not be enough to engage with other people outside of her friend group that she had established in elementary school:

> Maybe just like the fact that I'm really reserved. I know when I'm out and about, I'd like barely interact with people. I'd rather just keep to myself half the time. Because like…my

[235] I found it interesting that Wing-Yu does not perceive each bar as limited. For example, the intelligence bar is much larger than the other stats, which does show that she views that as her strength. But when I asked her if that bar could get bigger or if there was a limit to what that bar could look like (i.e., trying to understand what the "whole" is in this specific bar), Wing-Yu simply stated that these bars are always changing and that there is no one bar to compare it to.

> friend group has been friends for such a long time that it's like an unhealthy mindset, I think. But for me, it's like while I don't want to—I don't really want to get to know new people when I've been friends with. …I have these group of friends that I've known for long that know me. It's easy to talk to them. I've never talked to people I don't know, I guess. (Interview 1)

Having made a few friends on campus has helped her create bonds with other students and communicate with them about classes. Her friend group helped her mental strength go up because they communicate with one another in various forms (i.e., through Discourse[236] or online games) daily.

Despite the areas she feels she needs improvement, Wing-Yu often stated that she knows she can accomplish her goals if she "puts the work in" (Interview 1). To emphasize this point in her map, she wrote "work harder now so it's easier later" (shown on the right-hand side). Wing-Yu stated that this statement was her "unofficial motto" (Interview 1) because she believes that if she puts in the hard work now, the path to her success will become more attainable. For example, although she was extremely stressed in high school taking multiple AP classes, she felt she had to go through that process to help her move forward with her degree. She stated that that plan has worked for her because she was able to use all those credits to further advance in her degree.

Wing-Yu has chosen a degree that focuses on intelligence (what she views as being like Artificial Intelligence [AI]) and media. She feels choosing AI will help her learn the basics of what is needed in the technology realm (such as learning different programs like Python and Java). Media however pertains to her love of playing games. She mentioned that one of the

[236] Discourse is a JavaScript application that runs in a web browser and is an application many students use to communicate with one another.

courses she looks forward in taking is a game design class where she has heard that students can create their own game as an end-of-semester project.

Connections Between Concepts

Wing-Yu's concept map may appear to be disconnected, but in the way she constructed the map, she indicated that the worlds and the figure she drew of herself are related. For instance, the stats she created next to her character can change depending on the world she is in and what she has gained from that world. The bars that are associated with each stat, according to Wing-Yu, are not fixed, she simply drew them as she sees herself currently:

> I think these [pointing to the worlds at the top of the map] are like worlds. And each world can be broken down into like, a bunch of levels—like individual levels. And I think like through each level, like in each world, as I go through, I gain like. …I gained something in these stats. (Interview 1)

At this current phase in her life, Wing-Yu sees herself as having gained "a lot of intelligence points" because as she has traveled through each of the worlds depicted in Figure 18, the amount of knowledge she has accumulated has increased. Intelligence incorporates not just how much she has learned in school, but also things like "life lessons," "how to navigate social situations," and "learning how to draw" (Interview 2). But her HP did not change much because she hasn't had to change her physical activity in any of the previous worlds that would contribute to increasing that bar.[237]

In addition, Wing-Yu states that the length of each bar is "relative to every other bar" (Interview 2). When questioned how the bars' lengths were determined in this current mapping,

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[237] Wing-Yu did have asthma as a child and so has viewed herself as not being "super healthy." She was also not a part of many school sports (although she did do some swimming as a child); therefore, these elements of the worlds she has navigated through have not impacted her HP much.

Wing-Yu stated that she tends to create the other bars based on her "best stat"—her intelligence. Because she views one of her best qualities as being intelligence, every other bar must be smaller than that one. So, while some of these bars may appear to be small, Wing-Yu stated they are not constant, can shift, and some of these stats has changed dramatically over time. Her mental HP and stamina, for example, have also increased.

Wing-Yu's Perceptions of Her Own Mathematics Success

Although Wing-Yu considered herself as being successful in school overall, she specifically stated that she "excelled in math" (Interview 1). Unlike some of her peers in school, she said she enjoyed doing mathematics and did not experience much anxiety with mathematics or on mathematics exams. In fact, she enjoyed taking timed mathematics tests because "math came really naturally to me" (Interview 1) and she would often earn high grades on them. She considers most of her struggles with English, as she often "struggled to get an A" (Interview 1).

She credits part of her success in mathematics to her parents, as they often encouraged her to "focus hard" on school and expected her to earn As in all her classes:[238] "They always told me, you know, study hard and you'll make a lot of money. He [her father] always told me that. So, I guess that's where I built my habit of studying" (Interview 1).[239] Her parents instilled this work ethic at a young age. One of Wing-Yu's earliest memories was when she was in preschool and her mother had a whiteboard that had a multiplication table on the back: "And basically, my mom would sing the timetable song. And she would like…teach me all the timetables. It was all

[238] Wing-Yu often spoke about how grades were the driving force for her parents as an indication of whether she was doing well in school. According to Wing-Yu, her parents expected As—"if it's not an A then it's not good enough yet" (Interview 2).

[239] When speaking about her parents, Wing-Yu often referred to their sacrifices and struggles to help her be successful. For example, money has always been tight for her family, with both parents working as sushi workers (until their retirement) in a local grocery store. Still, Wing-Yu's parents tried to provide as many opportunities for Wing-Yu to learn as much as she could. They relied on resources, such as the local library and other Chinese families in the area, to learn more about American culture and ways to help Wing-Yu.

the way from one to nine…I guess she wanted me to get a head start" (Interview 2). It was expected in her family for her to come home after school and study. If Wing-Yu claimed she did not have any homework or anything to study, her parents would require her to read books.

Wing-Yu described her parents as being worried mostly about mathematics and English at home. While they could help Wing-Yu with some of the mathematics content, they did not feel as confident in their ability to help her learn English. And because money was a source of struggle for Wing-Yu's parents, they often relied on the local library to provide Wing-Yu with books she could read to practice her English. In addition, her parents required her to write in a notebook every day, despite not knowing English themselves. Wing-Yu stated that her mother would check to see that Wing-Yu wrote something in her notebook every day but didn't think "she could comprehend what I was writing" (Interview 2).

Her confidence in her mathematics capabilities never wavered in elementary and middle school (despite not being initially placed into the gifted program).[240] High school, although challenging, presented other problems for Wing-Yu, as she spent the last couple years of high school during the COVID era. She stated that the mathematics content was not necessarily difficult, but the way in which she had to learn the content presented other challenges. Many of her teachers and professors (from her dual enrollment courses) provided videos online for their students and students were expected to "teach themselves" (Interview 1). She took AP Calculus her junior year but did not feel as though she learned enough of the content. The modality of her courses and having to struggle with her mental health during COVID made it difficult for Wing-Yu to focus. Wing-Yu stated that she earned mostly Bs on the AP Calculus course exams and

[240] Recall that Wing-Yu was tested initially in elementary school for the gifted program but did not get in on that first attempt. Wing-Yu stated however that her mathematics teachers (in elementary school and middle school) would often challenge her because they did not think she was placed correctly.

when she took the AP exam, she only scored a 3. Her junior year was also the year she was taking four other AP courses. Not being able to earn the high grades she could easily earned in the past, Wing-Yu stated, “I think my confidence level dipped a little bit because of how hard the topic was…because usually it came naturally to me…I just think I kind of struggled a little bit more than I usually did” (Interview 2).

Wing-Yu considers her junior year as “one of the worst years ever” (Interview 2) and thus, made the decision to be a full-time dual enrollment student her senior year. At that time, some of the courses offered were face-to-face. [241] After having taken five AP courses her junior year, Wing-Yu stated that her college-level courses were “pretty easy” (Interview 2) in comparison. She was more stress free and did not have to “sit at my computer and slave away” (Interview 2).

She was surprised however that she had to retake College Algebra in her first semester as a dual enrollment student her senior year. She was not sure why this was the case, as she had already taken algebra in high school, but took the course anyway.[242] It was not until she met with her advisor halfway through that first semester that she realized she was misplaced. Luckily, she was able to skip the Precalculus course[243] and take Calculus I the following semester. This initial placement in the algebra course upset Wing-Yu, as it prevented her from taking the additional mathematics courses she wanted to take before applying to college.

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[241] It was during this time that Wing-Yu took my Calculus I class as a dual enrollment student. After hearing about her struggles, it now makes sense why Wing-Yu was not as social as some of her peers in class. Although she excelled in my class, earning a A, she does not consider high school as an enjoyable time in her life.

[242] It is unclear why Wing-Yu was placed into the algebra class given that she had already taken AP Calculus. Additionally, Wing-Yu stated that she sent her SAT and ACT scores to the school.

[243] The typical path in mathematics is to take College Algebra, then Precalculus, and then Calculus I.

When Wing-Yu went to college, she felt she was able to “start fresh” because COVID was technically over. It was also a time when she began to feel more “comfortable with myself and just kind of accepting of who I am” (Interview 2). She was excited to start at a new school but soon began to struggle with mathematics, as she realized that she was “no longer at the top anymore” (Interview 1). Being at a prestigious college and seeing how “everyone is just smart” (Interview 1) started to affect the way she began to see herself. In addition, she found the mathematics courses held a much higher standard than what she was used to. She was shocked when she got her first test back in her linear algebra class and it was a 72: “It was so bad…like my average was a 78. But that count as a B [by the end of the semester]. I barely passed that class” (Interview 1).

When describing the differences between the mathematics courses at college versus the courses she took as a dual enrollment student, Wing-Yu noted that a big part of her struggle was how different the professors conducted the class. As a dual enrollment student, she was in a class with a maximum of 28 people and felt that the professors she had were more “approachable” (Interview 2). Conversely, at her current institution, she stated that most of her mathematics courses have about 100 to 200 students in each class and are then broken up into multiple “studios” (Interview 2), with about 20 students in each studio. These studio classes were considered as an extra support class that was led by a Teaching Assistant (TA), rather than the professor, and was required. When describing the difference between the lectures and the studios, Wing-Yu stated,

> I feel like, I learned the general idea of how to do it [in lectures] …I would understand the process. Like, I have a foundation of how to do this, but it’s kinda shaky. But once I

> go to studio, it would like…firm up that foundation. And we would go through multiple problems. (Interview 2)

In addition to how the lectures were different, Wing-Yu stated that there were inconsistencies between the lectures and the studios, which was often dependent upon the professor/TA. In some of her mathematics courses, she felt the alignment with what was covered in lecture to what was covered in studio prepared her well for the exams. In other cases, the inconsistencies between the lectures and studios created a lot of stress for Wing-Yu and forced her to try and find alternative ways to learn the content, such as working with other students outside of class.

Although "successful" in her mathematics courses (as indicated by the grades she has been able to earn), Wing-Yu stated she no longer likes math and that "math is just something that is needed for my future" (Interview 2). She elaborated further by stating,

> I don't like it anymore. I liked it when I was younger, but I think ever since the moment that AP Calculus hit…I need to do a lot of it to understand it. I don't necessarily mind that but it's annoying the fact that like the problem can be solved in 10 different ways. But then sometimes you are forced to pick the most optimal way even though you learned a different way…I am good at math, but I can't confidently say that I can do everything related to math." (Interview 2)

Wing-Yu's Definition of Mathematics Success

Just like with her identity map, Wing-Yu decided to describe her thinking process as she was creating her mathematics success map:

> My first thought was like for success is like climbing like a set of stairs…because it's like understanding, application, and stuff. But then I was thinking like steppingstones. It's

> like…you know in like scenes in a movie where they are forced to cross a dangerous path, but the steps are like really wobbly? I thought of that. (Interview 2)

Wing-Yu then proceeded to draw a stick figure of herself in a lava cave trying to cross a pit of lava by stepping on stones that represent the different mathematics courses she has experienced so far (see Figure 19).[244] Because her struggles with mathematics began in her junior year as a student in her online AP Calculus course, Wing-Yu started this “treacherous journey through the cave” (Interview 2) by labeling the first two stepping stones as “AP Calculus.” She chose to draw two stones because she struggled academically and socially during that time.

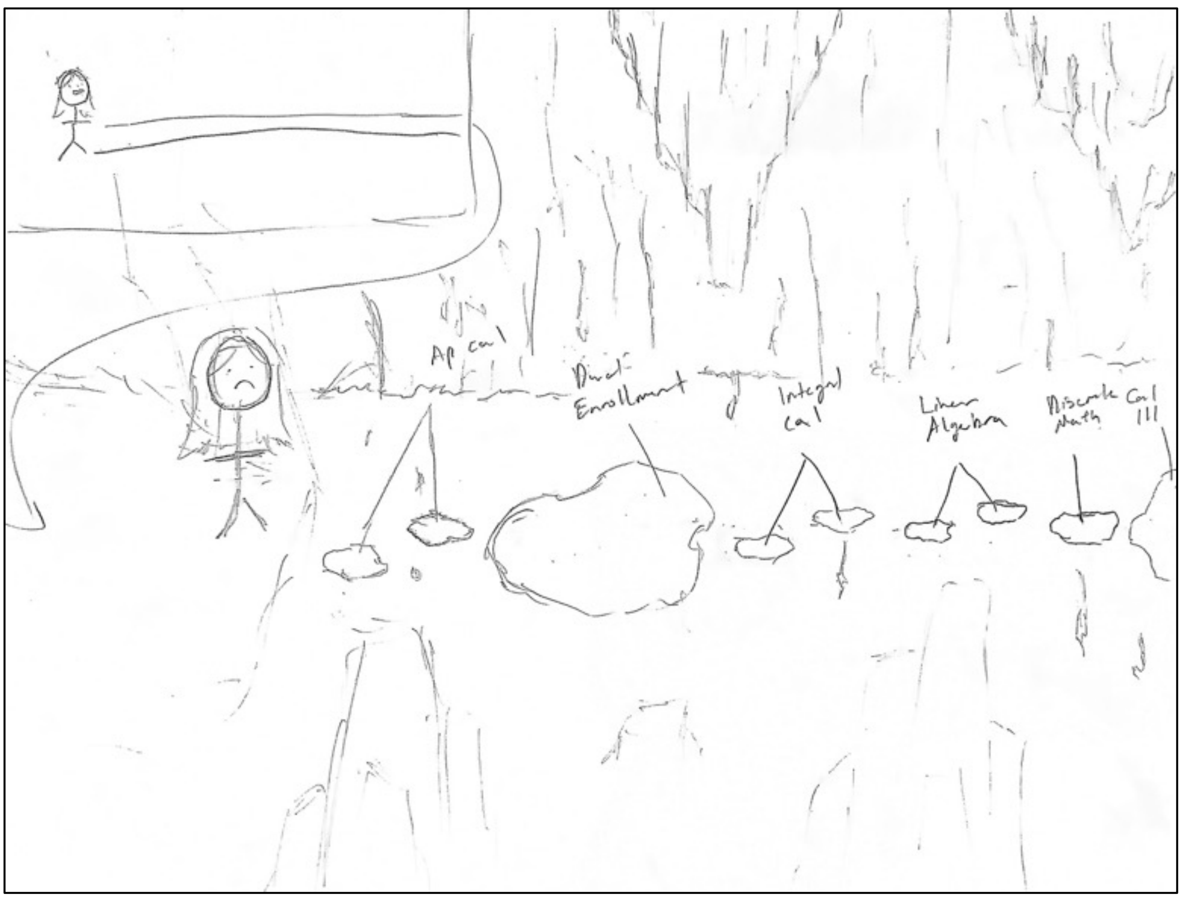

Figure 19. Wing-Yu’s Initial Map of Mathematics Success.

[244] Unlike the other women in this study, Wing-Yu stated that she did not think it was appropriate to draw an overall mathematics success map because she felt that how she defines mathematics success is very specific to her and her experiences.

Note. There are two parts to this concept map: the top-left hand corner represents Wing-Yu's journey to success in her elementary school years up to her junior year in high school (as indicated by the straight path drawn from the stick figure) and the rest of the map represents the path Wing-Yu had to take to be successful in mathematics.

Wing-Yu proceeded to describe her drawing and stated that the goal in mathematics is "understanding" (Interview 2) and if a person does not "understand one thing, the rest kinda tumbles down" (Interview 2). She views mathematics as a linear path, as each course is necessary to move to the next stone. Thus, the lava in her map represents "if I don't understand it, it is going to screw me over like really bad" (Interview 2). Wing-Yu considered the lava to represent the situation she feels she is currently in, and the lava would burn her if "I didn't pass the class because I didn't do as well as I wanted to" (Interview 2). Wing-Yu later described this as her overall "failure" as mathematics is a necessary component to earn her degree in CS.

Wing-Yu continued to add details to her map as she described more about the setting of the cave. In her mathematics courses at her current institution, there have been moments where Wing-Yu did not feel confident in her abilities to pass the course. Thus, her journey through the cave represents how she feels about mathematics currently. She described her anxiety of knowing that her overall course grade was often reliant upon two exams (typically a midterm and a final), which caused her a tremendous amount of stress. For example, although she would try her best on the midterm, she would earn a 78, and then would stress more about making sure she earned at least a 78 to get an overall grade of a B. Although she was typically accustomed to earning As in her mathematics courses previously, she stated that she "lowered [her] standards" (Interview 2) once she began to struggle in her classes and witnessed others (who she perceived as being "smarter" than her) also struggle. According to Wing-Yu, many students, including herself, started becoming dependent upon knowing that their professors would curve the grade to "help them out" (Interview 2): "My overall grade was a 78, so I knew I did bad on that test. But it curved to a B. So…that class must have been bad to have to raise my grade" (Interview 2).

Wing-Yu expressed concerns about her grades, but also stated that she knew she had to be "above the curve" (Interview 2) because she would always end up with an A or a B in her mathematics courses by the end of the semester (even though she would often get Cs on all her exams). For this reason, she explained that the steppingstones in her map were "wobbly" (Interview 2) because the grades were "pretty good," but she didn't think she was understanding the material as much as she should have. Without a strong foundation, Wing-Yu perceived most of the steppingstones in her map as being wobbly, except for the one stone that represents her time as a dual enrollment student (the third steppingstone from the left in her map).

Wing-Yu stated that when she was a dual enrollment student, she felt secure as she was more supported in those classes, which is why she drew the steppingstone much larger than the other stones in her map. As a junior in high school, Wing-Yu felt she had to support herself. Although her teacher provided videos online, there was not significant time spent on making sure students understood the content. Similarly, at her current institution, she feels distant from her professors; only really building bonds with the TAs. These relationships however were heavily dependent upon who the TA was or how the TA would conduct studio sessions. With a shaky foundation and a lack of support, Wing-Yu drew those stones much smaller. In addition, the smaller steppingstones meant she had to learn how to "navigate more" (Interview 2). The only way to move from one stone to the next is "finishing it and getting a good grade on it" (Interview 2), which required her to learn new skills and rely on others (such as a study group) to ensure she could move from one class/stone to the next.

While reflecting on her struggles in the cave, Wing-Yu then stated that she didn't always feel "this way about math" (Interview 2). When asked what she meant by that, Wing-Yu described how much she loved mathematics in her younger years because it always came easy to her. She proceeded to draw another stick figure in the top, left-hand corner of her map, indicating that the stick figure represents her at the beginning of this mathematics journey. Unlike how she feels about mathematics now, in the beginning she felt math was fun and easy and so the path she drew next to the stick figure represents "how much easier life was before" (Interview 2).

When asked if anything lied beyond cave, Wing-Yu stated that she was not sure, but knew that—

> the cave ends when I don't need to take math classes anymore. I need to pass these classes to get credit and if I pass them eventually that goes towards my degree and that degree shows like I did a good job. (Interview 2)

Being successful in her goal of obtaining a Computer Science degree means Wing-Yu also needs to be successful in mathematics. While her journey has been difficult, Wing-Yu stated she is determined to pass through the cave and expects the path beyond the cave to be "much easier and happier" (Interview 2).

Revisions to the Mathematics Success Map

When Wing-Yu and I met for her third interview, I gave her the opportunity to make any changes to her initial mathematics success map. Wing-Yu stated there was not anything on the map itself that she wanted to change, but she did want to go into further details about specific aspects of her map. Although she drew herself as standing on the ledge before the "AP Calculus" steppingstones, for example, she emphasized that she is currently on the last steppingstone

("Calculus III") as she was taking that course during the time of the interview.[245] She also wanted to share that she has been "burned by the lava" (Interview 3). She began to feel the "heat" when she began to struggle with mathematics when taking AP Calculus. It was not until she took her linear algebra class did she feel the "burn of the lava" because her focus in the class shifted to her grades, rather than learning:

> That's when math became not as fun. It's because I started worrying more about this big number representing my score for the class than like, you know, actually learning. I think I was just worried about my grade but then I felt like it was a result of me not doing enough. Like, I didn't study enough, I didn't understand the material enough, I didn't understand what I was doing. So that's when I felt like that's truly…I didn't step in the lava, but like, it burned me. (Interview 3)

So, although mathematics used to be considered one her strengths, Wing-Yu stated that the way in which she has perceived herself doing mathematics has shifted. She could not identify which aspect or life experience led to that change, but that her overall experience with mathematics has become harder and more negative.

Wing-Yu's Final Concept Map

For Wing-Yu's final concept map, she decided that the best representation of her personal journey would be to include the "gaming worlds" again (like the worlds she represented in her identity map) to show her journey to success and "what I've gained, or like how I felt at each stage of my life" (Interview 3). Wing-Yu then proceeded to draw "World 1," representing her early childhood (see Figure 20) as this was the earliest memory she had about mathematics.

[245] Wing-Yu also reiterated that she does not know what lies beyond the steppingstone because she was not sure what additional math classes she needed to take. She did reiterate that the end of the cave would be when she was done with all her mathematics classes.

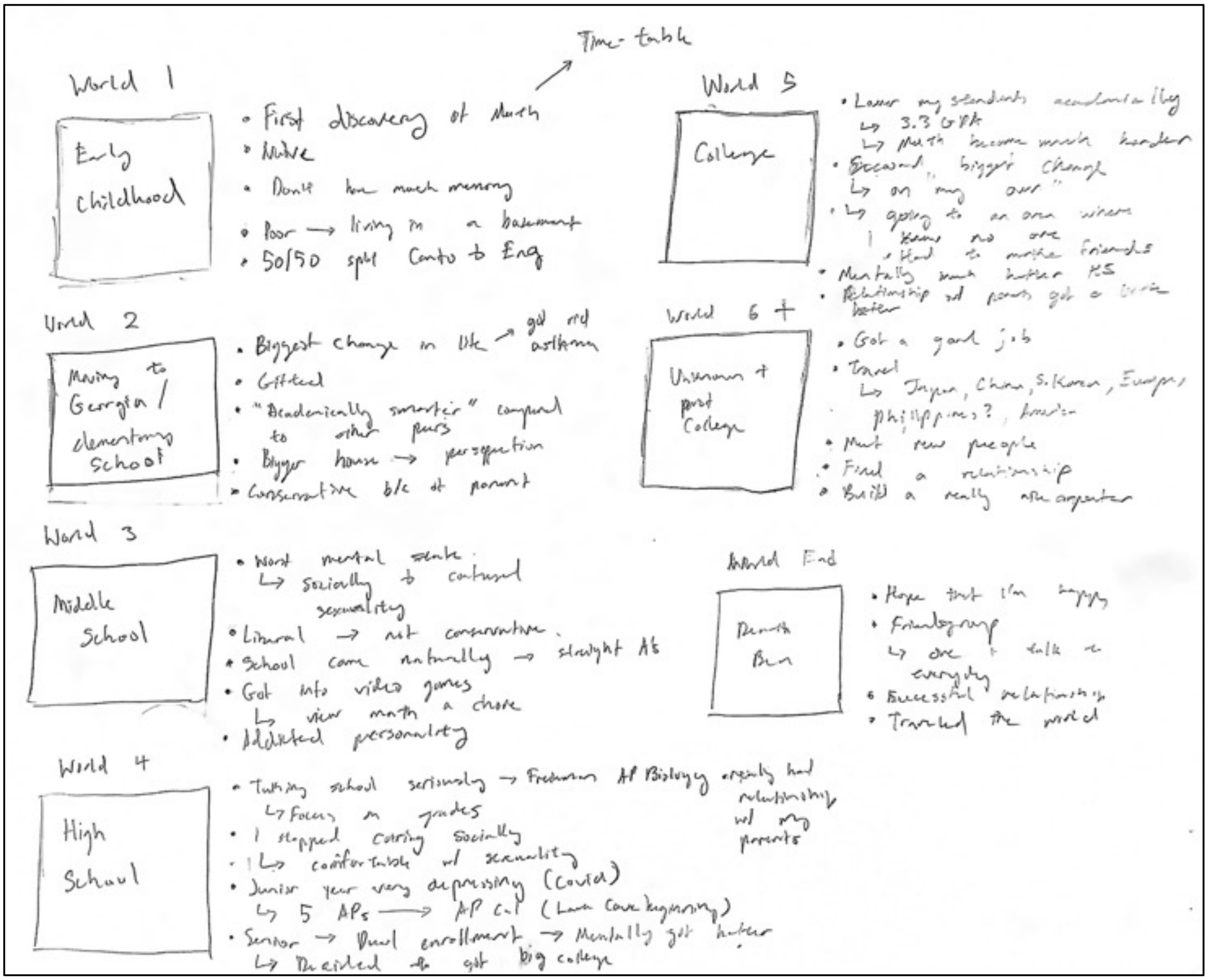

Figure 20. Wing-Yu's Final Concept Map.

Note. In her final concept map, Wing-Yu emphasized that each world represented a significant time in her life, starting with early childhood up through the end of her life. Although not drawn specifically in her map, Wing-Yu stated that the worlds were connected and progressed in a linear order.

Wing-Yu admits she doesn't have many memories of that time, but she does recall the times table on the back of the white board her mom used to use and practice with her when she was young (before starting kindergarten). She indicated that that was a happy memory, even though she knew her family struggled financially (writing she remembered "living in the basement of someone's house" (Interview 3). In addition, although she spoke only Cantonese with her parents, she recalls speaking English with those at the daycare center.

The next significant phase of her life was when she moved to Georgia and started elementary school. The move to Georgia was not only significant for her overall health (as her asthma "disappeared" when she moved), but also for her experiences in school. She spoke about how the school tested her for gifted but that she did not get into the program. The rejection she felt brought many contradictory feelings for Wing-Yu, as she perceived herself as being capable as those who were in the gifted program, but still blamed herself for not getting in:

> Looking back at it…it is really my fault, even though it's stupid. I don't think it should be a system. I feel like at this point is when I realized that like, I was technically… . I was academically smarter than a lot of my peers. (Interview 3)

Wing-Yu was not able to specific how or why her "rejection to the program" was her fault but stated that it must have been. Regardless of how she was perceived in school, Wing-Yu stated that her time during elementary school was overall positive as her family was able to live in a house of their own and felt that her family was in a better place.

Middle school, on the other hand, was "the worst mental state" (Interview 3) of her life. Wing-Yu described that phase of her life as a time when she was confused about her sexuality and her exposure to other types of people in school made her begin to question her own political stance. This confusion and exposure created a source of conflict for Wing-Yu because her parents are "conservative and transphobic" (Interview 3), and Wing-Yu was afraid to have conversations with her parents about her sexuality. School, although in some ways liberating, became a source of pain and conflict as rumors about her sexuality spread around the school.

Wing-Yu kept close to the friends she had in elementary school and tried to ignore others in the school.

Despite being worried about her social status in middle school, Wing-Yu's success in school "came naturally" (Interview 3) and Wing-Yu was able to get into the gifted program and maintain her high grades. She stated that she did not struggle in any of her classes and did not need to study outside of school. Although her parents still forced her to do some studying at home (recall the daily journal she had to write), Wing-Yu said her parents also gave her some freedom to do other things, such as video games. While she used to do mathematics "for fun" in elementary school, video games were more fun for her than doing mathematics: "When I found video games—that's more fun than doing math. So, I wanted to do that instead of doing math…. This is when I started to view math as a…as a chore" (Interview 3).

With her newfound freedom to use her spare time to do something she enjoyed; Wing-Yu spent most of her time on the computer playing video games. Although her hobby did not affect her grades in school, her parents began to worry about her "addictive personality" (Interview 3). They began to limit her time on the computer—only allowing her to play games on the weekend. Wing-Yu attributed this time as a time when her "additive personality" began to manifest. Rather than being able to enjoy playing games in moderation, she would binge on the weekends. This type of behavior has become a way of how she approaches other aspects of her life, especially schoolwork. She stated, for example, that rather than work on a homework a little bit at a time through the week, she will often designate one day to get all her work done. She admitted that this way of working has not been easy for her but continues to work in this manner on schoolwork that she does not find interesting or fun (such as mathematics).

While middle school was a time when Wing-Yu could enjoy her time (especially outside of school), high school became a time in her life when grades became a top priority. Knowing that grades were an important indicator of success (and a pathway to a good college), Wing-Yu spent much of her time ensuring she earned high grades. She began to take school more seriously and no longer cared about the rumors about her sexuality. Her friend group supported and accepted her along her journey: “At this point, I just grew and learned that I should only care about how I think about myself and how my close friends think about and care about me” (Interview 3). By the end of middle school, Wing-Yu became comfortable with her sexuality[246] and was able to turn her focus to her academics.

Wing-Yu described her high school years as being difficult as well because she took as many AP courses she was allowed to take. The increasing pressure she put on herself to earn As while also taking more demanding courses created a lot of stress for Wing-Yu. In addition, COVID changed the way she experienced her learning. During that time, she stated she became very depressed, as she was not able to engage with her peers (who have been a constant source of support since moving to Georgia) and having to learn much of the content for her AP courses on her own. According to Wing-Yu, her time taking AP Calculus was when “my lava cave started” (Interview 3) because it began to change her perception of herself and her capabilities of doing mathematics. She was unable, for example, to earn a 4 on the AP Calculus exam and felt that indicated her “failure” to learn the content. She also realized that she no longer enjoyed learning or doing mathematics.

For her senior year, Wing-Yu became a dual enrollment student and took multiple courses, including mathematics and English. Having gone from taking five AP courses her junior

[246] Wing-Yu stated that she came out to her friends as “bi.” When providing feedback for this study, however, Wing-Yu has informed me that she is not only interested in women (personal communication, September 28, 2023).

year to taking dual enrollment courses, she stated that the workload "significantly decreased" (Interview 3). This period was also a time when Wing-Yu was able to leave her house, as many of her courses were either face-to-face or hybrid. Being able to engage with people outside her home and not having to rely on just herself to learn the content for her courses, Wing-Yu stated that her mental state began to get better. With her success in her courses as a dual enrollment student, Wing-Yu made the decision to attend a prestigious college (where she is currently).

"World 5," which represents Wing-Yu's college years is the world Wing-Yu said she is currently in. While describing this world, Wing-Yu indicated that her second map, her mathematics success map (see Figure 20), is a good representation of the way she feels about her mathematics journey thus far and didn't feel there was anything additional to add. On the other hand, she did want to emphasize that being in college and surrounded by classmates who she perceives as being "smarter" than her has made her lower her academic standards for herself. Rather than try and earn the As she was accustomed to while in middle and high school, she is now "okay with a 3.3 GPA because the math became much harder" (Interview 3).

Yet, college itself is viewed as an overall positive experience for Wing-Yu because she has been able to be on her own for the first time in her life. As an only child, Wing-Yu often spoke about her struggles with her parents and wanting some freedom to make her own choices. According to Wing-Yu, the separation from her parents has improved her relationship with them and has also helped her mentally. College life has provided opportunities for Wing-Yu to explore and understand her own sexuality and has forced her to engage socially with others.

Life beyond college is unclear for Wing-Yu, but she felt she had to represent those worlds in some way in her concept map. She then created two[247] additional worlds and began to

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[247] Although Wing-Yu created two additional worlds in her map, she gave the label "World 6+" to indicate that there may be additional worlds beyond World 6. Because she has not experienced them yet, she did not want to limit

outline her goals. In the “World 6+,” Wing-Yu outlined the goals she wishes to achieve, such as “getting a good job,” “travel,” “meet new people,” “experience a new relationship,” and “building a computer” (see Figure 20). Ideally, Wing-Yu would accomplish these goals while in college or shortly after, but she also stated that some of those goals were “not in [her] control” (Interview 3).

The last world on her map, labeled as “World End” and “Deathbed,” represents the end of her life: “At this point, I just hope that I’m happy with my life. You know, with my friend group…especially the ones I talk to everyday. I hope I am in a successful relationship, and I especially hope I travel the world by that point” (Interview 3).

herself by creating a specific number of worlds. Instead, World 6+ outlines the goals she has for herself during the remaining time she has in college and beyond.

CHAPTER 9

CROSS-CASE ANALYSIS

Listening to and writing about these women's stories allowed me to gain a better understanding of the complexities of their lives and encouraged me to reconsider my own meaning of mathematics success (addressed in Chapter 10). In this chapter, I describe how despite the intricacies of their lives, there were some similarities (and differences) in the ways they thought about mathematics success and how mathematics success contributes to their pursuit of obtaining their goals.[248] Each section[249] presented in this chapter correlates to the research questions that guided this study:

1. What are undergraduate women whose first language is not English perceptions of mathematics success?
    a. What qualities distinguish mathematics success from other forms of success?
2. What STEM institutional cultural norms have played a role in how they define mathematics success in STEM?
3. What role, if any, does language play in determining how they perceive their success in mathematics?

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[248] I do not claim that I have "captured" all the ways in which these women think about mathematics success. I am aware that each of their perceptions are multifaceted and will not ever truly understand their positionalities. Some of this is limited by my own capabilities but also by the participants themselves. Although this research is intended to focus on these women's perceptions of mathematics success and the ways in which they have navigated toward that success, there were times in the study when the participants chose not to share information about themselves. For example, Skylar outwardly said and recognized that what she drew in her identity map was "enough of what I want to show" (Interview 2). This statement highlights that although she was willing to share some aspects of herself for this study, she was only willing to share those parts that she felt most comfortable with. I do not assume that the data collected can fully represent a person—even at that moment in time. I do, however, present (to the best of my capabilities) the ways in which these women spoke about their mathematics success and the ways I have tried to make sense of their words and drawings.

[249] For each section, I highlight the ways in which these women spoke about or addressed the topic. Not all women in the study, however, spoke about all the pieces presented in each section. Thus, if one (or more) participant was "left out," it is only because she did not explicitly talk about it in our conversations.

   a. How do they navigate their gender, race, and language in college, and how does the intersection of language influence their perceptions of mathematics success?

4. How has this perception of mathematics success affected their decision to pursue a STEM degree?
   a. What factors do these women attribute to their success in college?

I then conclude the chapter with a summary of the study's findings—not specifically to provide answers to the research questions but to showcase the ways in which these women thought about their own mathematics success and the ways in which they intend to achieve it.

Defining Mathematics Success

As each woman described her mathematics experiences and the way she thought about her own mathematics success, it was clear that mathematics success (and the experiences that have led to that success) is distinctly different from other forms of success, including other subject areas and overall life success. In this section, I describe the ways in which these women talk about mathematics: how they define mathematics, how they view mathematics success, and how they describe the role mathematics has played (and continues to do so) in their overall success.

Defining Mathematics

The way mathematics was perceived by each of these women varied according to their perception of their own success with mathematics at specific points in time. Mathematics could be viewed as a useful tool for their future careers, a hobby they enjoyed doing, or a source of anxiety (or all the above at once). The feelings these women had about mathematics were not always stable and were heavily dependent upon their interactions with mathematics.

For instance, when Skylar was in Vietnam, she stated she did not enjoy mathematics as much as she does in the United States because the mathematics required in Vietnam was more difficult: “In Vietnam math, they want us to prove something, for example, that gives you a theory or something like that. And they want you to prove it. But I don’t have that much knowledge and materials to prove that” (Skylar, Interview 2). Because Skylar was expected to use mathematics to prove theories, mathematics was seen as being abstract and unattainable with Skylar feeling unprepared to do it. According to Skylar, her experiences with mathematics in the United States, however, have been more focused on the procedural actions of doing mathematics, such as solving problems or following a sequence of steps. When describing her experiences in the classroom in Vietnam, Skylar often spoke about the “traditional” way of teaching as teachers were seen as authority figures in the classroom and students learned from direct instruction. Skylar preferred this style of teaching because she could easily follow the steps and mimic them to obtain the correct answers. Using mathematics in an “unconventional” way, such as proofs, did not make Skylar feel comfortable about her capabilities.

Mathematics, as an entity itself, was often perceived as being attainable (or not) by many of the women in this study. Although a couple of them wanted to push against this notion, the justification of whether a person could do mathematics “well” was often dependent upon whether she was perceiving herself as a “math person.” Sasha, for instance, stated that she has “never been a history person. I always say there’s history and language arts people and then there’s math people. I’m a math person” (Interview 2). For Sasha, although mathematics could be difficult at times, she perceived herself as being capable of doing it. In addition, her love and passion for mathematics were sources of motivation for her to continue through the struggles: “I enjoy doing math. I enjoy it. Even if I’m struggling with something. I still enjoy learning about it. That don't mean that I'm perfect at it or that I don't struggle, but I enjoy it" (Interview 2). To Sasha, the struggle is just a part of the process of learning, and she does not perceive her struggle as a sign of weakness. The passion and love she has for mathematics overrides any insecurities she has for the subject and motivates her to continue.

In some ways, the debate of "nature vs. nurture"[250] became the center of conversations when describing mathematics. Skylar, for instance, when describing her mathematics success map (see Figure 16), indicated that "some people just need more… less access, and less exercise to get higher grade, because they're smarter" (Skylar, Interview 3). Although everyone is "starting at the same place" when referring to the first step in her mapping, Skylar stated that the place that everyone starts at may not be adequate in meeting all their needs. While everyone can have access to the lectures, examples, and materials at the school, Skylar distinguished between ability versus the amount of time and effort put into the work to achieve success. The height of the steps represented the amount of work that a person would need to accomplish to move to the next step and thus, the height of each step would vary depending on the needs and capabilities of each person. But according to Skylar, those abilities were not enough to guarantee that a person would be "good" at mathematics: "I feel like the abilities not that important, because if you practice a lot, and you can still improve, okay, it doesn't matter what's your grade that much" (Skylar, Interview 3).

Similarly, Wing-Yu often stated that when she was in elementary and middle school, she "excelled in math" (Interview 1) and "math came really naturally to me" (Interview 1). Despite not being placed into the gifted program initially when she was tested in elementary school,

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[250] I highlight this to say that sometimes, in the way that these women spoke about mathematics, it seemed as though they viewed being a "math person" as something that is innate (i.e., born with a specific talent). Yet, in describing their own success, they spoke often about developing skills that would help a person be good in mathematics.

Wing-Yu appreciated that she was not placed in the gifted program. Wing-Yu stated that some of her friends, who were placed in the gifted program early, are now struggling in college because they never learned the importance of studying; often relying on their “natural ability” to get through college:

> I know a lot of other gifted kids. It’s like they were—they’ve been told the idea that they’re special. But then now [in college] they see like other people who are probably better than you, you know? And now they see like other people who are smarter…. They might get like demotivated and stuff like that.... They don’t know how to study now because they never had that habit of studying and then just kind of fall.... I’ve seen so many people who kind of like that it happened to them or like they were in the gifted program, and they just kind of fall off. (Wing-Yu, Interview 1)

Not being a part of the program and having to struggle and work hard, for example, helped her ultimately to learn the tools necessary (such as study habits) to be successful. Similar to Skylar, Wing-Yu seemed to believe that “natural talent” could only get a person so far. So, although Wing-Yu recognized she had some natural talent in mathematics, she also values the skills she has been able to develop, such as time management and a work ethic. The combination of her natural talent and work ethic is what has helped her move forward in school.

In addition, although mathematics can be seen as one entity, it is comprised of many different “types.” When describing their maps, both Skylar and Sasha often stated that the learning of mathematics was cyclical in nature as there are many types (or branches) of mathematics. When describing her mathematics success map (see Figure 16), Skylar indicated that the set of stairs she used to portray mathematics success does not represent just one journey:

> For example, for myself, the only new math that I studied this last semester was differential equation, which is I don't have any information like materials before. That is when I'm here [points to the first step of her map]…every time we start a new topic of math, we always have to go from here, start from here. And then go up to here, and then to a new topic. (Skylar, Interview 3)

In her experience, Skylar has often had to start back at the bottom step when learning a new type of mathematics (i.e., when taking a different mathematics course). In addition, the height of each step is dependent upon her level of experience and knowledge. Thus, there could exist multiple stairs and she could place herself at different steps for each staircase.

Similarly, when Sasha described her map (which ironically was also represented as a set of stairs—see Figure 11), she often described the journey as being cyclical within and across the steps she outlined. "When I don't have all the knowledge that I thought I had…. So, I guess I'll go back. Just makes sense that way" (Sasha, Interview 3). Thus, mathematics, although described as one subject was also viewed as having multiple subsets.

Relationship with mathematics and motivators for success. Some of the women, such as Sasha and Skylar, used their past experiences to judge whether to consider themselves as "math people" because their prior successes in mathematics helped them realize mathematics was a strength for them. Wing-Yu did not characterize a person as being able to do mathematics or not but did realize her strengths in mathematics at a very young age. Cassandra, although did not state whether she considered herself to be a "math person," did describe herself as being a "humanities person" and claimed, "I don't think I'm math inclined, but I've been trying to make it happen" (Interview 3). So, although mathematics does not necessarily come easy to Cassandra, she believes she has the potential to do well in mathematics.

These perceptions about the way in which people could be categorized as "math people" affected how these women perceived themselves as mathematicians. In most cases, the women did not identify as being mathematicians themselves. Skylar, for instance, described a mathematician as being "some professor, crazy genius who finds something or who define new theory" (Interview 2). Although Skylar stated she enjoys doing mathematics ("I like to solve problems" (Interview 2)), she did not necessarily perceive herself as a person who would reach the top of the stairs in her mathematics success map (see Figure 16), having stated it was "far" (Interview 2) but not necessarily unattainable. But because many of them had success with mathematics, as evidenced by their grades, they felt they were capable of doing well in it.[251]

In every conversation, the source of motivation to pursue a STEM degree centered on passion for mathematics or the need for financial stability and success (or both). Skylar and Sasha often spoke about how it is necessary to have "passion" and "love for mathematics" to take the journey in obtaining a STEM degree but also *staying* on that journey (as a continued source of motivation), especially when faced with struggles:

> I feel like if you have more passion in mathematics—if you have more interest in it, maybe you can do like, for example, just like me…. I want to take a math. I want to study another major, like mathematics. But some people don't have that much interest in math. So, they just follow another path related to math. For example, like IT has some related to math or chemistry also has…but it's not that much. (Skylar, Interview 3)

Sasha also stated that if she did not "have that love for math from the beginning, I would have gave up that first semester" (Interview 2).

[251] What was interesting is that when they were asked what a mathematician does, many of them stated that mathematicians solve problems or come up with new theories. Although they could see themselves as being capable of solving problems, they distinguished themselves from being considered mathematicians because they did not think they could contribute the field of mathematics with new theories.

The passion for mathematics was not always for the mathematics itself, but the role in which mathematics plays to obtain success. For Cassandra, she relied on her passion to wanting to make a change in the world and to be one of the few Latinas to be a "part of the conversation" (Interview 1). Inspired by political figures, such as Stacey Abrams, Cassandra wants to change the narrative of what women in politics, education, STEM fields, and so on can accomplish. Cassandra made the conscious choice to enroll in a women's college first, hoping to develop the leadership skills she would need to become a "girl boss" (Interview 1). Although she continues to struggle in her mathematics courses, Cassandra's drive to make changes in the world for women keeps her motivated to continue.

In addition to passion, financial security was often discussed as a strong motivator to pursue a STEM degree. Wing-Yu, for example, has seen the financial struggles of her family growing up and so she uses that as motivation to want to be successful. For Sasha and Wing-Yu, their passion stemmed from their experiences of living without the financial security they felt their families needed and deserved. Wing-Yu specifically stated that she considers computer science—

> as the fastest route to a lot of money, because compared to like, you know like engineering.... or being a doctor or a lawyer. Those—like being a doctor and lawyer—that's eight years...and that's like, a long time, and I'm not willing to go to school for eight years, honestly. But then CS [computer science] —four years. You know, probably get a job as a starting salary like maybe like 80k. (Wing-Yu, Interview 1)

Cassandra also suspected that her family would rely on her financially as they continue to get older. Like Wing-Yu, earning a STEM degree meant that Cassandra would make enough money to help pay her parents as her parents "haven't explicitly told me about anything, but like, there was no retirement plan. There is nothing set up for them" (Cassandra, Interview 1). Regardless of where the passion came from or how it was identified, each of the four women identified passion as a necessary component for a person to be successful in mathematics (even though they considered mathematics success as a prerequisite to the success they were really striving for).

What Does Mathematics Success Look Like?

The fluid nature of how these women defined mathematics extended into the way they perceived mathematics success. In trying to define what mathematics success looks like, the conversations often centered around grades. Rather than speaking of success, however, almost all the women in this study first spoke about what failure was to them (interestingly, Cassandra was the exception). In most cases, failure meant a grade of a B or below—not the typical definition of what educational systems call a failure in a class. Perfection, in particular, was what some of these women strived for. For example, although Skylar earned high grades in school, she stated that she wasn't necessarily successful in school because her understanding of the content was "like around 80 or 90%, not 100% because some of them I don't know how to do" (Interview 2). Despite not reaching that 100%, Sasha tried to apply less pressure on herself about being perfect. Although she would always strive for an A, she also expected to struggle:

> I'm not saying I'm gonna learn something and then just get it. You know what I mean? Like, there's some times I'm gonna struggle there. Sometimes I'm gonna, you know, not be able to do something like, get 100. So yeah, I mean, I feel like, throughout any journey, you have to be okay with failing. Feeling okay with failing. I mean, I don't think I've ever been easy on myself, if that makes sense? Like when I don't get that A, or when I don't get a 90 or 100…. Or when I don't learn something as quick or easy as I want to, I

have to learn to be okay with that sometimes, you know what I mean? Like, I can't just be perfect. (Sasha, Interview 3)

The idea of perfection, which often correlated to their grades was often the focus of how they judged their performance in a mathematics class.

Interestingly, "perfection" was not always "equivalent" to getting a 100 as a grade in a mathematics class. Both Sasha and Skylar often stated that their goal for the course would be to earn an A, which is not equivalent to getting a 100. Because the grade range for an A goes from 90 to 100,[252] the goal, then would be to earn at least a 90, allowing some "wiggle room" that didn't necessarily require perfection. Cassandra, who often struggled in her mathematics courses and tried to earn at least a B, had a similar comment about grades. Although she did not try to be perfect in the same sense as Skylar, for instance, she did appreciate the "wiggle room" because she felt she had a greater chance to earn a B by making sure she got at least an 80 in her class.

Yet, grades were not the only ways in which these women talked about mathematics success. Skylar received an award for physics, which she perceived as necessary as it helped her "get into the high school for the gifted" (Skylar, Interview 2). Wing-Yu used other measures of success, such as AP test scores to determine how well she understood the material. Because Wing-Yu was able to take AP exams in high school, she often spoke about her AP scores of indicators of her success. These scores, however, still did not validate for Wing-Yu her ability to know or understand the content. Despite getting a 4 on the AP Language Arts exam, for example, Wing-Yu did not perceive her writing skills as "amazing" (Interview 2). In the remaining section, I discuss other indicators of mathematics success that was discussed in our conversations.

[252] It is important to note that at this institution, there are no +/- in grades. The highest grade a student can earn is an A, which is equivalent to the grade range 90–100.

Communicating what you know. Standard measures, such as grades and AP test scores, were not the only ways these women tried to make sense of their success. Some of them, for instance, would gauge their understanding of content based on whether they could "teach other people" (Sasha, Interview 2) and how comfortable they felt with the content. According to Sasha and Cassandra, people should view success as a journey—one that can have its ups and downs, but the ultimate outcome being that they learn the material and that they are able to explain it to someone else. In addition, Skylar stated: "It's more important that you can understand that materials, actually in STEM. And then, even better if you can explain for other people what the materials was about. Help them to understand" (Skylar, Interview 3).

Communication and being able to showcase knowledge therefore are some of the most important ways to determine if a person truly understands the material: "When you're sharing your knowledge with other people in math, you have to know how you're doing it. And you have to do it in a way where the other person will understand it" (Sasha, Interview 2). Because learning the material is hard to assess (which makes grades unreliable at times and highlights the subjectivity of grades),[253] the hardest step is communication. Cassandra stated that she valued this skill but has not often felt capable of doing it. She stated: "I don't really trust myself to explain the concepts to somebody because it's like, well, I'm not too sure. I didn't know it myself. But being able to teach someone else does help" (Interview 2). Although seen as a very important aspect of demonstrating knowledge, all four women stated that the ability to communicate what they know was an area they all needed to work on.

Application of Knowledge. Understanding the material however is not quite enough for Skylar because she views the learning that is done in college as preparing you to do well in your

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[253] The concept of grades is discussed in more detail later in the chapter. Although grades were an indicator for success for most women in this study, they also brought up some concerns about grades.

job. She rejects the idea behind the common phrase “Cs get degrees” because “everything will show when you actually get to that work” (Interview 3). Although she is aware that there are students who graduate from college with Cs, Skylar still differentiated herself from them because she believed she has more knowledge and understanding of what she learned in school; something that is reflected in the workplace. For Skylar, “the foundation is more important” (Interview 3) because she can take her knowledge and extrapolate to different areas that may be needed when she starts her job. Sasha made a similar statement, adding that she finds value in the mathematics she is learning and that the math she was learning will be valuable for her career in engineering as well as in her life:

> I mean, math’s my major. Math is a lot of things…I mean, when you’re making a budget, you need math, you know what I mean? If you have a business, you need math. I mean, I don’t think math—I’m not thinking of just as for my major. I say I like math, like, I’m a math person, so I’m aware that I will use it in a lot of things, even investments and stuff like that, you know what I mean? So, I just feel like having that knowledge in math is just gonna help me, like, for the long run—inside and outside my major. (Sasha, Interview 3)

Sasha particularly made connections to other areas of her life and would often state that mathematics was more than just learning how to solve an equation. Sasha viewed her mathematics learning as a way for her to prepare for her future.

Cassandra also stated that she knows she is successful “when I’m able to kind of see the correlation between what I’m learning in the course and when I want to do in the future. But like, that doesn’t happen often” (Interview 2). In particular, Cassandra often stated that she needs the knowledge that a STEM degree can offer because to make any necessary changes in the world, it must be “backed up by facts and science” (Interview 3). To Cassandra, a STEM degree should provide the necessary skills and knowledge for her to apply in the field, but also to give her work justification.[254]

How Does Mathematics Success Differ from Other Forms of Success?

All women in this study spoke about how mathematics could be used to help them achieve life success. Regardless of whether they felt positive or negative towards mathematics, they viewed their plans to be dependent upon their success in their mathematics courses. In distinguishing mathematics success and what success means in their personal lives, all four women spoke about maintaining a "balance" between the fulfillment they can get from their career and their happiness from their personal lives. Skylar indicated that she would consider two things to determine success: "success in more materials and success in like mental life" (Skylar, Interview 3). When asked to clarify what she meant by materials, Skylar stated, "in the way that I have enough food to eat, and I can buy what I need" (Interview 3). Skylar further explained that there are levels of success, so while she does perceive herself as being successful now,[255] she has not reached the level of success she would like in her life. To her, success is multidimensional—it entails being able to gain the material things she needs, but also a peaceful mind. Although she has been able to obtain the necessary things she needs now, she is not successful in meeting her own requirements of feeling happy and obtaining peace in her life (i.e., free of worry).

The overarching goal, according to Skylar, is to achieve that balance between the two dimensions: "I would love to see they're equal" (Skylar, Interview 3). When asked whether she can achieve that balance, Skylar indicated that she does see it as a possibility for her, but if she

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[254] More about the "validity" of a STEM degree is discussed further in Chapter 10.

[255] Because Skylar is currently in college, earning high grades, and is working towards a STEM degree, Skylar stated that she viewed her current situation as "one form of success" (Interview 2).

had to choose between the material things and her mental health, “spiritual is more better because if my mental health is not that good, it will affect the materials” (Skylar, Interview 3).

Sasha and Wing-Yu also spoke about reaching a “balance” and maintaining a “stable” life beyond college. While the specific goals for each woman in this study were different, they all wanted to get good jobs (both Sasha and Skylar stating specifically that they would love to work for a large tech company like Google), be financially stable, but also earn enough money to pursue their interests outside their careers. For Wing-Yu, her goal would be to travel the world. For Sasha, her goal was to move back to the Dominican Republic and be close to family. And Skylar wanted to travel, play games, and learn multiple languages.

Unlike the other three, Cassandra often spoke about making changes in the world. Her future goals included having a successful career, but she also felt that it was her purpose and responsibility to make changes for women of color and for the environment. This stated purpose is not to say that the other three women did not have similar purposes, but Cassandra was explicit about her mission and the changes she wanted to make for the betterment of society. So, while Cassandra did consider the same “balance” as the other three women, she had another dimension to defining success—a reflective dimension that included “success” in terms of the experiences and opportunities of marginalized population.

Role of mathematics. Each woman explained that mathematics was a criterion to achieve the specific type of success she wanted. In other words, mathematics is a necessary component or “a path” (Skylar, Interview 2) that will help each of them accomplish life and career goals. Sasha and Wing-Yu, although their feelings about mathematics varied greatly, both viewed mathematics as a requirement to obtain their computer science/information technology degree. Sasha, on the other hand, still enjoys mathematics even when she struggles and described mathematics as a "source of comfort" as she "used to do math problems to get my anger out" (Interview 1). Going through the process and getting the correct answer was a sense of satisfaction for Sasha. Wing-Yu however viewed mathematics as a source of anxiety and could not wait to finish her mathematics requirements. Having taken many mathematics classes already, Wing-Yu often questioned why so many mathematics courses were required for her major as she did not think some of them would be relevant or helpful in the future. But because these mathematics courses are requirements for her degree, she just accepts that she must take them and has tried to do her best.

Cassandra's feelings about mathematics varied from one interview to the next, often dependent upon how she was perceiving herself as a "successful STEM student" at the time of the interview. Cassandra stated that overall, she finds value in learning mathematics but often struggled through the coursework. She viewed mathematics as a form of "prestige" (Interview 3) because having a mathematics degree (or a related one) could open more opportunities as compared to a non-STEM degree. Her switch from a political science major to a STEM major has been an "uphill battle" (Interview 1) as she has had to learn the culture of STEM, but also herself as being capable of doing mathematics. Her confidence has slowly been waning because she often struggles in her mathematics courses, as reflected in her grades. Still, she did state that she continues this path because she believes that doing well in mathematics is one of the "key ingredients" (Interview 2) which is needed to do well in the STEM field.

Even Skylar (the only woman in this study to pursue an applied mathematics degree) considered mathematics as a steppingstone to lead her to her accomplishments. While mathematics is itself a major she is working toward, Skylar viewed mathematics as "like support [for] my IT.... But maybe I can do something with math if I couldn't find a job with IT"

(Interview 1). Her primary goal is to enter the field of technology but is also working toward a mathematics degree as a "backup plan" in case she needs more options in the future.

Barriers for Success

As these women spoke about their experiences as women whose first language is not English in the world of STEM, it was interesting to hear how their experiences were not only similar but also different, and how these experiences helped shape the way they view mathematics success. For example, even though these women were different from each other, they all touched upon similar struggles as being a woman or as a person who "needed"[256] to learn English (or both). Rather than succumb to those pressures or barriers however these women described how they responded to certain criticisms and how they continue to work through some of their own insecurities to obtain their STEM degree. In this section, I highlight some of the common barriers these women have faced and describe how they worked through those barriers in their pursuit of a STEM degree.

Grades and GPA

For each of these women, the expectation was to earn an A, as many of them earned As in elementary, middle, and high school years. All four women stated that mathematics was not necessarily difficult for them in their elementary school years. Their experiences and grades began to differ, however, once they reached middle and high school. Although all four spoke about some of the struggles they had in middle and high school, only Wing-Yu and Skylar were able to maintain their high GPA (and did not consider themselves as "failures" during that time

[256] I want to emphasize that all four women, at some point during the study, indicated the importance of knowing English to be successful. Although they spoke of family and friends who may not know English and can survive in society without learning English, they were clear that in their path to success, English was necessary for them to learn and be successful.

period of their lives). Sasha began to see a dip in her grades due to the pandemic and Cassandra spoke about mathematics being difficult starting in middle school.[257]

When enrolled in college, Skylar and Sasha still maintained that a B is a failing grade, while Wing-Yu and Cassandra began to change their expectations of themselves and their definition of success in their mathematics courses. For example, as their mathematics courses became more difficult and their surrounding peers were performing just as good (or better) as they were, both Wing-Yu and Cassandra began to accept Bs for their course grades, not always expecting to earn an A. For Wing-Yu, this change started when she was surrounded by other students who she viewed as being "smarter" than her in addition to the rigor she began to see in her mathematics courses. For Cassandra, her expectations started to change once she decided to earn a STEM degree and began struggling in her courses.

For Skylar, however, grades continued to be her primary concern regarding her success in school because she intends to continue her education after she graduates. So important grades are to her that she was happy to learn she would have to retake several mathematics courses as many of them did not transfer to her current institution.[258] The opportunity to earn a higher GPA, which would then increase her chances to go to graduate school, was something Skylar felt she needed.

Like Skylar, Wing-Yu also experienced having to retake a course. Unlike Skylar, Wing-Yu was not happy about this "opportunity" because the college misplaced her. Having taken AP Calculus in high school (earning a B average, a three on the AP exam, and "high" SAT

[257] Cassandra stated that she didn't always get As, but that her grades were usually in the As and Bs range.

[258] Recall that when Skylar moved to Georgia, her credits from Vietnam and New York did not transfer and she was required to retake several mathematics courses.

scores[259]), Wing-Yu stated she should have been placed in a Calculus course. But when she went to orientation, the person who helped her during registration did not consider her scores and told her to take college algebra her first semester. Although Wing-Yu thought it was a very easy course and questioned herself as to why she was not in a higher-level mathematics class, it was not until midway through that semester Wing-Yu's advisor noticed the mistake. Wing-Yu was understandably upset and stated that she had wasted a semester.[260]

Grades (and GPA) however were also a source of conflict because while many of the women relied on grades to give them feedback on their understanding of the content, Wing-Yu and Cassandra, for example, often stated that grades were arbitrary. For example, in Wing-Yu's mathematics courses, Wing-Yu's course grade would change toward the end of the semester to fit a model of what her professors perceived where many of their students were at. Mathematics courses were difficult, and Wing-Yu often spoke about how her course grade would hover around a 78 during the semester, but then would change to a B by the end of the semester: "Yeah, the math classes are hard. It was so bad, like, my average was a 78.... And that count as a B. (laughs). So that means like, they lower the curve" (Wing-Yu, Interview 2). Although grateful to have the B as her course grade, Wing-Yu often relied on the "grade bump" to help her maintain her grades while questioning whether she understood the content throughout the duration of the semester.

Cassandra also questioned whether grades were an accurate reflection of one's knowledge. She began to doubt, for example, whether tests are the best types of assessments to

[259] Note that Wing-Yu never stated what those scores were, just that they were "high."

[260] Although Wing-Yu was upset, she also did state that she was not as upset as she could have been because she was not paying for the course as a dual enrollment student. She did however think that not being able to take the appropriate math course that semester has held her back in taking other mathematics courses earlier.

"capture your success in math" (Interview 3).[261] Standardized tests, like the SAT and ACT, require a lot of preparation and Cassandra questioned whether they were good assessments because to do well on them, "you have to have the time and the resources to get those materials. And not everybody has that" (Interview 3). Like Wing-Yu, she experienced many different grading systems and wondered if grades are a true measure as there are "no standards for grading" (Interview 3). Cassandra stated that some of her mathematics professors simply graded for accuracy and did not give partial credit. Other professors, on the other hand, would use a rubric to grade, which often focused on how the student solved the problem rather than if a correct answer was obtained. Cassandra preferred the rubric system (as the focus was on "your conceptual understanding rather than if you got the answer right" [Interview 3]), but then stated that she was not sure why professors did not use the same type of grading when grading mathematics: "My expectations or my grades, you know—changed when you're a STEM major compared to when you're a humanities major. Like when you're a humanities major, at least for me, like I had a 4.0" (Cassandra, Interview 2). Having come from the humanities field, Cassandra struggled with the content, but also stated that she had to change her expectations for course grades and her overall GPA. The expectations of grades created some anxiety for Cassandra as she relied heavily on financial aid and scholarships. Cassandra often stated, for instance, that while her expectations have lowered due to her "inability to get As" (Interview 3), she still had to ensure her overall GPA was high enough to keep her scholarships and financial aid.

[261] Although Cassandra questioned the value of grades and whether grades were a "true reflection" of a person's knowledge, she did often rely on grades to determine what she should do next. Recall that Cassandra believed that if a person earns a C in a course, that person should retake the course because it means s/he does not have a solid understanding of the content.

Sasha and Skylar, although they described instances where grades did not necessarily represent how much knowledge they had learned, still maintained that they relied on grades to indicate their levels of success. Although they both indicated that there are other ways of knowing whether they understood the content (professor feedback, finishing work in a timely manner, etc.), the importance of grades often outweighed most other indicators. For Skylar, grades were important because she intends to continue her education; possibly earn a master's degree which relies on GPA. For Sasha, grades represented her capabilities within the school setting but recognized that grades may not be enough in the field:

> When it comes to grading, I mean, anything that gives me an A, I feel like it's good. It's good enough for me. But out of school and especially in my field, I'm not saying that will be good enough. You know what I mean? Like you said, I can do 99 things, right. And then one thing is wrong, but that one thing that's wrong, will make something not work. So, I have to have it right. (Sasha, Interview 3)

As an IT major, Sasha stated that she would probably have to rely on the outcome of a project—not just the completion of it but if the project is able to execute exactly what it was intended to do. One small mistake could interrupt the entire code of the program and thus, that would mean she was not successful.

Nonetheless, all four women believed that there *should* be a correlation between grades and GPA and how much a person has learned but has learned over time that they do not always correlate. If there is a strong correlation, grades would not simply be seen as just numbers; they would represent the amount of knowledge and understanding of the content a person has accumulated over time. But because there is a disconnect between grades and how much a person might know, all four women stated that they had to rely on grades as indicators of their success. Grades did not just give them information about their own learning, but also represented their understanding of the content to their professors and peers.

In addition to what grades represent, the women of this study often spoke about how grades caused happiness or extreme stress. Wing-Yu, for example, stated that when she took multiple AP courses her junior year, the pressure to do well and earn high grades put a toll on her mental health and how she began to see her own mathematics ability: “I think my confidence level dipped a little bit, because of how hard the topic was because usually it came naturally to me…. I just kind of struggled a little bit more than I usually did” (Wing-Yu, Interview 2). In addition, college mathematics courses, especially at her current institution, have made her confidence in doing mathematics “much worse” (Interview 2). Even though many of her peers have also struggled in her mathematics courses (having stated that the overall GPA in her mathematics classes hovered around a 2.5), Wing-Yu felt that the classes became harder and that in general there was a higher standard of excellence she now had to achieve. She questioned whether it was “fair” for professors or institutions to change what is considered the minimum level for each grade range. In other words, should a 78 count as a C or a B? Having to constantly worry about grades while also trying to learn the content has put a tremendous amount of stress on Wing-Yu—so much so that the way she views her current journey through her mathematics courses as a cave filled with lava.

For Cassandra, grades were “sometimes frustrating because it’s like, I spent so many hours in this course, and I got a C. But it’s also like, maybe I wouldn’t have…I would have failed” (Interview 3). Cassandra began to see that grades did not reflect her effort and she often questioned her capabilities or whether she was “doing it right” (Interview 3). Although she described this back-and-forth with grades as “exhausting,” she also stated that at some point she had to learn to be content with her grade knowing that she put the time and effort in. Grades informed her of her progress, but also created a sense of anxiety because she was not able to earn the grade she wanted.

In all the ways these women spoke about grades, it was clear that they need the grades to inform them of their current progress but also did not like the concept of grading because they did not think grades could reflect what they know. This internal battle they had with grades has continued as they work through their coursework. Rather than give up on grades, however, they continue to take the feedback grades give them to continue working hard in their courses (i.e., putting in the "time and effort" [Cassandra, Interview 3]) needed to earn the grade they desire.

Gender Roles in STEM

Even with the diverse backgrounds and experiences of these women, they all spoke about the pressures of being a woman in STEM in varying degrees. Some of the women, such as Skylar, never mentioned anything to indicate she had felt the pressure of being a woman in STEM until the third interview when she created her final concept map (see Figure 17). It was not until she began to draw the "enemies," that she began to talk about what it meant for her to be a woman on this STEM journey. At that time, Skylar stated that although her parents are open to allowing her to pursue a STEM degree, many other women in Vietnam are not normally given the same luxury. Because she was able to demonstrate to others her strengths in mathematics and science, her parents were willing to allow her to continue her interests within STEM, but still felt concern for their daughter given that many people in Vietnam did not think women were as capable as men:

> Well, sometimes, especially in my country, because for STEM major, most of the time woman will be looked down. Because they feel like women are not smart enough, as smart as men…. Because of that it is hard to find a job in Vietnam. (Skylar, Interview 3)

Wanting to provide better opportunities for Skylar, her parents encouraged her to enroll in a bridge program to gain access to courses and knowledge outside of Vietnam. Given her experiences in Vietnam as a woman, Skylar was happy to find that women are treated "better" in the United States: "I feel like I am always respect. Like, they respect me more" (Skylar, Interview 3). For this reason, Skylar stated that she does not intend to move back to Vietnam and would rather stay in the United States or move to another country where women are seen more as equals.

Wing-Yu had a similar experience in that her parents have always been supportive in her endeavors to pursue a STEM degree, but she has also witnessed and spoken to other people who have not been as fortunate:

> Her [her friend] family actually got mad at her for pursuing college because she's from a Hispanic family and they see like.... college as like losing money, you know? Like, you're going to college, you're losing money. Like, you can work. It's not going to be paying off like fully. And it's like you're investing so much time, or rather you can work full time, and just make like, a lot of money then. But then like, I guess, I won't speak for all, like the entire culture, but it sounds like her family just values, you know, short term work better than like the long term of just trying to get a degree and getting like a better job. Well, compared to like, my parents…honestly, I say overall for like China, knowledge overall, is valued so much. They rather take like the financial burden of losing

> money for like four years, and then just getting a really good job, then, like just working already, and then just maybe eventually going to college. (Wing-Yu, Interview 1)

Although Wing-Yu did not directly talk about gender as being a concern for her friend's family, Wing-Yu questioned later if her friend's family was more concerned about money or "something else" (Interview 3).

Sasha on the other hand specifically talked about and described how she was disappointed with some of her own family members and how they treated her cousins, who are also women. Although Sasha's family did not require or encourage her to fit into the gender norms (i.e., women should stay at home and allow the men to work), she stated that other members of her family did not find issue with women not pursuing a college degree or make decisions about leaving to better provide for themselves and their families (due to the lack of opportunities for growth in her home country). She stated that while she thinks every woman "should make that decision for themselves" (Interview 2), she did not think some of her family members provided enough education or support to allow the women in her family to make those types of decisions for themselves. She questioned whether her cousins were made aware of alternative possibilities for their future rather than just assuming they would become wives and mothers.

Unlike the other women in this study, Cassandra spoke at length about how she felt women, especially women of color, were being perceived in the STEM field. Cassandra being in the unique position of transitioning into STEM while in college and being a woman of color, she stated that there were many times when she felt uncomfortable and noticed inconsistencies between what people were saying versus what they were doing. For Cassandra, "being in a STEM environment can be intense" as people are very competitive and "lack trust" (Interview 3) in one another. Due to the competitive nature of STEM, many people, in her experience, are unwilling to share resources or information (often “gatekeeping information” [Interview 3]), for fear they will be losing an opportunity for themselves. She has often felt that people within STEM treat the field as if only certain people should have access to it:

> I think those who don’t want other people to be successful in the course. Like, I think there’s some, like, there’s this mentality in STEM that I’ve observed from people that it’s like, there’s only a specific number of people that can get the A. Or there’s only a specific number of people that can really master the material or get a good grade or go on the path….and it’s like, there’s room for all of us to get As. There’s room for all of us to be successful. (Cassandra, Interview 3)

When asked who she feels creates this type of atmosphere, Cassandra often spoke about the differences between the men and women in her classes. Cassandra described how the men tended to stick together, would often exclude the women in their classes, or treat the women as lesser than. For example, when sitting in a classroom, Cassandra has noticed the different ways men and women are treated. According to Cassandra, the men in her classes seem to be “more willing to fight back on what you said if you’re a woman” (Interview 3). They appeared to be more critical of women than other men in the class. For example, if a man said something incorrect, other men in the course would not correct them and would allow them to continue without interruption. When a woman spoke, regardless of whether she was correct or not, the men in her classes would always interrupt; often not letting the woman finish what she was saying. Cassandra wondered if the men realized they were doing this or if they were completely unaware of their biases.

Cassandra also spoke about how "isolating" being in STEM has felt for her because the men often isolated themselves in the classroom (and in study groups) and the women, although the same gender, were not always receptive:

> Another thing about being a woman in STEM, especially like a woman of color…I just feel like, I don't know, they're against women. You think like, oh, they're gonna be your allies. And then it's like they're not…. even if I'm a woman of color, and let's say for example, I'm in a classroom with white women, and like, and with men, I think I still feel isolated. My experience of them being white, like, for me, it's kind of like… I will always be friendly, of course, like to the women of my courses, but like, I'll extend the olive branch… But I feel some type of way, or like sometimes they can just be kind of indifferent or like they don't really say anything, or they kind of already have their friend group or… they'll only ever talk to the other white woman in the course. (Cassandra, Interview 3)

Cassandra had a difficult time conceptualizing what these experiences were like but did state that feeling like she belonged in STEM comes in waves. It was not until she saw the same familiar faces from the previous couple of semesters, was she able to create a strong friend group because they were going through the program together. Without seeing those familiar faces in multiple classes, she wondered if she would have ever made friends in this program.

When asked what made them continue in STEM even when hearing how others could have perceived them, Cassandra, Wing-Yu, and Sasha each stated the best course of action was to ignore those voices. Because many of them had support from their own families and friends (and the support of educators), they were able to work through their struggles. For Skylar, it was more than just ignoring them—she said that she had to rely on the fact that she has already proved herself to be capable of doing something in STEM and to physically move. Moving away from Vietnam was seen as a necessary choice as Vietnam could not provide the opportunities, she felt she deserved.

Lack of Opportunities

Sasha and Cassandra were the only women in this study to question whether they had enough access to opportunities that would help them be successful. Cassandra, for instance, spoke about how her parents were not able to help her at home:

> Not being able to have like parents that could help me with... I think kind of just makes me a little bit more not so confident because it's like, well I'm not coming from the background of somebody who has like, math professors as parents or like just teachers or like, an education background. Like you hear about people who are like well, everyone in my family is an educator, so I'm going to school to become one. (Cassandra, Interview 3)

From a young age, Cassandra stated that she had to figure things out on her own as her parents were not sources of information she could rely on. According to Cassandra, schools, then should provide the necessary support for children who may not have access to the type of knowledge that is necessary to be successful in school.

Sasha had similar concerns about the role of schools in helping students prepare for college. Although Sasha was happy to be a part of a new school, for instance, she stated that she did not think the school was equipped to handle all the necessary demands of students. For example, as one of the students whose first language is not English, Sasha did not feel as though her school had a strong ESOL program, stating "I don't think they were expecting so many…immigrants" (Sasha, Interview 1). Sasha often spoke about how she did not think her teachers were prepared to teach students who did not understand English. Although she felt most of her teachers were "nice," she did not think they knew how teach to non-English speakers.

In addition, Sasha often spoke about "not knowing important stuff" (Interview 2), such as how to apply to college or filling out a FAFSA form.[262] Similarly, Cassandra stated that she was disappointed in how her school did not let *all* students know about opportunities beyond high school. Although Sasha always knew that her goal would be to go to college, Cassandra stated that many of her Hispanic peers did not even consider college because it was never presented as though that was an option in high school. Disappointed by the lack of resources available for her and her peers, Cassandra helped establish a HoPe leadership chapter at her school. Both women stated that it was "unfair" how others in their school seemed to know things they did not. Rather than get upset however both decided that the best route to take would be to ask questions and to get close to a teacher or another advocate in the building. From their relationships with a teacher, for example, they were able to learn more about the different colleges in the area and what steps were necessary to apply to college.

Family and Peers

Although family and peers were often seen as a strength and as reasons why these women were able to pursue a STEM degree, there were moments when the conversations would center on how family and peers were sources of conflict. Sasha spoke about her desires to attend a school for engineering that required her to live on campus her first year. Although Sasha's family wanted her to pursue a degree, there were some limitations to what they would allow Sasha to do to pursue that path. When her family refused to allow her to live on campus for her first year in

[262] FAFSA, which stands for "Free Application for Federal Student Aid," is a federal form students need to fill out to receive financial aid for college. This form is long and can be confusing to students, as questions often ask about tax information, business assets, and so forth.

college, she decided to take a gap year: "If I wasn't gonna go to a school, I just wasn't gonna go to any school" (Sasha, Interview 1). During her gap year, Sasha chose to work at a retail job. But within a year her family started to put pressure back on her to go to college. Although Sasha wanted to go to a particular school (one that offered the degree she wanted), she knew her family would be unwilling to allow her to attend the school (due to distance, the living on campus rule, and finances). Thus, she resigned to doing an IT degree at her current institution with the intent to transfer to another school after a couple years so that she does not have to pay the full four years of tuition but also be able to get the degree she wants.

Cassandra faced similar challenges with her family. Her father, for instance, has never understood why she wants to go to college and does not see the value in it: "Like, my dad's not really that encouraging. Actually, he tells me that I shouldn't be working three jobs, and that I shouldn't even go to school" (Cassandra, Interview 1). The pressure from her father increased when she left the women's college and started working through her gap year. During that time, Cassandra was able to make "decent money," but she felt the pull again to pursue her passions. When she told her parents she was going back to school, her father continued to ask her why college was important when she could just work now.

For Sasha and Wing-Yu, they often felt responsible to help their families while also trying to balance school and work. For example, Wing-Yu stated that she is often called on to help her parents translate documents. When she confronted her parents about why they did not learn English to be able to navigate on their own, her parents responded they are "too old to learn English" (Interview 1). Although Wing-Yu said she would be willing to help her parents, she did not feel she was capable to help them with things like tax documents or emails that had words she did not know how to translate to Cantonese. In addition, she stated, "I don't want my whole existence to be just limited to being a translator" (Interview 1). Despite having immigrated to the United States over 20 years ago, Wing-Yu stated her parents are able to hold "simple" conversations in English but don't necessarily need to learn English beyond basic conversations due to the large population of Chinese people in the area. Similarly, Sasha stated that her parents, while they don't depend on her financially (even though she does contribute to the finances at home), they often rely on her to take them to the doctor or the grocery store in case they need a translator. The extra responsibility of having to take care of their parents took time away from focusing on their own goals.

For Sasha, she stated she didn't necessarily have a choice in helping her family because she still lives at home. While she does not mind helping her family, the added responsibility of knowing that they cannot do simple tasks on their own, while also maintaining her responsibilities at work and school has added to the struggles she has mentally. Until she can live on her own, she stated that she felt "stuck." Cassandra had a similar response, but stated that because her mother can speak English, the demand for her help is not as intense as it is for Sasha. Wing-Yu, who currently lives on campus at her current institution, has stated that she has been able to maintain a good relationship with her parents because of the physical distance that separates them.

Language and Mathematics Success

Although all four women were proud to state that they could speak another language, they felt the tension of not knowing English within the educational setting. Each explained that knowing English was necessary to be successful in school because it was the dominant language and the language that was "valued" (Cassandra, Interview 3). Although only Skylar and Sasha discussed more about their struggles learning English and mathematics content at the same time,[263] each questioned to some degree why language was not perceived as an asset in the classroom or why English was perceived as the language all should know. In this section, I describe some of the ways in which these women thought about language (English as well as their own) and how language contributed to (or not) to their success in STEM.

The Value of Knowing English

When Skylar spoke about her time in school, she often spoke about the importance of language. Although her primary language is Vietnamese, English was a required course for all students in Vietnam starting in primary school up to "when we grow up" (Interview 1) and was seen as a necessary component of being successful in life. Students could learn other languages if they wanted to (like French), but Skylar stated that English was one of the core courses she had to take—it was not a choice. She assumed it was because "English is common" (Skylar, Interview 3), but did not fully understand the reasoning behind the country's decision to mandate that all children learn English. Despite the reasons, Skylar often stated that knowing more than one language, especially English, was a benefit and could open more educational and professional opportunities for her. For example, because Vietnam was not considered a place for her to pursue her IT career (due to the gender biases discussed earlier), Skylar and her family valued learning another language so that she could study abroad and earn her degree.

Although Skylar often spoke about her time in school learning English, she also indicated that it was not until she enrolled in a college English-only program in Vietnam did she realize her English limitations.[264] Her parents ensured she spent a good amount of time learning English,

[263] This discussion was limiting in part because both Cassandra and Wing-Yu started their educational trajectory in the United States (elementary school) and could not recall many experiences when they struggled learning English and mathematics at the same time.

[264] It was not until Skylar and I spoke about her experiences in college, did she talk about the ways in which she learned English in Vietnam. In our second interview, she indicated that her English course in school "mostly focused on grammar and vocabulary" with not a lot of opportunities to speak English.

as that was seen as a necessity (both to the country and to her parents) by enrolling her in English courses on the weekends. But because she was “too scared of being judged” (Interview 3), she did not engage in English conversations. Skylar, however, also stated that even if she did practice English more in those courses, she is not sure it would have prepared her to learn the “type of English” she would need in her academic courses: “But those are just English, not English in math… I can make like normal conversation, like being [able to] explain your feelings and stuff like that. But not like going specific to math. Or any subject” (Skylar, Interview 2). Skylar considered this “language barrier” (Interview 2) as one of the primary reasons to why she began to struggle with mathematics in college. When trying to understand material, for example, Skylar would not seek help from her professor due to language: “Well, I would just listen to it again. And I still don’t understand” (Skylar, Interview 2). She did not think that listening to her professors speak in English again would help her understand the content. It was too much of a struggle to learn content and English at the same time.

Sasha had a similar experience when she first moved to the United States as a sophomore in high school. When Sasha came to the United States and struggled in her mathematics course, she initially started to question why she was having such a hard time. Her experiences conflicted with the way she was performing back in the Dominican Republic. Despite being good at mathematics in the past, not knowing the English started to persuade Sasha that maybe her mathematics abilities were linked to her English abilities. As a student, she relied on her mathematics ability to carry her through school, as that was the one area where she felt the most confidence in. Yet, as she began to experience what a mathematics classroom looked like as compared to what she had experienced in the Dominican Republic, she soon came to realize that learning mathematics also required her to know some English. In addition, her mathematics teacher only spoke English, and so Sasha would rely on herself to try and understand the mathematics. She became frustrated whenever people would say to her that she should understand the mathematics because "math is universal."[265] According to Sasha, if mathematics was universal, why couldn't she understand how to do it, even without knowing English? She stated that she should have been able to understand what the teacher was writing on the board and follow the steps without having to rely on what the teacher was saying if mathematics is truly a universal language: "It's not numbers. We're not only talking numbers. In order for you to teach, you have to explain what you're doing with the numbers" (Sasha, Interview 1). Her history with mathematics had always been positive, as she was often "number one" (Interview 1) in her class. So, having to experience the struggle of learning mathematics and English made her first semester in school "horrible" (Interview 1):

> Because in DR, I was always number one in math. Always number one in math. But that first semester was horrible in math here. Because it's different, like, it don't matter if you don't speak English or not—that's not true. It does matter. You have to understand what they tell you. (Sasha, Interview 1)

To be successful in her mathematics courses (and school in general), Sasha stated that she spent most of her time learning English—in and out of school. It was only when she learned more English did she started to see an increase in her grades: "Okay, this is math. You don't need the English. But you do!" (Sasha, Interview 1). To Sasha, knowing and understanding English is linked to her ability to do well in mathematics. Because she does not currently believe that her

[265] I put this phrase in quotes because there are those who believe that mathematics is universal in the sense that it comprises of "just" numbers and symbols, which are used across the world. Wing-Yu, for example, was the only one who stated that "math is kinda universal" (Interview 1), because her family, not knowing English, could only really prepare her for mathematics before she entered elementary school by showing her the multiplication table.

English skills are that great, she continues to think that she is limited in the ways of learning mathematics even though her grades would indicate otherwise:

> I was still in the top half but it's not the same.... I still love math. That never changed. But…I feel like I'm not as good. But at the same time, we're talking about more harder stuff that still need English. So yeah…. I'm not as confident. (Sasha, Interview 2)

Her experiences being in a mathematics classroom and having to learn English at the same time in the United States has affected her confidence level in mathematics.

Cassandra and Wing-Yu, both having been born in the United States and exposed to the English language at an early age, did not speak specifically about language being an issue for them in their mathematics courses. Wing-Yu did however state that although she feels like her English is "pretty good now,"[266] there was a time in elementary school when she struggled with English. She didn't necessarily see the value in making sure she knew English well (because at the time she felt she was able to communicate well with her peers), but her parents often took her to the library and required her to read and write in English. Because her parents valued her learning English, Wing-Yu stated that she was able to learn English but still struggled with reading comprehension tests. In addition, although English is her primary language now, Wing-Yu is aware that she has a "limited vocabulary" (Interview 2), and she tends to use only "simpler" words in her writing. Despite having taken AP Language Arts in high school, she stated she is still not fully confident in her abilities to write well. Luckily, she is not too concerned about her writing abilities as she does not think she needs them in her career as a computer science major.

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[266] Wing-Yu stated that she was able to determine her English skills as "pretty good" because she started to earn As in her English classes in middle school.

Of the four women, Cassandra was the only one to state explicitly that knowing another language was a benefit in the classroom. While most of the other women focused on their struggles with English and how English was required for their success, Cassandra stated, “I think you’re more creative in some ways when you’re bilingual (Interview 3). For her, Cassandra stated she felt that she was able to visualize things in her mind differently depending on which language she was using to think about a particular concept. If she thought about a mathematics concept in English and then in Spanish, she said that sometimes she would have a different image or perspective. In addition to the creativity that can occur with knowing more than one language, Cassandra stated that it is “really important to have a really diverse background to consider different perspectives” (Interview 3). In other words, with more people in the classroom who speak more than one language, Cassandra stated that the entire class would benefit.

Language and Culture

For many of the women in this study, having to learn English while also going to school and participating in activities outside with their peers, they often struggled with knowing where they belonged.[267] In addition, as they became more acclimated to American culture, they started having personal and familial conflicts (surrounding language and culture) about whether the opportunities of earning a STEM degree in the Unites States also meant they were losing a part of themselves.

Sense of belonging. As these women learned more English and the American culture, there were concerns about them “losing themselves” or not knowing where they belonged. Sasha spoke about the role of language and how it has shifted some of her relationships with her

[267] The exception was Skylar because although Skylar goes to school and must engage with others in school, she stated that she often keeps to herself and does not participate in American culture. All those she spends time with outside of school are Vietnamese and she stated that she only eats Vietnamese food, watches Vietnamese shows, and so forth.

family. For example, as Sasha spoke more English and became more acclimated in American ways, she and her family became concerned that she was beginning to lose her “heritage” (Interview 2):

> I’m always speaking English. Like, I only speak Spanish when I’m talking to my mom, to my brother or to my grandparents. Even when I’m talking to my aunt. She knows English enough. Or my stepdad. I’m talking in English. It’s just after five years, that’s just natural, more natural to me. And it’s crazy. (Sasha, Interview 2)

Rather than speaking Spanish all the time, Sasha admits that it has become to feel more “natural” for her speak in English on a regular basis. Although she is still fluent in Spanish and speaks it regularly, she has found that she often prefers to speak in English most days.

In addition, when visiting family and friends in the Dominican Republic, Sasha stated that she was often seen “as a visitor and that makes it horrible because I’m not” (Interview 2). Visiting her home country, she still feels like a resident, but others have begun to see her differently. She could not pinpoint specifically what differences they saw in her, but she also recognized that she has begun to have strong attachments to the United States as well. Living in the United States for more than five years, Sasha has started to build stronger connections within the United States (i.e., to her boyfriend and his family) and has lost some of the connections she had in the Dominican Republic:

> I don’t know, it’s a little complicated. Because I’ve [been] here [in the United States] for so long, and this is my day-to-day life. When I go back, this is not me anymore completely. So yeah… It’s hard because I still want this [points to the Dominican Republic on her map]. I wish all my connections to the Dominican Republic were still

> strong. But…it's hard having strong connections in two different places at the same time. (Sasha, Interview 2)

After spending about two years in the United States, Sasha stated that she did not feel like she "belonged anywhere" (Interview 2) as it took some time to feel comfortable.[268] Not quite fitting in in either country, she began to question who she was.

Wing-Yu had similar concerns about where she belonged, but it didn't start to worry her until she started noticing that she was losing some of her Cantonese language abilities. Wing-Yu stated that she started to feel there was a language barrier between her and her parents in high school. As she is now fluent in English and speaks English every day, the only time she can speak Cantonese is with her parents. Even when she meets other young people like herself, who can speak Cantonese, they all prefer to speak in English: "Even the Canto [Cantonese] kids. They all speak English. We rather speak English" (Wing-Yu, Interview 1). Wing-Yu stated these were the primary reasons why she was "slowly losing" her Cantonese language skills. She attributed a part of this to being a teenager, as most teenagers "don't really want to talk with their parents" (Interview 1).[269] But not being able to speak Cantonese with her parents has made her feel as though she is losing a part of herself.

In addition, Wing-Yu stated that although she speaks Cantonese, she would not be considered Chinese to people in China. Having grown up in the United States and embedding some of the cultural elements here has separated herself from other Chinese people:

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[268] In her third interview, Sasha stated that she now feels she belongs in the United States. But her sense of belongingness did not start until she started to work full-time, and she started dating her boyfriend.

[269] To learn back some of the Cantonese Wing-Yu has lost over the years, she decided to take a Chinese class as a dual enrollment student. The class, unfortunately, was Mandarin based and so she was not able to practice the language her family speaks. As she has grown, however, she has started to speak more to her parents and now feels that her Cantonese is starting to get better. Although she is not confident in her speaking abilities, she can have a conversation with her parents in Cantonese—which is what is important to her.

> I think I just wanted to take it because I feel like a part of me wants to like connect with, you know, the side of me that's felt like.... It's Chinese. But then it's hard because…it's a weird disconnect. It's always like, you feel like you belong. I think not as much as compared to like, you know, the earlier generation of Asian…like other races combined…not Asian but like American as a race. It's like a place of you wouldn't really belong. I wouldn't belong in China, you know? I don't know how to speak the language.[270] But then like in America…. I feel more belonged here. But it's also like a little bit of a disconnect because it's like…. I can relate to other Asian Americans. But then some Asian Americans are just like, either they're more in tune with this or more in tune with that. It's just kind of hard because you're technically like two identities at once. (Wing-Yu, Interview 1)

Wing-Yu stated she does not quite feel "American," as she is aware that she not only looks different but was also raised by parents whose culture differs from the dominant one.

Skylar, too, often felt conflicted about how much to engage with Americans given that she was beginning to understand more of what people were saying. Unlike Sasha and Wing-Yu, however, Skylar has not engaged in any American activities as she stated that she often socializes with other Vietnamese people in the area. As her English skills got better, she began to see and hear how people in the United States engage with one another. In some cases, Skylar was shocked and disappointed as it would conflict with her cultural upbringing. For example, when comparing to Asian families, Skylar viewed children in America as being rude to their parents. She stated that she—

[270] Wing-Yu does not refer to the language itself, but to all the ways language is used to communicate. For example, "slang" would be different in China.

> feel like children in here [United States], they kind of like more…they have more freedom…I saw some kids kind of like, a little bit, I will say rude? Which is not what we experienced in Asia. Because the way you talk—It's kind of like parents want to make children feel like parents are friends. But…in Asia, Asian families not like that. Parents are parents. …respect like, really, really respect the older people. (Interview 2)

Being disappointed in the ways U.S. people interact with one another, Skylar stated that she preferred to only socialize with other Vietnamese people.

Cassandra, despite having grown up in the United States, also stated that there were times when she felt "isolated" (Interview 1) when in a classroom with only English speakers. When the opportunity came for Cassandra to take a Spanish class for native speakers, she jumped at the opportunity to be surrounded by people "like her." Although she can speak English fluently and has spoken English all her life, she stated that being in—

> white spaces…it can be kind of a little bit like, isolating in some ways, because like, people don't really understand you. Not just because you're not speaking English, but culturally there's like cultural differences. And, when you're bilingual, and you meet other bilingual people, the people think that they know that you speak Spanish, like, they'll be more comfortable with speaking Spanish versus trying to speak in English with like an accent or like broken English or, they'll be comfortable speaking in Spanglish to you and things like that. So, I feel like, it's just a little bit different. I think it's a little bit more community centered when you're…when I'm like with other Spanish speakers versus English speakers. (Cassandra, Interview 1)

Simply knowing English and being able to speak it "well" did not guarantee that Cassandra would be able to make connections to her White peers.

Nationality, ethnicity, and race. When speaking about their experiences in the U.S. educational system, many of the women brought up issues surrounding nationality, ethnicity, and race. There were times when engaging in conversations with others, for instance, that other aspects of language and culture surfaced and sometimes they did not know quite how to respond. Although the high school Sasha attended was diverse racially, she noticed that students tended to group themselves according to race:

> I don't like…mentioning race, but like, Hispanic people were on their end…. White people were on their end. …Yeah. It's a wide variety. I can't tell you that school was predominantly White, or predominantly Black or predominantly Hispanic. It was a little bit of everything, but it was still separated in those groups. (Sasha, Interview 1)

How people looked or grouped themselves, however, weren't the only things Sasha noticed when she was a student. She also began to learn how people categorize others based on the language they speak. In our discussions about her experiences with race, language, and culture, Sasha made it clear that language was one way in which she was able to bond with the Black community. When she first arrived in the United States, she could not speak English, and was "forced" to speak with other Spanish-speaking students (the "Hispanics of the school" [Interview 2]) because there were no other Dominicans at her school. On the other hand, Sasha did not feel as though she could relate to the other Hispanic students and began to realize their cultures were completely different from hers: "It's crazy, but my culture is more similar to African American culture than Mexican culture. So, I started relating more to black people. And I mean, it's been like that. I don't think that's gonna change either" (Sasha, Interview 2). Sasha stated that being Hispanic did not automatically mean that their cultures are the same.

Spending more time with the Black community seemed like a natural progression for Sasha, as she always felt more connected to Black people. But her relationships with Black people appeared to be odd to others in society, given that she “does not look Black” (Interview 2). Sasha stated that race was never a thing in the Dominican Republic, and it wasn’t until she came to the United States that she had to think about how people are categorized—especially based on their skin color. As a lighter skinned woman, Sasha recognized that she may not “look Black” but back in the Dominican Republic, there were all shades of skin colors that fit under the umbrella term “Dominican.” She doesn’t understand why this is a hard concept for people in the United States to understand, especially given the diverse population and the “mixing” of cultures: “You can have a 100% African American that’s not—they’re like light skinned, but they still black. Being Black doesn’t mean that you’re dark skinned” (Sasha, Interview 2). She was surprised to learn that many people in the United States do not know the difference between nationality, ethnicity, and race:

> When I look at myself, I don’t see myself—because Hispanic, like being Hispanic is not a race. You know what I mean? So…and this is what I say every time I have this conversation. When I’m filling out paperwork, there’s two questions that I have to answer. Am I Hispanic or Latino? Yes or no? And then what is your race? I put Black, I always put Black. (Sasha, Interview 2)

As her language skills developed, she began to separate herself from the Hispanic community and she now no longer has any friends who are Hispanic. She has naturally gravitated more to having Black friends: “Like, let’s look at the facts. I relate more to black people. That’s personally me. Let’s look at the history. I’m not saying I’m black because I want to be black. I’m saying I’m black because of my history” (Sasha, Interview 2). Although her outward appearance or her ability to speak Spanish may suggest she is Latina, Sasha didn't think it should reflect her cultural upbringing.

Like Sasha, Wing-Yu also discussed issues of race, ethnicity, and nationality. Although she felt uncomfortable speaking to her parents about these ideas, Wing-Yu stated her parents are often asking about what type of people she spends time with and she has felt uncomfortable speaking to her parents about issues of race, knowing that they are often concerned about stereotypes of racial groups that may not necessarily be true. For example, when driving Wing-Yu back to her college dorm, her mom asked her about the racial makeup of her classmates. Uncomfortable at the time, Wing-Yu told her mom that she "didn't know and didn't look at people through those characteristics" (Interview 1). Unsatisfied by her response, her mother then told her that she should "pay attention to your surroundings because you never know what might happen" (Wing-Yu, Interview 1). Although Wing-Yu did not want to talk about race with her mom at the time, she has noticed some of the ways people have treated her differently based on their perceptions of her racial makeup:

> I remember one time when I was working last summer, someone was like—because I had my name tag and they literally put their hand on me and asked, 'so what's your real name? Like where are you really from?' A lot of my Asian friends will like talk about that. Sometimes you get those comments like 'where are you really from?' you know? They laugh it off but at the same time, it's just like…there's so many people around us and it's like kinda stupid because I was confused. I was kinda flustered honestly. And I mentioned that this is my real name. And I think I mentioned that I have a Chinese name. And I did not like this guy's response. He was like, 'I knew it!' as if he cracked some code because I mentioned that I have a Chinese name. But then I was like, 'no, this is my

> government name. This is my legit name. I was born here.' …it's like frustrating. (Wing-Yu, Interview 1)

Wing-Yu stated further that she does not like to specifically talk about race because she feels that labels sometimes "limits" how one is seen. According to Wing-Yu, focusing on race also gives people permission to treat others badly based on their perceptions (which, most of the time, are false). This idea became apparent to Wing-Yu when the COVID pandemic started:

> I was also frustrated like, you know, during COVID—the stop Asian hate. That really frustrated me because…the president didn't help. There was tension because of China. And it's so easy to blame everything on China and Asian Americans got blamed for everything too. It was frustrating honestly. (Wing-Yu, Interview 1)

Although Wing-Yu began to see how Asians were being portrayed in the media, she stated that her parents tried to protect her from experiencing any "Asian hate" by making sure she only spent time with other Asian families and keeping her distance from others (for also the safety concerns of getting sick).

Unlike Sasha and Wing-Yu, Cassandra did not share a specific instance regarding race or culture, but she did state that people's perceptions are important in the mathematics classroom:

> I think, like, at a first glance are probably just based on my appearance…I don't think people are assuming I'm like, the most math person in the room. I think there's just the stereotype, like, if you're a white male, then you're going to be more of an expert on math versus like, anyone, else…It's just kind of like, why is it that stereotype? (Cassandra, Interview 3)

Cassandra did state that although she has not had anyone explicitly say anything to her about her race or how they perceive her mathematics abilities, she has "been able to tell" how people view her based on their actions and the way they approach her.

Navigating Through School

As these women described their experiences in school, they often spoke about how they had to learn to navigate by relying on their families and themselves. Many of the women indicated that their family had a large role in the way they approached education and, in many ways, continued to support them as they continued their educational journey. Their families would help instill certain "qualities" or would take certain actions to ensure they had specific opportunities that helped them move forward.

Sasha, for example, who moved to the United States at the beginning of her sophomore year of high school, stated there is still set gender roles for men and women in the Dominican Republic: "the man is gonna go work and bring some money to the table when you're [the woman in the family] gonna stay at home. Take care of the home and take care of the kids" (Sasha, Interview 1). Sasha's parents, however, did not put pressure on Sasha to take on the traditional role of a woman in the family but instead encouraged her to go to the United States so that she could earn a college degree:

> I feel like they want different for me. They don't know what it's like to not struggle. They don't want that for me. I feel like they also don't want me to be like the woman in the yard that depend on the man so even if it's a bad man, they can get away because they don't have…the skills I guess to be by themselves. You know what I mean? So, if I have a degree, you can work. You can take care of yourself. So that definitely plays a part in

their mindset. They just want to make sure that I don't have to struggle, and that I can have the future that made me come here in the first place. (Sasha, Interview 2)

Wing-Yu and Skylar also stated that although their parents had high expectations for them, they did not feel the pressure to pursue any one area.[271] Wing-Yu stated, "I feel like the stereotype is that a lot of Asian families tell you to be a doctor, lawyer, engineer…. My parents honestly, never put that pressure on me. They just told me to go to college" (Interview 1). Although Wing-Yu's parents did not speak English, they tried to find ways to support Wing-Yu in her learning of English. Learning English in school was a struggle for Wing-Yu, so her parents would take her to the library to check out books to read, teach her multiplication in preschool, and instill a sense of discipline and focus. Although Wing-Yu did not enjoy some of the activities she was forced to do at home, such as write in her journal every day, Wing-Yu credited her family for her habit of studying:

> My parents really encouraged me to focus hard on school, because part of it is because like, you know, our situation wasn't that good. So, they always told me, you know, study hard, and you'll make a lot of money. So, I guess that's where I built my habit of studying. (Wing-Yu, Interview 1)

Skylar described similar experiences with her parents as she indicated that there are certain characteristics that a person would need, such as being focused, having patience, and being hardworking. As a young child, Skylar was required to put a lot of time and effort in school in addition to her after school classes.

Cassandra, like Skylar, was bilingual because she had parents who spoke both Spanish and English to her. Just like Wing-Yu, Cassandra stated that her parents could not help her with

[271] Recall that Skylar's parents encouraged her to pursue a STEM degree even though women are not seen as capable in Vietnam.

the content of her courses, such as homework, but still found other ways to support Cassandra in school. Her mom, for instance, spoke only English to Cassandra so that Cassandra could learn both English and Spanish at home. Her mother's fear that Cassandra would not be given the same opportunities as other children in the school if she were to be placed in an ESOL program forced her mother to speak only English to Cassandra (while her father and grandmother spoke Spanish to her).

The actions their parents took to help them through school did not go unnoticed. As the women in this study described the sacrifices their families made to ensure their children got a good education, they also reflected on the specific qualities they have because of the struggles and hard work they had to endure. Qualities such as staying focused were necessary to accomplish their goals. Sasha, for example, stated that having a goal helped motivate her to continue with her path and remain focused to achieve it:

> I have a goal of graduating and doing a lot of things. And that's what I'm working towards. So that's why I'm very focused, like I don't usually get distractions that will like, how do you say that? … Like get off the path. (Sasha, Interview 1)

When asked if she has ever faced any challenges, Skylar indicated that she would often speak to herself to encourage herself to continue. She knows she is capable of being a good student (from her past and the accomplishments she has been able to obtain) so she continues to push through. Wing-Yu often incorporated a similar strategy when it came to challenges in the classroom. She would often speak about a "mantra" she would use as a guide to help her through the struggles—this idea that this current moment is temporary, and it might be struggle now, but it'll be worth it in the end to suffer through it:

> I mean, the only motivation I have is like, my thought process was always work harder now. … later, it'll be easier. And I just remember in high school that's why I took so many AP classes. If I pass them, I wouldn't have to worry about this credit in college. And it helped me overall. So, it's like, I still have that mindset of like, if I managed to keep the scholarship, and if because I work hard, then I will have to pay less money. Once I get out of college. It's like that mindset that I have, like, what I work harder now and later, like, it won't be as hard for me. (Wing-Yu, Interview 1)

This idea of "work hard now, so it's easier later" is a phrase that her parents would say often to her to motivate her to try her best.

In addition to remaining focused, all the women of this study discussed the importance of time management. Because students are required to learn material on a set amount of time (i.e., by the end of a semester), Skylar stated that sometimes students rush through the material rather than taking the time to make sure they understand it before moving on to the next part. A strategy Skylar often talked about is how to manage time so that understanding the content was the main priority. This emphasis meant that students should give themselves adequate amount of time to do the homework, review notes, and leave time to re-do homeworks (to study and reinforce concepts). Cassandra also stated that she had to "dedicate a lot of time to make sure that I feel fairly comfortable with the material" (Interview 3).

Sasha and Cassandra also stated that time management was an important quality to have to achieve success. Unlike Skylar, they did not think time management was limited to just spending enough time on homework and content. Because Sasha also has family who lives with her, she stated that the hardest part of going to school for her is to "manage your life with your classes" (Sasha, Interview 1). Cassandra, who also lives with her family, often spoke about how difficult it was to navigate school, work, and family. As the oldest child in the family,[272] Cassandra has often had to help with her younger sister at home. Time management thus incorporates all the ways a person should divvy up time to ensure all activities get the amount of time that is needed.

Family, however, could not always support them when they were in school as they had limited power within the school walls. In these instances, they often had to rely on themselves or other people in the school building. Of the four women in this study, two of them spoke fondly of at least one “good teacher” who helped them navigate through school. The actions of these teachers helped put them on a path to success. Wing-Yu, for instance, spoke about how her elementary teacher often grouped her with students who were in the gifted program, even though Wing-Yu did not get placed in the program. In addition, it was a teacher who ultimately decided Wing-Yu needed to be in the accelerated group in middle school:

> I think my teacher realized that, like, you’re smarter than like a majority—the other students. I think you should be put in accelerated. I think that’s what usually happens. And I think that it was the same way in middle school because my math teacher was saying, ‘yeah, you guys aren’t going to start in here, you should probably be taking accelerated,’ you know? That’s what they did. They just set up like, technically can just set up my classes for me—like as you move up. (Wing-Yu, Interview 1)

The actions of these teachers allowed Wing-Yu to be placed in an advanced group, giving her access to opportunities that she might not have had otherwise.

Sasha spoke fondly of an English teacher who helped her learn English quickly and provided support and guidance as a new student in the country:

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[272] It is interesting to note that all the participants in this study are all the eldest in their family (Cassandra, Sasha, and Skylar) or are an only child (Wing-Yu).

> She was amazing. That was my high school mother. When I was in my language art class. … She knew my background. She knew my level of English. She knew I try my best. And I feel like it helped me a lot. And it always does. Like it helps me a lot when professors can see that I like actually want to try, you know what I mean? (Sasha, Interview 2)

The support this teacher gave helped Sasha not only learn English but also made her feel seen. In a large school with many other students who probably also needed the support in learning English, Sasha stated she felt grateful to have a teacher who recognized the time and effort she was putting in to learn the language.

Yet, the support that these two women got in high school did not necessarily "transfer" to college. Once these women enrolled in college, they began to shift their focus from the teacher to getting help from other people. This shift is not to say that they did not have any good relationships with their professors, but they understood that college life required them to access other resources to be successful. One such resource that many of them mentioned was a peer group. Cassandra and Wing-Yu, for example, often relied on their peers to study and discuss their plans. In addition, Cassandra would seek out places (like the library, additional office hours, etc.) and opportunities to find people who had the same goals as she did—to learn math. Wing-Yu was able to find friends in her classes and dorm, but Cassandra had a more difficult time in finding a peer group. Not living on campus and being new to STEM, she stated that she had to be innovative in the ways she would find people to work with.

According to Cassandra, the men in her classes were not always as receptive to wanting to work in a group or go study, stating that "men may have more reservations" (Interview 3). As a woman, however, Cassandra said that because she knew what it felt like to be in a classroom with men who were not always receptive to working with women, she would purposefully reach out to other women in the class.

> Especially if it's like another woman that has questions in my course, I will always go out of my way to support them. Or like if I don't know the answers, and we can find it on YouTube, or…I'll go with you to tutoring or whatever. Like, I'll try to support you in any way. Just because I know what it feels like to be isolated in a course or like, not feel like you are wanted…to not feel like you can do it. But like, I'm gonna always support another woman in STEM. (Cassandra, Interview 3)

Reaching out to women in her courses has helped her create peer and study groups for her mathematics courses. Over time, she stated that the men started to notice and would ask to join. In some cases, having men join the group was "challenging" as some men would try and "use the group for notes and stuff" (Interview 3), but as the group continued to work together and their interests and motivations started to align, Cassandra stated that she now has a good group, consisting of both men and women, who she studies with.

Conversely, Sasha and Skylar stated that although they see the benefit of having a study group, they more often work alone, each of them having stated that they did not really have a core group of friends in college. Skylar admits that she "does not have much, many friends—English, American friends" (Interview 3). She does socialize and speak to others in her class, but still separates herself from acculturating into the American way of life. She attributes her success to her "foundation" (Interview 3) before coming to the United States.

Like Skylar, Sasha also stated that she struggled with making friends in school: "I'm focused. I mean, I don't need to have friends, but it's always nice. I actually think that people do need to have friends in some capacity because the relationships you have with your parents is different" (Sasha, Interview 1). Although Sasha stated that she would like to have a group to study with, she finds it difficult to find a good group given that she commutes to school and is on campus only when she needs to be. She therefore must rely on herself to ensure she gets the work done and earn the high grades she wants.

Relationship Between Mathematics Success and the Pursuit of a STEM Degree

As shown in the previous section, many of the ways in which these women were able to pursue a STEM degree often started because of the actions taken by themselves, their families and peers, or help from a teacher. But the path to getting a STEM degree was and is not an easy one. For three out of the four women, mathematics is not the goal—earning a STEM degree is.[273] Sasha, Wing-Yu, and Cassandra all found value in their mathematics courses because the success they had in those courses determined whether they could obtain their STEM degree. Mathematics, as one of the core requirements for their degrees in the fields of engineering and technology, is perceived as being a necessity. While Sasha embraced her mathematics courses because she still has the love and passion for mathematics, Cassandra and Wing-Yu had mixed feelings of mathematics, as it often brought anxiety to their lives.

In some ways, the ways in which these women spoke about their degree did not relate to their passion or interest, but because they feel that obtaining a STEM degree is the "safer" or "faster" route to financial success. For Cassandra, earning a STEM degree "carries more weight" (Interview 2) because of the way people think about STEM. For instance, speaking to those who are already in the field of environmental science or engineering, most of the feedback Cassandra receives primarily focuses on her continuing on the engineering route because "people [future employers] will look at me differently if I get this degree" (Interview 2). In addition, she has

[273] Recall that Skylar is the only woman in this study who is pursuing a math degree (in addition to her technology degree). The other women are pursuing degrees that need mathematics but is not a math degree.

heard that those who have a more "technical" background (versus "just an engineering degree" [Interview 2]), are offered a higher salary. The financial security that comes with getting a STEM degree is part of the motivation for Cassandra to continue down a path that she is not really interested in.

In this way, earning a STEM degree is considered a "safer" route "especially when you're like, a first-generation college student" (Cassandra, Interview 1). Wing-Yu expressed similar concerns about her degree, stating that was "settling" with a CS degree because it is one of the faster routes she can take to moving toward the financial security she wants. Sasha and Skylar also stated that getting a STEM degree, specifically in technology, opens more opportunities for jobs in their future. In some cases, choosing to pursue a STEM degree is more of a calculated decision rather than just following one's passion:

> So, I just finished my third year in college. … And in terms of where I'm at with this experience, I'm basically at the fork in the road, where if I want to do something that I really want to do versus something that I know will be safe. So, I've just been going back and forth…if it's worth it to…I don't know. … I guess pursue what my heart wants versus what I think is like job security. (Cassandra, Interview 2)

Cassandra is currently in that struggle—not having decided what she wants to do and instead have been going through the motions the past year, moving from one mathematics course to the next without thinking about whether taking those courses would benefit her or help her obtain her goal.[274] Now that she has forced herself to think about the type of degree she wants, Cassandra stated that she would ultimately like to get a "combination of some kind" (Interview

[274] Interestingly, Cassandra stated that one of the reasons she agreed to participate in this study was because she wanted to talk through her thoughts about her degree, thinking it would help her choose a path that is right for her—a time for reflection.

3) between an environmental science degree and engineering/mathematics. As a person who is concerned about the betterment of society, Cassandra stated, “STEM is like doing research—in labs doing hands on stuff. And it’s like, I want to do that. I feel like that is more conducive to change” (Interview 3).

Concluding Thoughts

Looking across the experiences these women have had in mathematics and STEM, it became clear to me that although the goal is to always “answer” the questions you have initially at the start of a study, sometimes the best answers are questions. In this chapter, I have tried to outline all the ways in which these women touched upon the ideas surrounding each research question, starting with how they perceive mathematics success and how it differs from other forms of success.

I then attempted to learn more about their experiences within STEM and the institutional cultural norms that have played a role in their mathematics success. While some of their responses were not surprising when discussing their potential barriers for their success, it was much more difficult to identify the *contributions* to their success. Although they were able to overcome some barriers, my intent was to learn more about the ways in which they have been supported in their path to mathematics success. In talking about their successes, the women often referred to the barriers first to define what their success looked like and what contributed to that success.

This idea of binaries or opposites extended to the ways they spoke about language. For each woman in this study, language is an important quality and is often a way they identify with themselves and others. Knowing another language was seen as a benefit in most cases, but the women did question the use of language in schools and in mathematics classrooms. In talking about their experiences as students whose first language is not English, they were able to highlight some of the ways in which the "language barrier" caused conflict in their learning but also provided opportunities for them to create bonds with others, such as family, peer groups, and other members in the school.

In this chapter, my intention was to highlight not only some of the struggles and barriers these women have faced in their pursuit of a STEM degree but also the ways in which they have navigated some of these barriers to get to where they are now. As previously noted, all four women are still on their path to pursuing a STEM degree but, in some cases, demonstrated vulnerability in choosing to stay on the STEM path.

CHAPTER 10

DISCUSSION

In Chapter 5 through Chapter 9, I outlined the ways in which the four women of this study have made sense about their own mathematics success and what they believe have contributed to their mathematics and overall success. To understand their perceptions of success, I was also brought along a journey of them trying to make sense of their experiences and how they have continued to persist despite the obstacles they have faced. As these women continue to work toward their STEM degree, it was not always easy for them to comprehend their beliefs and feelings about particular issues or topics.

In this chapter, I provide a summary of the study by revisiting each of the research questions that guided this study. The summary is then followed by a general discussion about the types of experiences they faced within the STEM culture and questions about how we, as part of the education community, can address some of the concerns brought up by these women (as recommendations for future research). I conclude this chapter by discussing the limitations of this study and an update of all four women since their last interview.

A Summary of the Study

I admit that when I began this research, I had high hopes of "answering" all my research questions because that is "what researchers do" —they ask questions and they attempt to determine the answers. It's a similar idea in mathematics; you are presented with a problem and the goal is to find the solution. But just like most of my professors warned me as I started this journey, I ended with more questions than answers. I do not think this research was a "failure," but rather in this journey I was able to critically think about the intersection of language, race, culture, mathematics, and success and how a seemingly "monolithic" group[275] of students was able to surpass many of the obstacles that stood in their way of obtaining their success. Before discussing how my thoughts have changed as a result of this study, I present again the research questions that guided this study:

1. What are undergraduate women whose first language is not English perceptions of mathematics success?
    a. What qualities distinguish mathematics success from other forms of success?
2. What STEM institutional cultural norms have played a role in how they define mathematics success in STEM?
3. What role, if any, does language play in determining how they perceive their success in mathematics?
    a. How do they navigate their gender, race, and language in college, and how does the intersection of language influence their perceptions of mathematics success?
4. How has this perception of mathematics success affected their decision to pursue a STEM degree?
    a. What factors do these women attribute to their success in college?

The following sections that follow are my attempt to "answer" these questions.

The Changing and Fluid Nature of Mathematics Success

As these women continued to talk about mathematics success, I began to realize that their definitions of what mathematics success is and what it looks like differed depending on the context of the situation. Mathematics success is multifaceted and complicated and often

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[275] I use this term loosely because these women are clearly very different from one another. They do, however, share one trait (i.e., their first language is not English) and that trait is often used to group students as if they are "all the same." I hope to trouble this idea further later in the chapter.

depended upon their experiences with mathematics or what they perceived to be as failure. Like Derrida's (2007) ideas about structures and centers, the relationship between text and meaning is not always static and continually evolves. Yet, within education, it is clear what "mathematics success" is supposed to look like—high scores that are often based on standardized tests and grades/GPA. This notion was not lost on the women in this study, as all of them first described their success based on the grades they were able to earn in their courses. But as the women and I began to discuss more deeply about what they envisioned their future lives to be and how their "success" in school could help them attain that, it became clear that in some ways, they were rejecting the idea that *their* success was based on grades alone.

One source of conflict was in the ways they defined mathematics and how mathematics, is a discipline that holds great "power,"[276] contributed to what mathematics success looked like. Mathematics, as an entity, was not something that they were able to clearly define. When thinking about my own definition of mathematics, I too struggle with how I would describe mathematics to another person. Is mathematics real or is it simply a construction of the human mind? How does someone define mathematics?[277] Is it necessary to define mathematics to define or know what mathematics success looks like?

In some cases, the women of this study felt they needed to define mathematics to speak about what it means to be successful in it. But in trying to explain what mathematics is, they had trouble connecting the definition to how people attribute "success" to it. In response, many of them decided that they did not necessarily need to know what math is to define mathematics

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[276] The term "power" in this sense is not to say that mathematics itself holds any power, but the amount of power they attributed to mathematics was clear in how they perceived their goals as being most dependent upon their success in mathematics (this argument is discussed in more detail later in the chapter).

[277] I know this has been a topic of discussion for philosophers for many decades and I do not attempt to define mathematics here. I simply ask these questions to highlight the complexity of even just defining something that often feels familiar.

success and instead, focused their efforts on creating a map that could lead one to be successful in mathematics (e.g., see concept maps made by Skylar, Sasha, and Cassandra).

Specific qualities of mathematics success (such as grades, accolades, and their ability to communicate their knowledge) were discussed in our conversations and presented in many of the concept maps. Yet, when speaking about each of these qualities, the women of this study often started with defining mathematics *failure,* as if success and failure are clear binaries without much "wiggle" room between them. Rather than starting with defining qualities of mathematics success, they began by first stating when they knew they had failed. The meaning of success, in some ways, is dependent upon the meaning of failure.[278] Most definitions of mathematics failure were dependent upon grades, as they all stated that earning anything below a B meant they failed the class.[279] Given that all these women are current college students, it was not a surprise to hear that grades were a big indicator of their mathematics success as they are often dependent upon grades for financial aid and scholarships. This idea that one can define success by first defining failure begs the question of whether deficit thinking has played a role in how each of these women have come to define mathematics success. Why is mathematic success dependent upon failure? Is there a way to define mathematics success without first thinking about what it means to fail at it? Are these ideas placed implicitly on purpose when students are subjected to relying on test scores to determine their success in school? In what other ways could educators show students that they are and can be successful in mathematics?

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[278] The dependency of defining mathematics success on mathematics failure reminds me of how Derrida's (2007) term "différance" because the meaning that was generated of mathematics success was based on its difference from mathematics failure.

[279] Recall that for some women in this study, their definition of failure changed when enrolled in college. Wing-Yu and Cassandra, for instance, began to accept Bs as their course grades as they struggled in their mathematics courses in college. On the other hand, Skylar and Sasha still maintained that earning a grade less than an A was a failure.

When they began to talk about what mathematics success looked like beyond the walls of the classroom, however, their ways of talking about mathematics and what success meant to them began to change. Sasha perceived mathematics as inherently a part of her IT journey, as she stated multiple times that knowing mathematics would help her in the field. As mathematics success in the field cannot be dependent upon grades because grades would no longer be available as one form of assessment, Sasha was forced to think about other indicators of success. Practices of mathematics (such as the process standards of problem solving, reasoning, connecting, communicating, and representing) was another avenue that these women took to describe the importance of mathematics. The content of mathematics itself, for example, is and should not be the goal of why a person learns mathematics (Li & Schoenfeld, 2019; National Council of Teachers of Mathematics, 2000; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The ways in which mathematics can help prepare a person in the future is another benefit of learning mathematics.

For example, Sasha stated that if she oversaw a website for a company to sell a product, mathematics success would mean that every aspect of that website (such as purchasing, shipment, etc.) would perform in the way it was intended to (as mathematics is needed to write the program or code). Having to write programs, for instance, gave "no room for error" (Sasha, Interview 3) and rather than use grades as an indicator of success, Sasha began to use the concept of perfection, as that was the only way a program would execute the way it was intended. Although grades were the way in which Sasha perceived success in school, the idea of perfection became a new way to determines success.[280] This "new definition" of the word implies that its

[280] Recall that Skylar also stated that she would know if she truly understood the content if she was able to understand 100%. Reaching the 100% was another form of perfection as success that was discussed during her interview.

meaning is never fixed and can change based on their perceptions and experiences. The fluid and changing nature of how mathematics success was defined opens new possibilities of what success can mean in different contexts.

The Role of Mathematics Within STEM

Although it is not always clear within the literature what role mathematics plays within STEM (Li & Schoenfeld, 2019; Martín-Páez et al., 2019; Maass et al., 2019), for these women, mathematics is an important hurdle they must pass to be successful in their completion of a STEM degree. Each of these women, except for Cassandra, started her STEM journey in high school, a time when she felt confident in mathematics and had the motivation to continue to learn mathematics. Thus, it was not surprising to hear that these women chose to pursue a STEM degree given that they have been proficient in mathematics and interested in STEM prior to going to college.

Continuing to pursue a STEM degree in college, however, has been more difficult. Despite their successes in their elementary through high school years, Sasha, Skylar, and Wing-Yu all experienced difficulties in their mathematics courses and in some cases, began to question the motivation to continue a STEM degree. Wing-Yu often voiced her concerns about having to take mathematics courses but continued to take the courses she needs despite the growing anxiety and pain she had while being in her mathematics courses. Mathematics, for her, is a necessary step she needs to take to earn a STEM degree and is a temporary burden.

Sasha and Skylar, who still have a love and passion for mathematics, also view their mathematics courses as necessary but not just for a completion of a degree. Although they stated that mathematics is a requirement in their respective programs, they also viewed mathematics as a tool that can be used in their future careers. Mathematics, although necessary in the completion of their degree, is also considered necessary in their development of their careers; suggesting that knowing mathematics and how to apply it is essential for their careers and their happiness in the future.

Cassandra, the only woman of this study who did not initially pursue a STEM degree, stated multiple times about the "power" of mathematics and the power a person has knowing mathematics. While Cassandra believed that mathematics is necessary in her path to earn a STEM degree and in her future career (similar to Sasha and Skylar), she also believed in mathematics as being a tool for social and political empowerment (Ernest, 2002). Throughout our conversations, she frequently stated that a person with a math degree would be a person who could be heard. Simply having a mathematics degree meant that others in the community would take her more seriously.

Although just a necessary component in their STEM degree plans, mathematics clearly plays a role in how they think about their own success in STEM and in their future. So, even though some institutions may not acknowledge or make explicit the role of mathematics within STEM (Martín-Páez et al., 2019), the ways in which the women of this study spoke about mathematics on their journey suggests that mathematics should and does play a bigger role in STEM programs.

Cultural Norms of STEM

When asked to define mathematics success, many of the women in this study often described the obstacles they had to overcome to get to where they are now. In many instances, they drew from their experiences in school and the relationships they had as starting points to describe how they became interested in STEM and how they have had to navigate the STEM world.

In their experiences in the public education system in the United States, institutional norms such as placement exams and whether people “gatekept” information were often the focus of determining whether these women felt they belonged in STEM or the mathematics classroom. For example, Wing-Yu’s denial into the gifted program could have potentially limited her opportunities to access higher level mathematics and science courses in her school. Without the help of her teacher, she might not have been challenged in the classroom given that her placement was with the general population.

Both Cassandra and Sasha questioned whether the school they attended could have provided more information about STEM, financial aid, and college life to students of color. Cassandra never believed that she could be a STEM major while in high school because no one talked to her about the possibility. She also recognized that there were many other women in school who lacked information about the options they could have after high school and thus, helped establish a HoPe chapter to raise awareness and to spread information about colleges to more students at the school.

Sasha, although she knew she wanted to go to college to get a degree in engineering, never felt she had the support of the school to help her navigate the path to accomplish her goal. Some of these feelings not only stemmed from her experiences as being an ESOL student and the lack of preparation on the teacher to help her students but also from thinking that the school would withhold information from her and other students; questioning whether the school was truly a STEM school when they did not offer information to students who may not know or understand the process of getting into a college. She does not recall, for instance, the school having conversations with her about going to college or how to prepare to go to college.

Rather than accept what they were told in school, both Cassandra and Sasha would purposefully seek out the information they needed to accomplish their goals. They were aware that they were not entirely privy to knowing about or getting access to certain types of information that they needed[281] and would often rely on teachers they respected or felt close to to get the support they needed.

These same issues of placement exams and people within STEM gatekeeping information continued in college for all the women. Both Skylar and Wing-Yu experienced having to retake mathematics courses due to errors in transferring credits or misinformation about their past coursework.[282] Sasha stated she continues to rely on herself to learn about the resources the school can provide, such as tutoring and clubs. For instance, when asked why she never joined the women in technology club on campus, Sasha stated that she did not know the club existed. Cassandra, being the only woman in this study who was not initially interested in STEM when she first enrolled in college, spoke extensively about the "chilly climate" (Parson, 2016) she experienced as a woman of color in STEM. The way Cassandra felt she was treated and the lengths she has had to go to be successful have started to become draining and has made her question whether the move to STEM was the right choice for her.

In addition to these obstacles, conversations often centered on the competitive nature of STEM and how grades, although a marker of success, were also a source of anxiety and confusion. Cassandra, specifically, stated that she saw a drastic difference in her grade when she

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[281] This reminded me of Bourdieu's theory (Devine, 2008) about cultural and social capitals and Yosso's (2005) critique about whose capitals are valued (recall her alternative concept of "community cultural wealth"). Because both Sasha and Cassandra did not feel as though they had direct access to information they needed about STEM and college, they used their own cultural capital to maneuver and resist the discourses that suggested they did not belong.

[282] Recall that Medhanie and colleagues (2012) found that appropriate placement in mathematics courses in college is key to their success as placement affects the types of mathematics courses students have access to. Their study, however, focused on students being placed "too high" but in both of these cases, they were not placed high enough.

made the switch to STEM. She questioned whether it was because she was not as capable as her peers or whether the grading system her professors were using were different. Wing-Yu and Sasha also stated that grades were a source of anxiety for them. Although both women thought of themselves as being capable of doing well in mathematics, the grades did not always show or represent their capabilities. Of the four women, Skylar had the most positive experience with grades, but also touched on grades were not always accurate.

All four women of this study also spoke about the competitive nature of STEM and how important it was to succeed by earning the highest grades possible. Rather than cave, however, all the women in the study described how they were able to surpass these obstacles by putting in the hard work and not giving up. Some of the strategies they have used include thinking about the temporary nature of their situation. They knew that while it was hard to be in their current situation, the time that they spent in a mathematics class was temporary. Skylar and Wing-Yu would commit to their work ethic because they believed that by putting the time in "now" meant that it would make their lives easier in the future.

Language as an Identity Marker

When speaking about language, each woman described and discussed the value of language in her life. Language was not just used to communicate with their family but was also considered as one way to represent their cultures and identities. Wing-Yu stated that language isn't simply just knowing the textbook definition of words, as language is another way of understanding one's culture. Wing-Yu stated she had to learn the "hard way" when she engaged in conversations with other people, who also speak English. Although Wing-Yu is bilingual, knowing English was not enough as there are different forms or types of English, and it is necessary to understand the history behind the language. For example, when Wing-Yu heard the

"N word" (Interview 1) for the first time in middle school, she asked her peers what the work meant. Rather than being told what the word meant, her friends told her she was not allowed to say the word because she is "not Black" (Interview 1). As someone who may know English but does not relate or know the historical roots of the language, Wing-Yu stated that she often struggled with when it was okay to ask questions and could not figure out when it was appropriate. This experience Wing-Yu shared highlights the complexity of language and how its use is just as important as what words are being used. Each woman spoke of instances where she had to continually learn and adapt to their surroundings in which they engaged and found themselves in.

The way in which each of these women engaged with language varied across contexts. As each of these women speak another language, they each spoke of times when it was "appropriate" to use their native language versus English. In most cases, the women of this study felt it was not appropriate to speak in the L1, as it was never considered an asset or others in society would misidentify them. Sasha, for example, had complications with language as she did not feel that language necessarily defined her culture. Language, although one form of representation of culture, did not always define a group of people and was disappointed to learn that people in society tend to categorize others based on language. Hispanics, for instance, share the language Spanish, but do not necessarily share anything else: "not food, not music, not culture" (Sasha, Interview 2). Although Sasha self-identifies as Hispanic, she stated she is also Black—the culture in which she was raised (as a Dominican) has similar roots/history to Black culture and thus she is "more Black" (Interview 2) than anything else. To Sasha, speaking Spanish should not be an identity marker or something people use to determine what group she belongs to—that choice is up to the individual. She stated that she has become so frustrated with other people trying to define or label her when they do not know or understand the history behind the language or culture of the group they are stereotyping.

Yet, language was often used to group these women in and out of school. Regarding learning mathematics as students whose first language is not English, both Skylar and Sasha spoke about their struggles and how their language was not necessarily valued in the classroom. Although mathematics was easy for them as young children, both began to struggle with mathematics once they had to learn it in another language (i.e., English). Skylar first experienced this struggle in the bridge program in Vietnam, where English was one of the primary objectives of the program. Although all her professors could speak Vietnamese, they insisted on speaking English to their students to prepare them before moving to another country. Although Skylar understood why they chose to do so, she did not feel she was getting the support she needed to do well in her courses.

Sasha too had to learn English at the same time as learning mathematics content, which started to affect Sasha's confidence in mathematics. Because her grades in her mathematics courses were dependent upon whether she understood English, Sasha spent most of her time outside of school trying to learn English as quickly as possible. These experiences of having to take a mathematics course with a teacher who did not speak Spanish made Sasha question why people consider mathematics as being a "universal language." If mathematics is just numbers and symbols, why couldn't she understand what her teacher was doing in the classroom?

Sasha also questioned why the teachers in her school did not know enough Spanish to teach the students. Although she understood that teachers could not possibly learn or know all the languages the students speak in one classroom, she did question why students were grouped in the first place by language alone. Being in a classroom with students who all did not speak

English, but spoke multiple other languages, was stressful and difficult for Sasha because she did not have any immediate resources in her classroom to learn. Rather than become frustrated about her situation however Sasha spent hours outside school hours to learn English so that she could exit out of the ESOL program as quickly as possible.

Deficit thinking has perhaps infiltrated into the way these women and their families think about their capabilities in mathematics and potential success in mathematics. Although there were ways in which these women tried to persist these thoughts about their own mathematics capabilities, there was evidence to suggest that they and their families have not been completely immune to these negative thoughts and beliefs. Cassandra's mother, for example, made the choice to only speak English to her when she was a child based on the idea that her daughter being placed in an ESOL program would somehow highlight the deficit or deficiencies of Cassandra's English skills as well as her capabilities to do well in school. Regardless of whether the message that Cassandra would be penalized for her "lack" of English skills was sent from school, deficit thinking has played a role in others' decisions. According to Cassandra, her mother focused on the idea that if her child did not know English, then she would be limited in the types of opportunities she would be given. In some sense, Cassandra's mother chose to reject a part of her own culture and self so that her child would not be affected in school. The fear that language could be viewed as a reason why Cassandra would be segregated from the rest of her peers and from opportunities, is a product of deficit thinking that has permeated beyond school walls.

Language is not just a way to identify or group people but is a potential weapon to ensure that those who do not belong do not engage in spaces that was not initially created for them. Although none of these women said that schools did outright say that schools the message was still clear: they had to learn English to be successful in school. The balance, however, of maintaining both languages proved to be difficult for all women, as their need and desire to do well would sometimes outweigh maintaining their language. The methods schools employed in schools to “help” children learn English in schools often forced students to reject using their L1 and assimilate into the second language (L2) culture. (Cummins, 1981).

Motivators of Success

Although the women discussed how they were able to navigate the culture of STEM by incorporating strategies such as working in study groups and relying on their own work ethic (such as putting the time in to complete assignments and encouraging themselves to focus), they often described reasons as to why they have been successful to where they could enter the world of STEM and continue to stay in it.

One of the primary reasons that these women were able to enter the world of STEM was through the actions of their parents or the structure of their family. Although not intentional, the participants of this study are either the eldest of their families (Sasha, Skylar, and Cassandra) or the only child (Wing-Yu). The responsibility and weight of being the oldest or only child in the family was prevalent in how they spoke about the actions their parents took and how it affected their future goals. In addition, being the first in the family (for all of them) to go to college and graduate was a big responsibility to take on. Being a role model for their younger siblings and cousins played an important role (whether perceived positive or negative) in the ways that the women negotiated their success in STEM.

Family roles however were not the only reasons why these women continue to stay in STEM. Financial security and trying to maintain a balance between what they want versus what they need were also motivators for them to continue. As most of the women came from families who struggled financially, they did not want to have the same future for themselves.

Their motivation has continued also because they have learned to rely on other support systems such as faculty and peer groups. Engaging with other women outside the classroom and having a STEM peer group of women (Espinosa, 2011) has helped both Cassandra and Wing-Yu to work through their struggles in their mathematics courses.

Unlike the other three women, Cassandra often spoke about her desires to make changes in the world for people of color. In addition, she recognized the significance of her participation in college, stating that—

> it wasn't until like the 60s or 70s, that women were allowed to go to college. And even then, most of the people that were going… the women were going were like white women. And then black women weren't able to go until a little bit later on. And then, just the numbers of women of color in higher education are really low. And so, I guess I want to be a part of that statistic of Latinas who have degrees. So, that's what like motivating me to stay in school and also to be a feminist. And I guess through whatever I do, like, even as simple as just connecting with other women of color and in college and uplifting them and encouraging them to stay in school. (Cassandra, Interview 1)

Knowing that she has the opportunity to be in college as a woman of color has given Cassandra the motivation to want to continue but also to help others in a similar situation.

Recommendations for Future Research

In the previous section, I provided a summary of the ways these women encountered issues in school and how these encounters have made them think more deeply about themselves and society. As they were processing their thoughts and perceptions of what success looks like, it allowed me to also reflect on my own ideas. In this section, I present some of the questions and concerns I had when doing this research. I hope that by describing some of the struggles I had will help others think more deeply about these issues.

Troubling the Word "Success"

The goal of this study was to understand how these women perceived mathematics success. I quicky learned however that how these women define success is just one interpretation of the word. Just as words depend on the meanings of other words (Derrida, 2007; St. Pierre, 2000), the way in which these women have come to define success for themselves have been dependent upon their experiences and conceptualizations of what mathematics is. Yet, feelings of whether these women felt capable in mathematics or whether they could consider themselves a "math person," were frequently discussed. Despite earning good grades or receiving accolades, many of the women continually felt they had to "prove" they are capable in doing mathematics. It is interesting that this idea of "perfection" was often made when thinking about mathematics. It is not unusual to see why—in the process of doing mathematics, perfection (i.e., obtaining the correct answer) is often the desired result and an indication of success.

In challenging this notion of perfection does raise some questions about how students are assessed and what continues to be perceived as being valued in a classroom. To talk about success, these women often spoke of failure first. They were not always sure what mathematics success looked like, but they were firm in their beliefs about what failure in math looks like. Are these two binary things or should it be considered more of a spectrum? Is the only way to define success is knowing what failure looks like? Have their experiences in schools often focused on failures rather than success or ways to be successful?

In addition, the ways in which students and their families perceive success is important to consider. In Wing-Yu's case, she and her family didn't completely understand the potential impact of being placed into the gifted program. She is not even sure if her parents knew about the gifted program as they have never had conversations about it. For Wing-Yu, the greatest impact was that she was not able to engage with her peers in an advanced academic setting, which made her start to question her capabilities in mathematics. She ultimately rejected the idea that she was not capable, but it does make one wonder how other students in similar situations would take the outcomes of these tests and reflect it back on themselves. In addition, many of their family members (across all women) insisted that they earn high grades (namely, As and Bs). Just like the women in this study, family members relied on grades to be indicators of their child's success in school.

Success in higher education and the expectations of grades (Parson, 2018) often conflicted with the expectations they set out for themselves when they first entered higher education. Within STEM, for example, maintaining a high grade became more difficult, especially with Wing-Yu and Cassandra. Although they all wanted to maintain a good GPA, being able to do that within STEM (Parson, 2018) created stress and anxiety. While they continued to stress the importance of maintaining a good GPA, Cassandra, for instance, began to question whether grades within STEM were held to the same standards across courses and schools. Earning a B within STEM became the new standard for Cassandra and Wing-Yu even though they understood that it may not be high enough to maintain their scholarships.

All the conversations about grades made me question how to determine whether someone is "capable of doing mathematics." While the women often tried to work against the stereotype that only certain people can do mathematics, Cassandra noticed behaviors within her mathematics classrooms that appeared to support the idea that men were more capable than women. The instances she described were not just students within the classroom, but also the lack of action of her professors. For example, when the men in her class interrupted the women as they were talking, Cassandra wondered why the professor (who were mostly men in her experiences) did not intervene to ensure that the women in the classroom had the opportunity to speak without interruption. These types of behaviors could be reasons as to why "women are more represented in less Math-intensive STEM majors" (Jiang, 2021, p. 14), as they continue to experience the "chilly climate" (Parsons, 2016) in their mathematics classes. While Cassandra was the most vocal about this experience, Wing-Yu and Sasha did state that they were not always comfortable working with men in their classrooms.

Future research could explore the types of discourses that occur within mathematics classrooms to learn more about how these discourses may potentially impact the way in which women perceive their own mathematics capabilities. Because mathematics continues to be the gatekeeper of whether a person completes a STEM degree, "how might mathematics educators ensure that gatekeeping mathematics becomes an inclusive instrument for empowerment rather than an exclusive instrument for stratification?" (Stinson, 2004, p. 9). Is there a capacity to "do mathematics"? Further research could explore the ways in which students think about mathematics and the "capacity" to do mathematics. I encourage readers to think critically about the issues that were raised within these interviews to further question how the education community pushes a particular idea of what mathematics success is, what it should look like, and who has access to it.

The "In-Between" Spaces

In speaking with these women about their educational experiences, many of them often spoke about being in these "in-between spaces." Most conversations around this idea centered on the ways in which they tried to "fit into" particular categories. Sasha often spoke about the struggle she had "fitting in" and her concern of losing a part of herself. For example, when creating her identity map, she would often discuss the "pull" she felt from both her life in the United States and her life in the Dominican Republic. Neither world could provide all that she needs and wants and so she often discussed the personal struggles she has had within herself. As she continues to live in the United States, she has started to notice that she speaks English more regularly than Spanish. Although this may not seem significant to others, Sasha stated her concerns about her slow transition to becoming "more American" has made her feel in ways "less Dominican" (Sasha, Interview 1). While in her heart she feels she is both, she often stated that she felt she could not be both, as people in society (including her family) often want to place her into one category.

This internal struggle seemed to permeate across all the women in this study who have found themselves engaging and assimilating in the American culture while also trying to maintain their family culture.[283] In some cases, having to speak English all the time has impacted the way in which they and their families view their participation in their culture. But learning English was also a necessity for all these women if they wanted to achieve success in schools. While they understood the value of knowing English as their L2 language, many of them raised concerns about why there were limited resources available in their L1 language. According to Walqui (2006), "at the global level, English Language Learners' perceptions of how the majority

[283] Recall that Skylar was the exception because she consciously chose not to engage in any American activities for her fear of becoming more American and less Vietnamese.

society accepts or rejects the culture and language they bring to school are extremely important for their eventual success in school" (p. 160). Although people in the school system never explicitly stated their culture and languages was not valued, Cassandra, Sasha, and Wing-Yu stated they didn't recall a time of when their schools show appreciation of other cultures outside of "required" times they were supposed to.[284] Traces of deficit thinking are still present in the way in which language is viewed in schools by teachers, students, and administration. Not having access to resources in their L1 language is just one example. Other ways in which language is viewed as an "issue" or "problem" is how students were grouped based on language. While it may make sense to teachers and administrators to group ELLs together to provide the necessary support students need (such as Sasha's experience being in an ESOL mathematics classroom), it does raise questions about whether students view it as being necessary. The simple act of separating these students and placing them into a classroom of their own also sends a message—whether it is intentional or not. Schools may not say outright that other languages are not welcomed in schools, but the way in which people in society (and schools) emphasize the importance of knowing English may implicitly send a message that other cultures and languages are not valued.

Future research could explore the ways of how students identify with their own cultural group and the types of engagements they participate in while being in school. As schools are often the place where students learn English and the content they need for success, it is important to know how schools provide spaces for students to feel they belong.[285] Do students feel it is

[284] Cassandra mentioned that her school did do events like "heritage night" or would celebrate "Hispanic month" but she did not take it to mean that the school valued knowing about or learning about other cultures.

[285] I am not saying that some schools do not do this already. Yet, the experiences these women have shared with me does make me wonder why they continued to feel that they didn't necessarily belong. Even if a school is providing many different activities/events and opportunities for students of color, there could be a potential disconnect because these women still felt that their culture was not being valued in schools.

necessary to be grouped with other ELLs? Do students feel as though teachers, administrators, and other students in the building value their differences or are their differences just another way to compare them against the norm?

To bring this idea further and into the mathematics classroom, it also raised questions about whether Sasha, who was “number one in mathematics” in her home country, possibly missed an opportunity somewhere because she was perceived as part of the group of students who don’t know English. As a student who excelled in mathematics before, was there anything in place that evaluated her mathematics ability that was not dependent upon her English language skills? Sasha does not recall taking any exams in her native language, Spanish, but remembers being placed with other ESOL students in a mathematics classroom. Was this placement based primarily on her language skills or were there other things in place that were used to determine that she needed to be in ESOL courses? The answer to this question is not simple and it is hard to know given that this idea has only been discussed in conversations with Sasha, but it does raise questions about the current systems in place and how students from other countries are perceived by those in the educational system.

Pereira and Gentry (2013) have raised similar concerns about the underrepresentation of ELLs in gifted programs, for example. This noted concern is not to say Sasha should have been placed into the gifted program, but because her perceptions of her mathematics success were so high, it does make one wonder what attempts were made by the school to determine how Sasha was placed when she first enrolled in school in the United States. The placement in this mathematics course may have limited her opportunity to excel in mathematics (Abedi & Herman, 2010). Future research could investigate the ways students are being placed in mathematics classrooms and the criteria used for that placement.

Land of Opportunity?

For the two women who came to the United States later in their lives, Skylar and Sasha, they often described the United States as a place for "opportunities" (Sasha, Interview 1). For both women, being able to earn a STEM degree in the United Sates meant they would gain access to a career that was not available to them in their home countries. In addition, the United States is viewed as a "perfect" place:

> I think over there [Dominican Republic] … the United States is a big deal. Oh, my God, you went to the United States, you know? They don't—when people look at United States from the outside…it's beautiful, like United States is perfect. (Sasha, Interview 2)

Yet, when Sasha began to describe her experiences trying to earn her STEM degree, she often spoke about the obstacles she would encounter from being a Hispanic woman in the United States. Even though Sasha is appreciative and grateful for the opportunities being in the United States have provided for her, she has questioned what aspects of herself she has had to sacrifice to achieve the success she wants. In addition—

> You know…being Hispanic…racism is still here…We're in 2023. But that doesn't mean that it's gone. It may be better than before, but…it happens more than it should. I don't think it's ever gonna be fixed in America—in the United States. They take race to another level. (Sasha, Interview 2)

Issues of race, language, and a sense of belonging has influenced the way Sasha has had to think about her progress and how she must navigate to reach her goal.

On the other hand, Sasha knows that the discourses around the cultural expectations of Hispanic women, or Latinas, is strong in persuading them to not go to college. Although Sasha's family encouraged her to go to college, she is aware of the "traditional cultural expectations of women becoming mothers and wives rather than pursuing a college education" (Leyva, 2016, p. 100). Wing-Yu and Cassandra also voiced concerns about this group as they have also heard from close friends of their struggles with family to pursue a degree.

Wing-Yu also stated similar concerns when she described herself as an Asian American. She recognized that although she speaks Cantonese and does participate in some part of the Chinese culture with her family, she knows that she is not Chinese. Having grown up in the United States, she stated that she has been exposed to a variety of people and has loved learning about other cultures and experiences. Society however does not always see her as an American because she looks Asian. Wing-Yu raised concerns about race and questioned whether her perceptions of identifying herself as American is "enough" in the United States as people will continue to treat her based on their own perceptions. She questioned whether the United States really does consider itself as "the melting pot" when people continue to group people into specific categories based on their perceptions and stereotypes. Wing-Yu stated, for instance, that although she is a part of the "model minority" (Tran & Birman, 2010) as Asians are normally seen based on their academic success, her experiences during the COVID era has shown that they are still seen as being different:

> Asians are seen as the model minority and they would look at every race, you know, and say, 'you should act like them.' But then literally not even that long ago they put a ban on immigrants from China and only recently they lifted it and said, 'ok, you can come in now.' It's frustrating. This country has this strength of having like so much diversity and I feel like they are not taking advantage of it. Because our country was built on diversity. And just seeing people like not accept it is very frustrating. It's like this country is accepting but only to an extent. (Wing-Yu, Interview 1)

How quickly people were to turn against Asians during the pandemic solidified the idea to Wing-Yu that Asians and Asian Americans are still "lesser than" than their White peers. So, although Wing-Yu identifies herself as being a part of both worlds, she questioned whether she was perceived that way by society.[286]

Skylar, being the only woman who described her experiences as being mostly positive in the United States, continues to perceive the United States as the land of opportunity for her. When comparing her experiences in Vietnam, the fact that she can go to college to earn a STEM degree as a woman and then have the possibility of getting a job in the field makes the United States as a place for opportunity.

These descriptions of how Sasha and Wing-Yu have come to experience their lives in the United States however still begs the question: what sacrifices would one have to make to achieve the success they work hard for and deserve? Should the United States be considered the land of opportunity when there are still discourses surrounding race, culture, and who is capable in doing mathematics that continue to work against those who try to accomplish goals such as earning a STEM degree?

These "outside" discourses are just some of the things that can influence whether a woman decides to pursue a STEM degree. Even when these women chose to ignore these discourses about women or race in their day-to-day lives as members of society in the United States, they still had to resist the discourses within STEM.[287] Because their mathematics success

[286] Sasha's and Wing-Yu's experiences about their struggles of identifying as American or Dominican/Chinese has affected their sense of belonging and whether they can identify as being a part of either cultural group (Cummins, 1981).

[287] In addition to "ignoring those voices," Cassandra stated that those within STEM should be more welcoming to those who are interested in exploring its possibilities. Cassandra, for example, never considered a STEM career in high school and did not enter the world of STEM until college. Specifically, she stated that colleges should provide opportunities for students who are interested in STEM to explore areas of STEM without it "being so risky, or feel

plays a large role in determining whether they would be successful in their pursuit of obtaining a STEM degree,[288] many of the women in this study had to find ways to be successful in their courses. Mathematics courses, in many ways, were considered gatekeeper courses for these women as they needed them to graduate with a STEM degree (Redmond-Sanogo et al., 2016).

The cultural and institutional norms within STEM have had an impact of how these women have experienced the world of STEM. Cassandra often spoke about the competitive nature of STEM (Parson, 2018) and how the "chilly climate" has made her start to question whether she belonged:

> It doesn't have to be like the squid game kind of elimination thing. (laughs)… Being in STEM is like being in squid games…because STEM is like one of those, especially like math, and like engineering. In order to unlock classes, you need to take the prerequisites or the co-requisites. So, it's like squid games because you get to Calc II…you're like, 'wait, shouldn't so and so be here?' And they were like, 'Oh, he didn't pass.' You know what I mean? And in order to get to these classes, you have to pass or do remotely well—not even just pass but you have to be willing to reassess, again. Is this something that I really want to do? And then if you do want to do it, then you keep on going, right? But then it's like, you know, are you going to make that effort for however many more semesters you need to do? Or if it's draining you… . If it's being like really taxing, then it's like…well, maybe this isn't the major for me. But anyway, it's kinda like the elimination squid game thing, because…who can make it really to the finish line? Who

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so detrimental to like your GPA, your transcript or whatever…and to explore that, because it should be more open to people" (Cassandra, Interview 3).

[288] In many ways, these women considered mathematics as a pre-requisite for their learning and STEM success (Li & Schoenfeld, 2019; Maass et al., 2019).

> has the stamina? Like, yes, STEM is hard. And it's not for everybody… . But there's people who…that are making it even if they're the second to last person in the round. (Cassandra, Interview 3)

The "microaggressions" (Sosnowski, 2002), such as how men have refused to work in groups with women or how the men in her mathematics classes treated women (and the lack of response from the professor), and the competitive nature of STEM often made Cassandra feel unwelcomed and unsupported (Ong, 2005). In addition, the confusion around grades and how she has felt about her own capabilities to do mathematics have made Cassandra start to question whether she should stay in STEM. Redmond-Sanogo and colleagues (2016) stated that those who are most likely to pursue a STEM degree and career are "those who are both proficient in mathematics and interested in STEM" (p. 379). But what does it mean when the culture of STEM persuades women and other marginalized groups that they do not belong?

Despite these experiences and the ways in which the culture of STEM have made Cassandra feel, she continues to push through because she still believes mathematics (and a STEM degree) can be used as a powerful tool for social empowerment (Ernest, 2002). In other words, she still sees value in having a STEM degree but also wants to empower others through her success. The question that remains though is why does Cassandra still hold this belief when all these forces continue to push her in the other direction? Is having a STEM degree really considered an asset in society? Does having a STEM degree provide more "power" or opportunities for those from the marginalized population in society? All four women believe that earning a STEM degree will help them reach the financial success they desire. In addition, Wing-Yu believes that a STEM degree (specifically a computer science degree) is the fastest path to her financial security. Cassandra, however, was the only one who considered the value of a STEM degree in changing the narrative of who can access it.

Limitations and Delimitations

A case study methodology was chosen because of the nature of the research problem and the strengths outweigh the limitations. The insights from this case study can play an important role in advancing the STEM field's understanding of success and how language-minoritized students learn to navigate the world of higher education, in general, and STEM programs, in particular. The examination of students' perceptions can perhaps improve the way in which beliefs about success are imposed onto students and inform policy. In designing this study, I had to make decisions about what to include and not include. I address some of these issues here.

Limitations

Many might argue that one major limitation of this study is generalizability.[289] The intent of the research however is not about generalizing the findings. Given that the primary criterion of selecting participants is to not have English as their first language, I expected students to come from a wide variety of cultural backgrounds, including racial, ethnic, socioeconomic status, and so on—each of which could contribute to their beliefs about their success.[290] The findings of this study therefore should not be generalized to all women whose first language is not English pursuing STEM degrees and who have been successful in undergraduate programs across the country.

[289] Although not necessary to state, given that I have conducted a case study methodology, I reiterate this as limitation because I want others to take caution of how to interpret these results. This study is not to generate or verify any findings, but rather to provide another perspective of how success can be perceived in STEM by those who have traditionally been marginalized.

[290] Chapter 4 highlights how different each of my participants are.

Additionally, this study is limited due to time as data collection was conducted during one summer (i.e., a few months); it does not discuss or provide any long-term descriptions. For instance, how do students stay motivated throughout their undergraduate education and obtain a STEM degree? Are they motivated to stay on a STEM-career path, or will they choose to switch paths? At what point is the "breaking point" for when students decide to leave STEM? Are there other notions of success that have not been explored? What "richness" do these students bring to the mathematics classroom (from prior experiences) and how do instructors "capture" that richness to help others to pursue STEM careers? These questions, along with many more, are still left unexplored. Given the nature of these questions, it would be ideal to conduct a longitudinal study to learn how these women perceive success as they work through their college journey.

Delimitations

Throughout this journey in conducting this study, I have had to make choices that affect the type of data I collected. One such decision was how participants were chosen. I understand that I am going against the conventional norm by not choosing a specific racial group and but rather I am using language as an identity marker. This choice was intentional because as someone who is considered "mixed," I have often found myself conflicted over choosing a box when given a demographic survey. I was also never happy with choosing "Mixed Race" or choosing multiple boxes.[291]

One could argue that I inadvertently did the same thing when choosing only women as participants. Although I do think that gender is more a societal norm that has created the illusion

[291] To elaborate further, choosing "mixed race" is unsettling because I was never asked which races, in particular, are mixed. Choosing more than one box was also unsettling because I never really knew which race was "valued more" or how the researcher would use the data to categorize me.

of the male/female binary (Butler, 2002), women historically have been perceived differently from men within the educational setting, especially in STEM. As this perception has started to shift in recent years (with more women in college and pursing STEM degrees), I wished to understand more about why this shift is occurring.

Other delimitations include the way in which I collected and analyzed the data. Using concept maps, for instance, may be a little controversial because concept mapping has typically been used to gauge student understanding of concepts. The concept maps alone, however, were not the focus of the interviews. The combination of the interviews and concept maps together provided information that may not have otherwise come to light. For example, I, as the researcher of this study, was another tool that was used in the collection of data. Throughout the interview process, I engaged in conversations with these women that certainly altered my own thinking and understanding of their experiences, but also affected theirs. While the concept maps were drawn by the women themselves, its creation is a culmination of all the ideas discussed in the interviews as I provided the stimulus of how they have come to understand their meaning of success. Thus, concept mapping, in conjunction with interviewing (Striepe, 2021), has the potential to help the researcher *and participant* gain a deeper understanding of participants' perspectives.

In addition to the way data was collected, some may argue that the theoretical framework for this study may not be epistemologically sound. The integration of postmodernism, feminism, and intersectionality, however, provided this study with a way to highlight the complex and multidimensional realities of each of these women. The way that each of these women have come to understand their own success is based on the reality, knowledge, and meaning that have been constructed through the social interactions they have had within and outside of education.

Intersectionality allowed me to understand that these women's positions and experiences are constantly changing over time and place and has influenced the ways in which they have been "categorized" based on their race and language. Postmodern feminism helped me think about the power relations that continue to exist and how these women attributed power in their relationships based on their conception of woman-ness and language. Thus, the eclectic theoretical framework (Stinson, 2004) of postmodernism feminism (Lather, 1991; Harding, 2004) and intersectionality (Collins & Bilge, 2016) allowed me to research and describe the multitude of factors that have contributed to their understanding of mathematics success.[292]

The Impact of COVID

COVID has had a significant impact on each of these women. Just as most other students in the United States, COVID presented many challenges, such as learning content online and on their own. For Sasha, COVID occurred during the end of her junior year. At that time, Sasha and her family were going through some personal struggles which required her to live with her aunt, her grandparents, and her cousin in a one-bedroom apartment. She struggled to find time and space to focus on her schoolwork while sleeping "on a sofa in the living room" (Interview 2). Trying to navigate schoolwork while living with so many people in one apartment affected her motivation and focus.

COVID lasted for about two years, which meant that Sasha was still taking online courses her high school senior year. Throughout this period in her life, she felt that she wasn't

[292] I want to highlight that the integration of these three theories together provided a more powerful way for me to analyze and think about this work. Just as Aristotle stated, "the whole is greater than the sum of its parts." Rather than viewing each theory as a separate entity, the union represents an innovative approach to studying how women perceive mathematics success. In a similar manner, Willett and Etowa (2023) propose that intersectionality and feminist poststructuralism be integrated to create the "intersectional feminist poststructuralist framework" and provide an argument to its potential contributions to qualitative research in women's health. Currently, I am not sure if this integration (beginning with "intersectional") quite fits how I interpret the merging of these theories, but I intend to investigate this union further in the future.

learning the content and began to lose all confidence in her ability to do well. Although she was in AP Calculus and did earn a B in the course, Sasha decided not to take the AP exam, for fear that her scores would be too low. Sasha began to lose herself; not caring about her grades (earning Bs rather than As) and not wanting to complete assignments: “Before COVID, school was my favorite thing” (Sasha, Interview 2).

Conversely, Wing-Yu enjoyed the first part of COVID because she felt it helped her discover more about herself—both academically and socially. She stated that that was when she started to struggle in her academics, which required her to focus and study more than she has ever had to in school. In addition, it was also a time when she felt she had more time to connect with her peers (through gaming and other forms of technology) and learned some “life lessons” of who she is as a person.[293] These new connections are not to say that Wing-Yu did not struggle during this time. Taking five AP classes, for example, was extremely stressful for Wing-Yu because the coursework was hard, and she had to learn how to navigate online on her own. The many challenges she had to go through this time however showed her what she was capable to endure (not just COVID as a social entity in the world, but also navigating new environments in her learning).

If these women struggled through a time when everything was required to be online and have been successful up to this point, it begs the question of how COVID has affected students who have struggled and continue to do so. There may be more work that needs to be done to reach out to those who have struggled and put more support systems in place to bring them back to the world of education.

[293] Some of these life lessons revolved around her taking the time to figure out her sexuality.

An Update

Although many of the interactions for this study occurred during the Summer of 2023, I have remained in contact with three of the four women in this study. Cassandra often visited me in my office numerous times throughout the fall semester, providing me updates in her life while also further discussing her academic goals. She has decided to transfer to another institution to pursue her goal of earning an environmental science degree. While she did initially think that she wanted to be a mathematics major, she decided to follow her passion in wanting to make policy changes around climate change. She begins her journey on this new path Spring 2024.

Sasha, who has also visited me often throughout the semester, continues to take courses in pursuit of her IT degree in software development. Although she had dreams of wanting to transfer to another institution, she has decided to stay and complete her degree. Many factors in her life affected this decision; the biggest factor being family. During the Fall 2023 semester, Sasha struggled with her mental health as she felt the tremendous pressure of maintaining relationships in her family. Fall semester was a challenge for Sasha to remain focused and motivated in her academic work. In her Calculus I course, for example, she passed the course with a C average—one of the lowest grades she has received in a college course. While she is not happy about that grade, she has stated that she was grateful that she passed because she did not spend the time she should have throughout the semester. Since our conversation in the summer, she has told me that she has moved out of her family's house and is currently living with her boyfriend and younger brother. Her mother has also returned to the Dominican Republic.

Skylar also continues to take the courses she needs to earn her IT and applied math degree. Although Skylar and I did not develop as strong a bond as the other women in this study, I do periodically see Skylar on campus. When we last ran into each other, she informed me that she continues to do well in school (earning her As). She intends to graduate with a dual major degree in May 2024.

Wing-Yu continues to do "well" in her studies, having stated that she is currently taking her last mathematics course (a statistics course) and is currently moving forward in getting her CS degree. She continues to live on campus and does go to her parents' house occasionally on weekends and holidays. She intends to graduate by May 2025.

Final Thoughts

I hope by reading about these women's experiences, the reader has gotten a sense of how complicated it is to be a woman in STEM. Not only is gender a significant factor to consider when we, mathematics and STEM educators, think about women in STEM, but these women have highlighted many other issues that continue to exist despite some of our best efforts to eliminate them. I am not sure we will ever get rid of some of these larger discourses that have so influenced the decisions women continue to make in determining their path—but it doesn't mean we shouldn't try. To begin, maybe we should start by thinking about what success means and how we can expand its definition to incorporate all the ways a person can be successful in STEM and "disrupt the discourses that may limit educational opportunities" (Leyva, 2016, p. 105). There are greater forces that are limiting people's success and rather than make it harder for them to succeed, we should focus on ways to meet them where they are and move them forward.

I end this dissertation with a statement Cassandra shared with me about what it means to invite people in the world of STEM and giving them opportunities to define success for themselves. My hope is that rather than focusing on what is taken away by inviting those to the table, that we begin to think what we all can gain by creating space for those who have traditionally been excluded. Cassandra argued:

There’s room for everybody to be successful…and it’s not impossible for everyone to learn. You can meet them where they are and they can get there. And you don’t have to gatekeep… so like, everyone’s capable of succeeding in STEM. It’s just gonna look different for everyone. I think people have just like the scarcity mentality. But…everyone is capable of succeeding in STEM and can share resources. Like don’t be greedy. There’s no success if only a certain group of people envision what success looks like for everyone. (Interview 3)

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Appendix A
Invitation to the Study

Dear [Insert Name],

I hope you are doing well and are having a great school year thus far!

As you may already know, I am currently a doctoral student at Georgia State University, where I am completing a case study dissertation (under the direction of Professor David Stinson) to explore how undergraduate women, whose first language is not English, understand and perceive mathematics success.

As a woman, whose first language was not English, I have navigated the terrain of "success" within Science, Technology, Engineering, and Mathematics (STEM). I firmly believe it is vital to hear from those who have had similar experiences so as to provide greater insight into the types of experiences undergraduate women have in STEM, how these experiences influence their perceptions of their own mathematics learning and success, and ways in which educators might assist women, whose first language is not English, within STEM.

I wish to invite you to be a participant for my dissertation research. If you are interested, please review the attached consent form. Please feel free to contact me if you have any questions at 617-750-6777 or tonyadegeorge@gmail.com. I appreciate your time and look forward to hearing from you.

Thank you,

Tonya DeGeorge
Georgia State University
College of Education and Human Development
Department of Middle and Secondary Education
Email: tonyadegeorge@gmail.com
Phone: 617-750-6777

Appendix B
Informed Consent Form
Georgia State University
Informed Consent

Title: Perceptions of Mathematics Success of Undergraduate Women Pursuing STEM Degrees Whose First Language Is Not English
Principal Investigator: Dr. David W. Stinson
Student Principal Investigator: Tonya DeGeorge

Introduction and Key Information

I invite you to take part in a research study. You will decide if you would like to take part in the study. The purpose of this study is to explore the mathematics successes of undergraduate women, whose first language is not English, from their perspective of their experiences inside and outside of the mathematics classroom and how these experiences shape their relationships with mathematics and their understandings of success.

Your role in the study will last approximately 10 hours over the course of 3–4 months. I will ask you to participate in 3 interviews (approximately 1.5 to 2 hours in length) that will take place at a location of your choice. During the interview process, you will be asked to construct three concept maps to reflect your perceptions of mathematics success and will be asked questions about that map from me. You may also choose to share documents or artifacts that you feel have influenced your thinking in the creation of the concept maps or have influenced your perceptions of mathematics success. After the interviews, you will be asked to confirm my initial findings that represent your understanding of mathematics success. You will commit to a total of no more than 10 hours of your time participating in the research process.

You will not have any more risks than you would have in a typical day. This study is not designed to benefit you, although you may benefit from the knowledge gained from this study and your contribution to it. This work has the potential to serve future students and institute policy changes within higher education. If you do not wish to take part in this study, you can drop out at any time. You may refrain from answering interview questions or stop participating at any time.

Purpose

The purpose of the study seeks to explore the mathematics successes of undergraduate women, whose first language is not English, from their perspective of their experiences inside and outside of the mathematics classroom and how these experiences shape their relationships with mathematics and their understandings of success. I invite you to take part in this research study because you are a woman who has identified herself as someone whose first language is not English and is pursuing a STEM degree. I will invite a total of 8 people to be in this study.

Procedures

If you decide to take part in this study, you will participate in at least 3 interviews (approximately 1.5 to 2 hours in length) and will take place at a location of your choice. During the interview process, you will be asked to construct three concept maps to reflect your perceptions of mathematics success and will be asked questions about that map from me. You may also choose to share documents or artifacts that you feel have influenced your thinking in the creation of the concept maps or have influenced your perceptions of mathematics success. In addition, after the interviews, you will be asked to confirm my initial findings that represent your understanding of mathematics success. The study will last 3–4 months. You will commit to a total of no more than 10 hours of your time participating in the research process. If you choose to no longer participate in the study, you may drop out at any given time.

Future Research
I may use your information for future research. I will remove information that may identify you. I will not ask for consent from you if I do so.

Risks
You will not have any more risks than you would in a normal day of life. I do not expect injury from being in this study. If you have been harmed, contact the research team as soon as possible. Georgia State University and the research team have not set aside funds to pay for any injury.

Benefits
This study is not designed to benefit you personally. You may benefit from the knowledge gained from this study and your contribution to it. I hope to gain information about how women pursuing a STEM degree and whose first language is not English perceive mathematics success.

Alternatives
The alternative to taking part in this study is to not take part in the study.

Voluntary Participation and Withdrawal
You do not have to be in this study. If you decide to be in the study and change your mind, you can drop out at any time. If you do not take part or if you leave the study early, you will not lose any benefits that you are otherwise entitled to.

Confidentiality
I will keep your records private to the extent required by law. The following people and groups will have access to the information you provide:

- Dr. David W. Stinson and Tonya DeGeorge
- GSU Institutional Review Board
- Office for Human Research Protection (OHRP)

I will use identification number and corresponding pseudonym on all study records, forms, and published material. I will store the information you provide on my secure, password-protected computer. Obtained hardcopy material will be stored in a locked drawer in my home office. To protect privacy, the consent form information as well as the identification key associating the participant's identification number and corresponding pseudonym will be stored separately from the obtained hardcopy material in a different locked drawer. Audio-recordings will be destroyed after they are transcribed, and the typed transcript will be destroyed 10 years from the date of each interview. When I present or publish the results of this study, I will not use information that may identify you.

Contact Information

You can contact Tonya DeGeorge at 617-750-6777 or tonyadegeorge@gmail.com and Dr. David Stinson at 404-413-8409 or dstinson@gsu.edu

- If you have questions about the study or your part in it
- If you have questions, concerns, or complaints about the study

The IRB at Georgia State University reviews all research that involves human participants. You can contact the IRB if you would like to speak to someone who is not involved directly with the study. You can contact the IRB for questions, concerns, problems, information, input, or questions about your rights as a research participant. Contact the IRB at 404-413-3500 or irb@gsu.edu.

Consent

I will give you a copy of this Informed Consent Form to keep. If you are willing to be in this research study, please sign below.

____

Printed Name of Participant

____ _______________

Signature of Participant Date

____ _______________

Principal Investigator or Researcher Obtaining Consent Date

Appendix C
Sample Interview Guide 1
Background Information

Participant Pseudonym: Date:

Location/Time:

Questions

1) Tell me a little bit about yourself. How would you describe yourself to others?
    a. What are your passions?
2) What is your native language?
3) Tell me about your family life growing up.
    a. Where did you spend your childhood?
4) How/When did you come to the United States?
    a. How long have you lived in the United States?
    b. What types of experiences have you had in the United States as a person whose first language is not English?
5) What educational background have you had?
    a. Tell me about your experiences in school from elementary school to high school.
6) What is college like for you?
    a. Have there been any surprises in what you thought college life would be like?
    b. What has been the hardest part of being a college student?
7) What are you studying at the college and what do you hope to do after you graduate?
    a. What is your major? (It is a STEM field?)
    b. What careers are you trying to pursue?
    c. How did you become interested in pursuing a STEM degree?
8) How do your parents feel about education?
9) Did your parents/family encourage you to pursue a career in STEM?

Appendix D
Sample Interview Guide 2
Mathematics Experiences

Participant Pseudonym: Date:

Location/Time:

Questions

1) Tell me about your mathematics experiences in elementary school.
    a. What kinds of grades did you earn?
    b. What were your mathematics classes like?
    c. What were your mathematics teachers like?
    d. Would you consider yourself a "good" student at that time?
        i. How were the other students in your class? Were they also "good" students?
    e. What kinds of support did you have at that time?
2) Tell me about your mathematics experiences in middle/high school.
    a. What kinds of grades did you earn?
    b. What were your mathematics classes like?
    c. What were your mathematics teachers like?
    d. Would you consider yourself a "good" student at that time?
        i. How were the other students in your class? Were they also "good" students?
    e. What kinds of support did you have at that time?
3) Tell me about your mathematics experiences in college.
    a. What kinds of grades do you earn?
    b. What are your mathematics classes like?
    c. What are your mathematics teachers like?
    d. Would you consider yourself a "good" student?
        i. How are the other students in your class? Are they also "good" students?
    e. What kinds of support do you currently have?
4) Would you encourage other women like yourself to pursue a STEM degree? Why or Why not?
5) You've talked about learning mathematics in English. Can you tell me more about that?
6) From your experiences, what have you learned about mathematics?
    a. What have you learned about yourself as a mathematician?
    b. How has learning mathematics affected your career choices?

Appendix E
Sample Interview Guide 3
Perceptions of Success

Participant Pseudonym: Date:

Location/Time:

Questions
1) How would you define success in education?
2) From your experience, what would you consider as “good academic performance”?
3) What qualities does it take to be successful?
4) Describe what it’s been like for you to pursue a STEM degree as a woman.
    a. Reflecting back on your own experiences as a student, what advice would you give to another woman about how to be successful in STEM?
5) Why do you want to continue to pursue a STEM degree?
6) How do you know if you’ve been successful in STEM? What indicates that success?
    a. In what ways have you been successful in school?
7) In what ways have you been successful in your mathematics courses?