Exploring the Narratives of Female Undergraduate Students in Math-Intensive Programs

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Abstract

In recent years, researchers have continued to examine factors that contribute to the ongoing loss of women in mathematics programs and careers at a higher rate than their male counterparts. An important element in women choosing to persist in mathematics may be the ability to identify as mathematically able, however popular culture often constructs ideas of ‘mathematicians’ and ‘femininity’ in ways which render them difficult to reconcile. This research explores the narratives of Canadian female undergraduate students in mathematics-intensive programs in order to develop further understanding of how they negotiate identities as ‘feminine’ and mathematically able. Four students from a Canadian university were recruited to participate in narrative research interviews. Using Holland et al.’s (2003) concept of figured worlds, this study employs a thematic analysis of the data to examine how participants use, adapt or reject available discourses to perform identities as feminine and mathematically able.

Depuis quelques années, les chercheurs continuent d'examiner les facteurs contribuant à la déplétion continue des femmes dans les programmes et les carrières en mathématiques à un taux plus élevé que leurs homologues masculins. Un élément important dans le choix des femmes de persévérer dans les mathématiques semble être la capacité de s'identifier comme mathématiquement capables, or la culture populaire construit souvent des concepts de «mathématiciens» et de «féminité» de manière à les rendre difficiles à concilier. Cette recherche explore les rapports narratifs d'étudiantes canadiennes au baccalauréat dans des programmes intensifs en mathématiques afin de mieux comprendre comment elles négocient des identités tel que «féminine» et mathématiquement capable. Quatre étudiantes d'une université canadienne ont été recrutées pour participer à des entrevues de recherche narrative. En utilisant le concept de «figured worlds» de Holland et al. (2003), cette étude utilise une analyse thématique des données pour examiner comment les participantes utilisent, adaptent ou rejettent les discours pour réaliser des identités comme féminines et mathématiquement capables.

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Chapter 1: Introduction

In this section I outline my research project and its place within the field of gender issues in mathematics education. I will begin by establishing some of the ongoing challenges faced by women in STEM fields. Among the challenges, is the continued lower enrollment rates of female students in STEM programs at the university level, despite overall rates of enrollment over past decades revealing a trend towards a higher ratio of female to male students (Government of Canada, 2013, 2016). Despite this shift in the general university population, STEM fields still exhibit gender disparities, particularly in mathematically intensive programs (Cheryan, 2012).

This absence is problematic, as women are disproportionately represented in mathematics and continue to face enough obstacles to pursuing mathematics that they leave mathematics at a much high rate than their male peers. These differences persist at higher levels of education although data gathered, for example, in the United States, tends to show that male and female elementary and high school students' mathematics grades have been settling to approximately equal levels of achievement in the average portion of the distribution in recent decades (Penner & Paret, 2008).

I believe that discourses surrounding mathematics and traditional femininity have contributed to the ongoing struggles of female students regarding the pursuit of mathematics-intensive interests and so theses discourses and their effects are what I intend to focus on in my research. In traditional Western stereotypes, concepts of femininity and mathematics are constructed in such a way that they appear to be oppositional and could pose difficulties for students trying to negotiate these identities (2005a, 2005b). Continuing to explore potential contributing factors to this issue is important in the hopes that, as Dorothy Buerk stated "we can enlarge the group of people who can bring mathematics into their lives." (1985, p. 70).

Positionality

Before diving into my research problem, I will endeavor to establish my positionality as a researcher and to provide context for my choice of research topic. As my research falls into the category of gender issues in mathematics education, I will begin by describing my own education and educational experience relating to mathematics. I was educated in the Ontario

public school system, in the French Immersion Program. I enjoyed school and learning new material and my parents were very encouraging regarding academics.

From a young age I showed a flair for reading and I read quite quickly; in other subjects, primarily mathematics, I struggled to understand. Yet, when I expressed frustration, my teachers would suggest that this struggle with mathematics was quite normal; even to the point where if I mentioned that my younger brother seemed to have better luck with mathematics, that this difference was 'typical'. This response came from many directions, not only teachers but other adults, and slowly I became disinterested and resentful of the subject and opted out of mathematics at the earliest opportunity in high school. This disconnect between myself and mathematics took place even though my two closest female relatives, my mother and grandmother, were quite skilled at mathematics and worked in finance and banking respectively. Even with female relatives as potential role models for mathematics success, I had decided that I was simply 'not a math person'. This anti-mathematics conviction followed me into undergraduate degree while I was completing a specialist in history with minors in classical civilizations and French as a second language, I was still obligated to complete the minimum of one credit in a math or science course. At that point in time I was still quite afraid of mathematics and immediately elected to complete my credit in science courses. In pursuing my history degree I found a love of narratives and the exploration of societal change over time.

By necessity I realized I would need to confront this issue as I applied for entrance, and was accepted into, the Bachelor of Education (BEd) program at the University of Ottawa. The turning point in my attitude towards mathematics came during an optional week-long program at the university designed to help refresh the mathematical skills of pre-service teacher candidates held in the week prior to the beginning of the BEd program. While I was not admittedly very enthused by the thought of attending what was dubbed 'Math Camp', I was quite concerned by my lack of mathematical ability and knew that the opportunity to practice would be beneficial. During that one week of camp I had the opportunity to see how mathematics could be made fun, collaborative and engaging while working alongside colleagues who often shared a similar trepidation towards mathematics, often prompting insightful discussions as to what had turned us away from mathematics. Often these discussions occurred with other women who shared a wide variety of experiences, from stories similar to my own to women who had excelled at

mathematics but had been discouraged, by, in one instance, comments to the effect of ‘slow down, you’re getting too far ahead of the boys’. I was completely unprepared for how that week would begin to reshape my views towards mathematics and I could not be more grateful for the change. I feel this change not only benefitted my teaching practices but marked the beginning of the journey to my master’s thesis. During my time in Math Camp, I found my mind reopened to the possibility of mathematics as a fun, interesting, and open-ended subject rather than one to be dreaded.

As a result, I was driven to explore my relationship with mathematics further and to maximize my opportunities to do so, particularly during my practicum placements, much to the surprise of my associate teachers who remarked that typically teacher candidates shied away from mathematics lessons or demonstrated a lack of interest in teaching mathematics as a subject. Through these experiences, as well as my subsequent master’s courses, I continued to explore the relationships of individuals to mathematics; I developed an even deeper desire to examine the discourse surrounding mathematics education. This was due in part to the feeling that many of the narratives I was encountering were similar to those surrounding science and mathematics that I had seen in my history courses. Some important questions I came away with from this experience included: how does the ongoing struggle women face when trying to enter STEM fields manifest? What discourses surrounding mathematics may pose a challenge for women? What are the current avenues of research on this issue? What factors have been suggested by scholars as contributing to the issue? These are just a few of the questions I had when I began my research; they guided my reading and provided the direction for my initial inquiries.

Research Problem

The central research problem for my thesis is formed, in part, on the evidence that women continue to drop out of mathematics-intensive fields at a much higher rate than their male counterparts. The gradual loss of female students as they move through their educational careers has been termed the ‘leaky mathematics pipeline’. In Canada, while women now comprise more than 64% of students in non-STEM undergraduate programs, they comprise less than 44% of students enrolled in STEM programs (Wall, 2019). The reasons for this phenomenon are not yet understood and indeed many theories have been put forward from a

range of academic disciplines from neurobiology to education. (For an overview of suggested reasons see Halpern et al., 2007).

One suggestion was that an element of this phenomenon could be that the ability to identify with a subject or with popular cultural perceptions of that subject, impacts students' decisions regarding their education and career options (Archer et al., 2012; Bieri Buschor et al., 2014; Solomon et al., 2011). This notion was one with which I identified, reflecting on how my own perceptions of future career options and in which fields I saw myself fitting influenced my academic choices. Further, scholars such as Mendick (2005a, 2005b), opened my eyes to ways in which researchers might examine the discourse employed by mathematics students and use this to develop insights into their perceptions of themselves and mathematics and how these perceptions might influence the ways in which these students negotiate their identity. Regarding this type of research, in my reading I came across more articles with research based in the U.S or the U.K than in Canada and so I hope in part that exploring my research question will contribute to the data available in the Canadian context.

The central research question for my study is how do Canadian female mathematics students engaged in mathematics-intensive undergraduate programs, identify themselves in relationship to mathematics and negotiate that identity, as it relates to holding identities as both female and mathematically-able? With this question, I hope to learn more on how female undergraduate students express their identities, their views towards their future in mathematics, and their perspectives on mathematics as a field. In collecting and analyzing their narratives, I hope to explore the important elements of identity and discourse and their relationship with the leaky mathematics pipeline through the voices of women engaged within that environment.

Chapter 2: Literature Review

In my literature review I will recreate the journey I undertook through my reading, which I have grouped into three phases: the first, a broad search to establish the issue and develop a sense of current theories; second, the transition to a focus on qualitative research; and finally, narrowing my focus further to discourse and identity as they relate to mathematics. These groupings do not comprise a strict chronological order, due to the non-linear nature of the quest to determine the direction for my study and some of the readings, particularly in the third grouping were sought out in response to trends I observed within my own data.

I began my research by exploring literature on gender issues in mathematics education, to see if what I believed - that there was an ongoing struggle with women's participation in mathematics, was correct. These early readings were wide ranging, from research into data publicly available from StatsCan as discussed in my research problem to a plethora of works from different fields in order to try to grasp the breadth of field. Many of the works were discussions of potential indicators for continued challenges or barriers to women's participation in mathematics including mathematics test scores and differing enrollment levels in high education within mathematically intensive disciplines. For instance, Cavanaugh (2008) in his discussion of recently published studies based in the United States, points to the 'leveling out' trend that has occurred over the past several decades regarding student scores particularly in elementary and high school. This trend has been documented in much of the literature, that in recent decades women's scores in mathematics now equal or exceed that of their male counterparts. Yet, as discussed by Cheryan (2012) there is still a great deal of disparity in the number of women who choose to pursue advanced degrees or careers in fields considered to be mathematically intensive compared to men (See also Grossman & Porsche, 2014). In that article Cheryan (2012) examines elements such as social pressure in terms of what is viewed as acceptable gender roles and how that pressure may dissuade women from entering STEM fields as they do not identify with them and may not feel they belong in that field. Many theories have been presented as to what may play a role in contributing to this lack of women entering STEM fields including connections drawn to discourse, including stereotype threat as it relates to the stereotypical belief that women struggle more with mathematics (For examples at the high school level see Picho, 2016, for an example of work at the university level see Steele et al., 2002). Other related factors that have been explored include anxiety which has been studied

across several fields from education to psychology. One such study, performed by Ganley and Vasilyeva (2014) with U.S undergraduate students, examined testing scenarios and found that female students tended to report higher levels of anxiety and obtained lower scores on tests than male students.

Influenced by some of the research I reviewed from psychology I began encountering suggestions from the field of neuroscience which put forward the notion of potential biological factors for the appearance of gender differences in mathematical ability. Coming from a background of historical study, I approached these claims with some trepidation and interest in seeing if they would present discourses which I had previously encountered regarding gendered ideas of intelligence. A suggestion from this field, albeit one facing some controversy, is that there are neurological differences between men's and women's brains which would provide a biological reason for why men would be better at mathematics. This notion of blaming biology, particularly the brain, is not new; biological determinism has long been used to justify men's 'superiority' to women, (for examples see Paule, 2015; and Halpern et al, 2007). There is speculation, as well, on the existence of a 'math brain', a theory suggesting that a specific 'type' of brain is required to succeed in mathematics, though skepticism remains. Some scholars, such as Dehaene (1997), posited that while theoretically possible to find neurological differences, that these were likely to be minute. This would render the effect insignificant and Dehaene instead placed the differentiation by gender down to differences in education and socialization as the likely causes. There are also important critiques of such scientific studies, which highlight the damage that can be done when gender and brain stories become part of public discourse. O'Connor and Joffe (2014) for instance, followed a single scientific article concerning gender differences within the brain. They found that the further the data got from the scientific community and into public discourse via traditional news media and subsequent public commentary, the information from the study was increasingly distorted and these distorted facts were used as proof for the validity of traditional gender roles (O'Connor & Joffe, 2014). While the scientific community cannot, of course, control what the media will choose to say, within the articles themselves there is often room for improvement regarding how they discuss gender.

These articles formed the earliest stages of my review, verifying the existence of an issue, and providing a sense of the wide range of theories concerning what may contribute to the

ongoing lack of women in STEM. Having explored a broad range of research, from education to neurobiology, I found that I was drawn increasingly towards qualitative methodology. Reflecting on my own experiences, I knew that my turn away from mathematics was fueled by negative experiences and so research regarding social phenomena and personal experiences was especially interesting. Fields that used strictly quantitative methods, such as neurobiology, had not provided any convincing evidence and there were key critiques of such research and so for my next phase of my literature review I elected to further explore what qualitative research had to offer.

The second phase of my reading was marked by the transition towards qualitative research. I decided to explore the variety of qualitative research being performed, and what studies conducted with these methods had suggested as contributing elements to women's lower participation in STEM. One article that caught my attention and helped to propel me towards qualitative methodologies, was Dorothy Buerk's " The voices of women making meaning in mathematics" (1985). In this article, she describes her work with women she termed 'math avoidant' and I was surprised to see that the quotations from participants that she included echoed many of the same feelings I myself held, until quite recently, towards mathematics. This similarity, particularly the characterization of mathematics as cold, distant and something for the special few who simply 'got it' while the rest of us did not, piqued my interest. I began examining theories put forth through qualitative methods and what ideas researchers had suggested. The studies were not always exclusively qualitative: Bieri, Buschor et al. (2014), for instance, conducted a mixed methods study, in which they interviewed participants and looked at factors that may have contributed to women's ability to persist in STEM (see also Sadler et al., (2012), on STEM interest in high school). Before delving further into other studies, I believed it was important to read theoretical works such as that of Burton (1995) on feminist epistemology in mathematics, as well as Damarin's "Thinking about feminism and Mathematics together" (2008). These provided a window into how women were challenging the narrative on the struggles faced by women in pursuing mathematics. The issues surrounding the narrative of women's ongoing struggle to participate in mathematics was first brought to my attention in the work of Valerie Walkerdine. There were several significant critiques offered in Walkerdine's *Counting Girls Out* (1998), in which she explores the relationship between girls and mathematics, often through examinations of discourse. Of these critiques, the one which struck

me was her critique of the way in which issues of gender in mathematics were framed, even by those intending to be helpful, as they: "…do more harm than good, because they insist there is something wrong with girls that has to be corrected" (Walkerdine, 1998, p. 16). This discourse, of women being cast as deficient, is problematic as it sets up girls as the problem to be fixed rather than the conditions surrounding their education. Many of the issues highlighted by Walkerdine appear to have changed little since, as popular perceptions of mathematics and femininity remain very similar,

> If mathematics is understood to be stereotypically male and unfeminine, conforming to mathematical standards conflicts with standards of femininity. This, at its simplest, means that women must choose to be feminine or choose to be successful at mathematics. If they opt for both, they have to live with the contradiction *mathematics≠femininity* (1998, pp. 11–12)

The exploration of this contradiction will be important in my own work, as I believe that this is an important element in the ongoing loss of women from STEM fields. Another key work in this vein was de Freitas's (2008) "(dis)locating the feminine within mathematics". I found de Freitas's (2008) article particularly compelling, as it discusses the lived experience of a Canadian female mathematics student and draws connections between this research and the works of Burton, Walkerdine and Butler, among others. The student, Agnes, creates a narrative that reveals the intensity of the impacts of gendered discourses on learning (de Freitas, 2008). Agnes's story highlights the difficulties in trying to connect or hybridize identities, demonstrating the struggle over the conception of mathematics as rational, cold, masculine while trying to develop a mastery in that field as a woman. As de Freitas discusses earlier in the article, there is the tendency to cast women as the threatening 'Other' in opposition to the 'rational man' and so continue the cycle of symbolic exclusion of women (de Freitas, 2008). Exploring these works expanded my understanding of some of the feminist theories and critiques concerning the type of literature I needed to explore; and I believe that these readings provided me with a more informed perspective and helped me develop a more critical lens through which to review subsequent research. I then returned to exploring different suggestions or theories that have been put forward in qualitative research, for instance: Leaper, Farkles, and Brown (2012) conducted a study with adolescent girls regarding their experiences and gender-related beliefs and the potential relationship to motivations in school subjects. Picho (2016) explored psychosocial elements in the experiences of high school girls susceptible to stereotype threat. Stereotype threat

can be defined as “the detrimental effect of math-gender stereotype salience on female students’ performance” (Steffens, Jelenec & Noack, 2010, p. 948). This phenomenological study expanded my understanding of students who may face more or feel more intensely stereotype threat (see also Steffens & Jelenec, (2011). Other researchers, such as Teo (2014), have written on the challenges of female minority STEM teachers in order to explore a more diverse range of currents within the leaky mathematics pipeline. These works represent a small sample of the qualitative and mixed methods research being undertaken to explore the challenges faced by women in mathematically intensive fields. In reviewing these articles, I not only learned a great deal about the types of research being performed, but began to better understand their history, context, and how this research could be viewed with a more critical lens. Of the all of the potential influences impacting women’s participation in STEM explored through qualitative methods, I was most drawn to the examinations of self-concept and discourse and how they can play a role in women’s interest in STEM fields.

The final phase of my review occurred as my research focus narrowed further, to issues surrounding identity and discourse. This choice of subject matter was the culmination of the readings conducted until this point in my literature review, combined with my personal interest in narratives and narrative methodology. I drew on sources that discussed STEM, particularly the ‘hard’ sciences and mathematics, as sciences that are mathematically intensive are often constructed along similar lines to mathematics within popular discourse. Authors such as Robnett (2016) examine the issue by looking at gender bias within STEM fields and if experiencing higher degrees of bias would negatively influence girls’ STEM self-concept with high school students in the United States. Others, such as Davis (2001) took a critical sociocultural approach to explore how women with a U.S academic institution challenged and worked around difficulties they encountered regarding their participation within the scientific community. Some researchers, like Hottinger (2010) chose to explore the discursive construction and gendered subjectivity within mathematics textbooks used in classrooms. This study provided several interesting examples of how, as the textbooks became more advanced, women either vanished from the books or were relegated to a state of confusion and cast as being in need of the reader's assistance. Hottinger (2010) also explored an instance where the media was seemingly unable to reconcile the idea of an actress who also held an advanced degree in mathematics and examined the various strategies they used to work around what were seemingly incompatible

identities. They appeared unable to conceive of an individual holding identities as ‘feminine’ and ‘mathematical’ simultaneously (Hottinger, 2010). Among the works I explored most extensively in terms of both methodology and content, were articles by Heather Mendick (2005a, 2005b) in which she analyzes the discourse from her interviews with high school students in the United Kingdom participating in an advanced optional mathematics course. In analyzing the discourse used by these students, gendered discourses appeared within their language, differentiated between male students and female students without mentioning gender explicitly (2005a, 2005b). Mendick (2005b) noted that there often appeared to be a binary of being good versus bad at math, that paralleled a masculine and feminine discursive binary pairs, where terms associated with traditional feminine qualities were linked to those who fell under the category of bad at mathematics. Further, Mendick (2005b) explores the influence of the popular image of mathematicians as ‘nerds’ which holds negative connotations and how that image can make it difficult for some students to identify with mathematics. The potential influences of images of mathematicians in popular culture was discussed further in Epstein, Mendick, and Moreau’s “Imagining the Mathematician: Young people talking about popular representations of math” (2010). In that article the authors explore “the ways in which young people respond to prevailing images of mathematicians as geeky, nerdy or odd, realising that they are ‘stereotypes’, yet largely unable to find other ways of imagining mathematicians” (2010, pp. 47–48) The prevalence of the stereotypes mentioned in this and other research, brought to my attention the importance of considering these as potential contributors to how my own participants might navigate their identities. Other studies that were influential to my research, were Solomon, Lawson, and Croft’s (2011) and Solomon, Radovic, and Black’s (2016) articles which provided insights into the struggles female students in university mathematics programs may face. These articles focused on how these students try to negotiate the apparent conflicts and contradictions that can arise from trying to reconcile an identity as feminine with one that is mathematical. Of particular interest was the concept of ‘fragile identities’

> while many learners may be successful in mathematics they nevertheless see themselves as existing only on the margins of the practice, or as lacking stability in it – in this sense, they have what can be called a fragile identity. Although this is by no means the sole province of girls and women, they do appear to express such fragile identities more often or at least more readily (Solomon et al., 2011, p. 565)

As I became increasingly focused on the role of identity in women's continued participation within mathematics, concepts such as this became valuable sites for potential exploration within my own study. Not all of the articles I reviewed in this section were concerned with mathematics directly, as studies such as Archer et al. (2013) and Archer et al. (2012) looked at how young female students in the U.K. balanced ideas of femininity with their interest in science. As discourses around mathematics are often similar to those around the 'hard sciences' I felt that their inquiries into how students constructed identities related to their science aspirations provided valuable insight into ways in which participants in my research might work to construct their identities as they related to mathematics. Another study that informed my understanding of the potential for stereotypical images to impact how much women were able to identify as mathematicians was Piatek-Jimenez (2008). Piatek-Jimenez found, through semi-structured interviews with participants recruited from an undergraduate program at a university in the southern U.S., that they held stereotypical beliefs about mathematicians who they characterized as exceptionally intelligent, obsessed with mathematics and socially inept (Piatek-Jimenez, 2008). As each of her participants firmly believed they did not meet at least one of these criteria, Piatek-Jimenez (2008) suggests that belief about mathematicians may prevent them from identifying as one and choosing a career in mathematics. Further, Piatek-Jimenez (2015) discussed the persistence of women in mathematics and found that when speaking about career selection that they desired careers that were social in nature and involved mathematics, however many were not aware of careers aside from teaching that would satisfy these requirements. Rodd and Bartholomew's (2006) work "Invisible and special: young women's experiences as undergraduate mathematics students" dealt with how students locate themselves in relationship to mathematics as a subject but also how they behave in their classes and relate to the coursework. They noted that several female students had difficulty identifying as good at mathematics and were less inclined to participate during lectures, suggesting that they may wish to remain invisible as a form of self-defence (Rodd & Bartholomew, 2006). Finally, Margaret Walshaw's "A Foucauldian gaze on gender research" (2001) provided an interesting look at poststructural debates on knowledge and power, and uses Foucauldian ideas to discuss how girls become gendered through discourse and practice. In this article, Walshaw (2001) observes a high school student called Donna as she speaks to her teacher, classmate Brett and herself to see how Donna navigates competing discourses to fashion and refashion her identity.

These articles formed the third phase of my review and reaffirmed my interest in pursuing a qualitative approach with a specific focus on discourse and the role of identities. In particular, I was intrigued by research such as that of Mendick (2005a, 2005b) not only for her fascinating discussions on the discourses of her participants, but in her methodology as well. The type of interview-based data collection that she employs with a thorough discursive analysis is in part the inspiration for my own choice of narrative methodology. The articles grouped into this phase affirmed my interest in identity and discourse as issues regarding mathematics and gender and gave me a greater understanding of different ways in which these concepts were being studied.

These groupings for the readings parallel my journey through the literature. Beginning by exploring the literature to confirm my belief that women continued to face challenges in pursuing STEM careers, narrowing to a qualitative focus, and finally focusing my readings on research that investigated the roles of discourse and identity in this issue. My belief in the continued existence of challenges to women's participation in mathematics was confirmed through a variety of research which seemed to indicate that there is indeed an ongoing lack of women pursuing higher levels of education in mathematically intensive fields. While it is true that on average test scores of male and female students have largely evened out over the past few decades, this is not true for all areas nor is it true at the extremes of the distribution, with a disproportionate number of men at the highest range for mathematics (Penner & Paret, 2008). My hope is that my research will, albeit in a small way, contribute to the ongoing exploration in qualitative research on the role of discourse and identity, by engaging students within the context of a Canadian university.

Theoretical Underpinnings

In this section, I discuss the significant theoretical concepts that form the foundation for my study as well as provide definitions for key terms and concepts. At the core of the theoretical foundations for my study lies the concept of discourse. It is important to begin with this concept for two reasons: firstly, the notion of discourse and its potential impacts and influences on society was a driving force in shaping the direction of my research; secondly, I found that authors of other texts I will be relying upon to define concepts contained references to Foucault on discourse and discursive analysis and, so it is with Foucault I will define the term and surrounding theory.

A common conception of discourse is that it consists of speech, text and other forms of dialogue that people engage in and use to communicate, often categorized in groupings such as 'public' discourse or 'scientific' discourse to denote differing registers of language. Yet, to me this does not quite capture how pervasive discourse is, how we both shape discourse and are shaped by it. Discourse is not some separable phenomena from ourselves, even our thoughts make use of, and are shaped by, the discourses we know. This idea is expressed by Foucault in varying degrees throughout his work, including the following passage:

> I shall abandon any attempt, therefore, to see discourse as a phenomenon of expression... discourse is not the majestically unfolding manifestation of a thinking, knowing, speaking subject, but, on the contrary, a totality, in which the dispersion of the subject and his discontinuity with himself may be determined (2002, p. 60)

This passage expresses a crucial element, that discourse is not something that we can separate from ourselves. We are immersed in discourse from the moment we are born, we live and learn surrounded by it. The discourses that we encounter influence and shape us just as we in turn learn to use the available discourses in ways which can alter the discourse. As Foucault stated, discourse is not a phenomenon of expression, of an individual's thoughts or opinions, but rather something in which we are so immersed that it forms a totality within which human beings as subjects move. However, it is important to note that, discourse is not something that remains fixed nor without contradictions. This understanding of discourse is relevant to my work, in that participation in discourse is performed not only by a knowing subject but rather can be participated in without being consciously aware of doing so. While this does not negate human agency and our potential to change discourse, I believe it speaks to the fact that we are often to differing degrees limited by the available discourse; the available knowledge, as we are influenced by the society around us. This is not to say that discourse is limitless, but as Wetherell and Potter clarify:

> Discourse...is not partially constitutive or only constitutive under some conditions but is thoroughly constitutive. Our accounts of objects always construct these objects in certain ways and this construction is inescapable...we are not suggesting that there is nothing but discourse - only that we come to know what there is in the context of some historically specific and socially contingent account (1992, p. 62).

While discourse is not the only thing which exists, but we are bound up by discourse as we learn and attempt to explain the world around us and our experiences. Wetherell and Potter note:

> Ideology and discourse become implicated in the very instantiation and maintenance of social and economic relations...discourse is active, compelling, and a pervasive part of the fabric of social life. (1992, pp. 60–61)

These statements help illustrate the presence of discourse, even if individuals are not consciously or critically aware of the concept or their participation. Discourse helps to both create and maintain social relations, an element I feel is on display regarding the maintenance of gender stereotypes and gendered language in society. Discourse, then, in my research will be defined as a totality through which we move, and in which we participate whether or not we are conscious of doing so. I wish to use this understanding of discourse to ground my discussions and my analysis, to observe how individuals navigate and use discourse to describe themselves, the world in which they live, and how they relate to mathematics.

Perhaps one of the most critical terms to define for my research is gender. On this subject, I will begin with a quote from Simone de Beauvoir "One is not born, but rather becomes, a woman" (1990). This statement connects with my view, as I believe that gender is not an innate quality possessed by human beings, but rather one assigned to them by the culture and society in which they live. As to how I intend to define the term gender in my work, I will draw on the work of Judith Butler (1990). To aid this endeavor it is important to establish the difference between the terms 'sex' and 'gender,' as they are sometimes used interchangeably. The distinction between the two is perhaps best described in the following from Butler:

> If gender is the cultural meanings that the sex body assumes, then a gender cannot be said to follow from a sex in any one way...the presumption of a binary gender system implicitly retains the belief in a mimetic relation of gender to sex whereby gender mirrors sex... it would make no sense then, to define gender as the cultural interpretation of sex... gender must also designate the very apparatus of production whereby the sexes themselves are established (1990, pp. 9–10).

This is to say, that the concept of sex and the concept of gender are intricately linked, as while 'sex' is generally used to designate the biological male/female distinction, the way in which we think about the sexes is heavily influenced by how we perceive gender. When 'the sexes' are discussed, it is rarely a matter of strict biological discussion but one laden with gendered connotations. As my research is designed to explore discourse, narratives and the lived experiences of individuals, rather than biology, I will be referring only to gender in my work. To elaborate further on the definition of gender I use, I turn to the following from Butler (1990):

> gender proves to be performative - that is, constituting the identity it is purported to be. In this sense, gender is always a doing, though not a doing by a subject who might be said to preexist the deed…There is no gender identity behind the expressions of gender; that identity is performatively constituted by the very "expressions" that are said to be its results. (p. 34)

Butler's assessment that gender or gender identities are performative and that these performances change in accordance to the socio-cultural context in order to 'produce' a gender, is what informs my understanding of gender for this work.

While the discourse and framing of what constitutes a given gender at a particular moment in time changes, people work within their circumstances to 'perform' gender, to project or express the appearance of the gender they associate themselves with. There is no genderless subject beneath these expressions; gender identities are just that, part of our identity and therefore, while they may change, we do not exist separately from them. In my work, 'gender' will be understood as the presentation and expression of one's gender identity.

Finally, I will define the last two concepts that form the foundation of my research. As they are intertwined I will discuss them together. The first of these is the term identity. Identity is a complex topic, which was mentioned briefly in the above paragraph in the context of gender identity. To set out what I mean by identity, I use the definition offered by Holland et al.:

> Persons develop more or less conscious conceptions of themselves as actors in socially and culturally constructed worlds, and these senses of themselves, these identities, to the degree that they are conscious and objectified, permit these persons... at least a modicum of agency or control over their own behavior (2003, p. 40)

This statement emphasizes a key component of identity; that it comprises our sense of self, but that this sense is shaped by the society and culture around us, as well as how we perceive that culture and our place within it. An important discussion in Holland et al., highlights the multiplicity of identities, we do not hold one singular identity but rather a multitude which intermingle and pose contradictions to be negotiated (2003). This conceptualization of identity, bridges into the central theory in the key concepts for my work, namely that of Holland et al.'s (2003) 'figured worlds':

> By "figured world," then, we mean a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others…these collective "as-if" worlds are sociohistoric…the figured world becomes embodied over time, through continual participation. (2003, pp. 52–52)

These imagined worlds are intricately linked with identity, wherein identities are formed within these spaces and our interactions with the world and other actors. This concept will be important to my thesis, particularly in my interviews with the participants, as we explore their relationship with mathematics; which I aimed to accomplish by trying to understand their figured worlds and how they view their roles within them. I believed that this would help me to gain a better insight into their experiences, how they interpret the world around them, and how these elements might mediate their identity in relation to mathematics.

Each of the terms and concepts I have outlined within this section have a vital role to play in both the collection of the data as well as the analysis. Discourse, as noted above, forms the foundation of the intended study given its ever present nature and constitutes not only this proposal but the subsequent concepts that were discussed. Understanding the role of discourse is critical, as the discourses we are exposed to help to shape and constitute how we see ourselves, that is to say, our identities. The shaping of identities through discourse includes gender identities as perceptions of gender change depending on the socio-cultural context. These three concepts are intricately linked, and I intend to illustrate the interconnectivity of these ideas throughout my work. Finally, these definitions build into my interpretation of Holland et al.'s theory of figured worlds, as identity formation often takes place within figured worlds which are naturally constituted within discourse. I believe these concepts to be significant not only in their relationship to each other, but that when understood together allowed me to best explore my research question.

Chapter 3: Methodology

For my study, I selected a narrative inquiry research approach. The definition of narrative research, will be as described by Creswell: "[narrative research] begins with the experiences as expressed in lived and told stories of individuals…as the procedures of analyzing stories told" (2013, p. 70). I chose narrative research, as I believed that by exploring with the participants the stories they wish to share, I would be able to get a sense of their figured world and how they identify in relation to mathematics. An important element of narrative methodology that will be of benefit is its collaborative nature, as Creswell notes "As researchers collect stories, they negotiate relationships, smooth transitions…both parties will learn and change from the encounter." (2013, p. 75). In collecting stories from the participants, I was asking them to share personal moments and details from their lives, which may be sensitive and, so by emphasizing the collaborative aspect I hoped to create an atmosphere in which the participants feel comfortable sharing their experiences. Further, in analyzing the discourses that participants engaged with to gain insight into their figured world, I needed a methodology that would allow for the individuals involved to share information in a way that they wished to present it, rather than one which might involve too much direction from myself as the researcher, which could have skewed the stories they wanted to tell, even if unintentionally so. I selected female undergraduate students that have persisted in pursuing mathematically intensive programs in order to explore the way in which they have negotiated their identities within their figured worlds. The guidelines for the study that are outlined in the following section have been structured by this understanding of narrative inquiry methods.

Study Guidelines

I established the guidelines for my study in accordance with narrative research methods and was informed by the reviews of other qualitative work of a similar nature. Narrative methodology encourages participants to tell their stories, prompted with open-ended questions as needed. For examples of the interview questions please see Appendix A. The interview questions were designed with the open-ended style of narrative research in mind, as well as based on my own experiences with previous narrative-based research projects. For the data collection, I recruited four participants from an Ontario University in mathematics intensive programs such as mathematics, physics, engineering and economics. This number of participants is reasonable given the methodology, as Creswell notes "Narrative research is best for capturing the detailed

stories or life experiences of a single individual or the lives of a small number of individuals." (2013, pp. 74–75). The participants were asked to engage in interviews of a minimum allotted time of an hour, at a location that was selected in coordination with the participant to ensure they felt comfortable in the space. By conducting interviews which ranged from 1 hour and 25 minutes to 1 hour and 45 minutes, I believe that this allowed me to better engage the participants by providing with sufficient time to become comfortable in the interview style and format and I hoped that this encouraged them to share the full extent of their experiences.

The interviews were recorded, transcribed and analyzed both individually and as a group. To analyse the data collected from the recordings, repeated close readings of the material were performed. Themes, significant anecdotes relating to mathematics or identity formation, and other discursive elements have been documented in detail. This type of analysis is particularly important as instances of gendered language may be used without the student ever mentioning gender explicitly. An excellent example of this is the work of Heather Mendick, where she discusses how the students she interviewed described those who were good/bad at mathematics did not mention gender yet used characteristics for each that paralleled stereotypical masculine/feminine attributes (2005b). This process of transcription and review was done by hand due to the small sample size of the study and in order to develop a deeper understanding and connection with the material. I believe that one of the key advantages of narrative research to be to open further the world of academia and to provide a means of gaining perspective on a given topic, through the eyes of an individual experiencing it. While this method requires the collecting of a smaller sample size of data, I believe that the depth of the interviews provided an opportunity to hear the voices of the participant directly and gain the necessary insight into this complex and evolving topic.

Participant Background Information

Participant numbers were assigned based on the chronological order in which the interviews took place. While the students were not asked for their age directly, each of them would be considered 'traditional' undergraduate students in that they came directly to the university after completing high school. To facilitate discussion and reading within the document, pseudonyms were assigned to each participant. The pseudonyms were selected using a random name generator. Each participant is linked with their pseudonym in the descriptions below.

Participant 1 – Rebecca

This student was engaged in her third year of a joint honour's degree in economics and mathematics. She was initially enrolled only in economics and had tried adding a life science minor but did not find it to her taste and added mathematics instead. Participant 1 appeared to be Anglophone, and while she did not specify the location of her elementary or high school, from her descriptions it seemed that they were Canadian. She indicated that her parents had immigrated to Canada and that both encouraged her in academics pursuits, her mother often provided assistance with homework at a young age and she mentioned that her father worked as an engineer. Of the four participants, she seemed the least enthused about the discussion of mathematics itself but was the most goal oriented about her program in the sense that she repeatedly stressed that studying economics would result in obtaining a good job after she completed her degree.

Participant 2 – Amy

Participant 2 began university in the psychology program but soon after found herself enjoying her math electives much more than her psychology courses and so switched into mathematics and computer sciences. Due to the change part way into her time at university she was taking a combination of second and third year courses for these programs at the time of the interview. She is a Francophone from the local area of the university and attended a high school that used a European rather than Canadian curriculum. She described her mother as holding a Bachelors in mathematics and her older brothers as engaged in STEM programs. Quite happy to discuss mathematics and especially keen to talk about how critical mathematics is to modern society, and she was the most interested in the other participants as she felt there were not too many other women in mathematics.

Participant 3 – Kim

Participant 3 was in her fifth and final year of the Civil Engineering program, although she began her university career in a joint Honours of mathematics and physics. She elected to switch into the engineering stream as while she found the more complex mathematical theory interesting, she felt more engaged by putting mathematics into practical and tangible applications. She credits at least in part her father with inspiring her love of mathematics as she says he was a mechanical engineer. She is a Francophone from a different province who had only moved away to attend university. Of the participants her views of math were by far the most

literal as she describes frequent occasions where things in her environment will prompt her to begin doing various calculations.

Participant 4 – Megan

Participant 4 was the only one of the four participants who was engaged in the mathematics program alone and was in her second year at the time of the interview. She appeared to be Anglophone and was homeschooled for elementary school before attending a Christian high school. She was the sole participant to have changed her mind about how she felt about mathematics, having explained that prior to high school she had no interest or love for the subject. This change in opinion was prompted by one of her high school mathematics teachers who was incredibly passionate about the subject, she expresses that she is very much interested in potentially becoming a high school mathematics teacher herself.

Transcription Conventions

I elected to use 'naturalised' transcription, where care is taken to represent accurately the precise wording of the speaker even if mispronounced rather than denaturalised transcription which, while perhaps more legible to readers, can lose some of the nuances in conversations (Oliver et al., 2005). I have chosen to present them in this way throughout my thesis to more accurately share the 'voice' of each participant with the reader. Throughout the analysis section, the excerpts from each interview appear in their original transcript form and typical writing conventions are not observed apart from apostrophes in a contraction which have been added to this document to improve the reading experience. For the purposes of legibility of the transcripts, some features have been removed, primarily instances of overlapping speech which might be heard on the recording, but which consisted only of a 'mhhm' or 'yeah' which did not impact the flow or understanding of the conversation. Instances where there were sentence fragments, or the active speaker appeared the respond to the noise remain in the finalized copies. The conversations have been transcribed in their entirety, the only omissions or substitutions made have been to protect the anonymity of the participants and wherever possible these alterations have been made clear. In addition to the symbols which were used to demarcate features in the interviews, a symbol has been added that will appear exclusively in the thesis document in order to indicate sections that have been dropped for the sake of brevity. The explanation for each symbol can be found in Table 1.

Table 1

Transcription Symbols

CF/P	Indicator of who is speaking
|0:00:00|	Time stamp from beginning of comment
bold	Emphasis placed on that word by the speaker
italics	Words in a different language (French)
{*text*}	Audible noise on transcript other than speaking i.e. tapping a hand on the table
{*laughs*}	The speaker is laughing
{*laughter*}	Both participant and researcher laughing
^text^	Quieter speech
[	Indicates beginning of overlapping speech
=	Latching/words run together
-	Breaking off/restarting a word
?	Questioning intonation
!	Exclamation, rising intonation or volume
:	Drawn out letter sounds : per additional beat
A	Italicized majuscule letters indicate that the letter sound was made i.e. *A B C*
(text)	Audio unclear, researchers interpretation
(.)	Pause of less than 1 second
(2)	Pause of greater than 1 second, timed
A	Majuscule letter indicates replacement of a place/personal name listed by speaker
///	Thesis only, indicates that portion of the comment from that timestamp was dropped
‘	Apostrophes have been added to contractions in quotes within the thesis document to improve legibility

Analysis

Before I begin to describe not only the format I developed and implemented for my analysis as well as the findings themselves, I wish to return briefly to my research question. Through the process of my analysis, this was of course first and foremost in my mind, as I considered how to best answer: how do Canadian female mathematics students engaged in mathematics-intensive undergraduate programs, identify themselves in relationship to mathematics and negotiate that identity, as it relates to holding identities as both female and mathematically-able? Most importantly, I needed to devise a way of doing so that reflected the transcripts both individually and as a group, the research I had engaged with for my literature

review and of course the theoretical underpinnings for this project. Equally critical to my work is the need to ensure that the voices of my participants and their unique stories can be heard clearly by those who read this work, not only to try to illustrate the integrity of my research but simply because the participants deserve nothing less. During my undergraduate degree in history I developed a passion for reading firsthand accounts of historic events as these often provide the clearest understanding of not only the events themselves but also of contemporary views of them. So, in my own research I hope to share their voices and in doing so provide insight into the lived experiences of female Canadian mathematics students and how they see not only themselves and society but mathematics itself.

I had considered a variety of approaches for the analysis, from coding to thematic observations from the narratives. I have opted for a focus on thematic reflections from the narratives as I believe that this best reflects the voices of the individual participants while still providing the opportunity to discuss them as a group. To accomplish this, once I had completed the transcription of all four interviews I returned to the first transcript and began taking a series of notes documenting moments of interest or emphasis by the participant and taking into account the knowledge of the other transcripts, added notes if pieces of the conversation reminded me of another participant or stood out in sharp contrast with another. After completing these notes, in which I focused primarily on moments in the individual transcripts that stood out, I reviewed them and then with this set of notes in mind reviewed the transcripts again. I went through multiple iterations of close readings of the transcripts and forming notes, refining the themes I could see throughout the transcripts as well as drawing connections back to the literature. Each set of notes and highlights were done on notepads and printed versions of the transcripts as a part of this process. Once I felt I had taken the close readings and notes as far as would be helpful, I charted out the themes on large scale graph paper, then refined them using several sets of the transcript notes. At this point in the analysis development I had established three broad categories for themes and within each, had three subpoints to illustrate different types of moments within each grouping. These three overarching groups were originally entitled Oh the Humanities!, Busy Bees, and How is <u>this</u> still a thing? However, as my analysis evolved these broader groupings were dropped, as they no longer suited the final themes. To establish my themes, I focused on links that could be found not only between the transcripts as a group and with literature but worked to relate my own observations to the works of other researchers where

relevant. As I began writing the themes, I refined some of the ideas I wished to discuss further and so arrived at the seven themes that I will present in this dissertation (for an example of this process, see Appendix B). Through each theme I have explored the figured worlds of my participants, as I believe that through this exploration, I came closer to understanding their perspectives and how they perform different elements of their identities as they narrate their experiences. Figured worlds, as per Holland et al.,

> By "figured world," then, we mean a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others…these collective "as-if" worlds are sociohistoric…the figured world becomes embodied over time, through continual participation (2003, pp. 52–53)

Through the theory of figured worlds, I felt I could best understand how my participants worked to negotiate identities as mathematically able and feminine as they narrated accounts of themselves, about others, and on the world around them. In my analysis then, each theme is focused on different aspects of the figured worlds of the participants and while each is unique, I found that there are discourses they engage with that connect across the interviews. All the participants use these discourses in different ways, and I have tried to highlight their unique perspectives while speaking about the connections or contrasts between them.

Limitations

As with all research methods there are limitations which must be acknowledged regarding narrative inquiry research and to my methods specifically. Firstly, the recruitment was done largely via posters, which may attract those students who are more inclined to take initiative or a have stronger desire to speak about their experiences. As the study participants were screened only by their participation in a mathematically intensive program and their gender, the differences in age, prior education and socioeconomic class have contributed to greater variability in the results. There is, as well, the chance that participants entered the interview with preconceived notions regarding the research topic and what I may have been expecting from them and so may have selectively provided information that they believed I wanted to hear. Finally, it is important to note that the data collected was assessed and reviewed by myself exclusively and so there were no other researchers to provide a comparison or offer different opinions on the content of the interviews. However, in order to address the issue of research

quality I made use of two important elements suggested by Creswell (2010) to improve the trustworthiness of narrative research: taking care to establish my positionality and potential bias and by ensuring I provided vivid detail. The first step to ensure the quality of the research was to carefully elaborate upon my positionality and biases to provide the reader with a clearer understanding of how the research was approached and how that may influence it, which I provided in the positionality section of this document. Secondly, when presenting the data collected from participants, I have endeavored to include as much detail as possible from the transcripts (while protecting information that could identify participants). In doing so, I aimed not only to best share the voices of my participants, but to also allow provide the reader with as much detail as possible with which to assess the validity of my interpretations. As the primary focus of my research was an exploration of participants identities as 'feminine' and mathematically able, there were limitations on the opportunity to explore other key elements that influence performances of identity such as ethnicity and socioeconomic class.

Chapter 4: Findings

Introduction

The way in which the themes are presented in my findings is designed to highlight their complexity and to account for the overlapping and interconnected nature of the analysis. I have organized the themes to begin with an exploration of how each participant understands mathematics, as they all have a unique perspective on what constitutes mathematics. I believed that sharing how the participants understand mathematics provides context necessary to best appreciate the nuances in subsequent themes. The themes which follow explore various ways in which participants work to negotiate their identities as they narrate their stories; to see how they view themselves, others, and their relationships with mathematics. As much of the dissertation is, in some sense, focused on peering into their figured worlds, in my last theme I take the opportunity to share how they reflect outwards at society. A brief summary of each theme is provided below.

In the first theme, 'Sure, Structured, Strong,' I examine the ways in which each participant works to define mathematics and what it does as learning about how they understand mathematics is key to further discussions on how they do/do not relate to it. The second theme 'Binary 101' is divided into two sections, the first of which is STEM versus Arts that examines some of the ways in which participants construct those who 'do math' and those who do not. The second section of Binary 101, Men versus Women? explores moments in which participants spoke directly and indirectly about gender. The fourth theme, Freaks and Geeks, looks at how participants navigate the complex web of stereotypical images of mathematicians. The following theme, Sharing is Caring, highlights a key site of identity hybridization as each participant works to balance the 'masculine' image of mathematics with the 'feminine' image of the caring for others. The sixth theme, Good at Math? showcases the struggles participants faced when trying to maintain a position as 'good at math.' My final theme, Participants versus the World, contains reflections on how participants spoke about their views of society and how they feel society sees/treats mathematics. For each participant, mathematics is immensely valuable and critical to their figured world and through these themes I have endeavored to arrive at an understanding to the answer to how Canadian female mathematics students engaged in mathematics-intensive undergraduate programs, identify themselves in relationship to mathematics and negotiate that identity, as it relates to holding identities as both female and mathematically-able?

Sure, Structured and Strong

The first of my themes, was titled ‘Sure, Structured, Strong’ as a reflection of conversations with my participants on how they would define or explain what mathematics is and what it does. To begin developing a sense of each participants figured world and how they negotiate their identities particularly in relationship with mathematics, I felt that I first needed to engage with each student regarding how they understood mathematics and its functions. As Holland et al. (2003) note, what acts are deemed significant and what outcomes are valued is essential to the concept of figured worlds. Given the significance of mathematics to the lives of my participants, I believe it to be critical to my understanding of their figured worlds to gain a sense of what it is that they consider mathematics to be, what it does, and what about mathematics they find appealing or valuable. Broadly, mathematics is often framed in Western society as rational, and this rationality is heavily associated with masculinity (Hottinger, 2010). This generalized perception is well described by Rodd and Bartholomew “Mathematics is a troublesome subject: it has an aura of being important, hard, boring, high status and challenging.” (2006, p. 35). (See also: (Archer et al., 2013; Mendick, 2005a; Rodd & Bartholomew, 2006; Walkerdine, 1998). During each interview I spent time with each participant exploring how they understand mathematics, as I could not assume that their understanding would be the same as my own. Throughout these discussions, I made efforts to circle back to this idea of a personal definition not only regarding what mathematics is but also what it does. In my discussion of these definitions, I want to not only highlight the unique views of each participant as it relates to their figured worlds, but to showcase the ways in which these definitions intersect or differ from each other. These personal definitions were often heavily connected to the participants worldview, yet each seemed to struggle with how to explain or define what mathematics **is** though they had much less difficulty and more enthusiasm in describing what mathematics does. The imprecise nature of their commentary when defining mathematics may be due to, as Damarin suggests “ambiguity about what it is…mathematicians and philosophers of mathematics have devoted a great deal of discussion to the question of what constitutes mathematics…but have derived no definitive definition” (2008, p. 116). In the definitions offered by participants, some of the prevalent discourses across the interviews was a view of mathematics as holding a degree of certainty and logic they felt was lacking in other

disciplines, that mathematics was a concrete foundation from which to understand the world around them, and that mathematics was a necessity for everyday life. Some of these discourses, particularly those which framing mathematics as certain and logical, appear to draw on popular perceptions of mathematics as described by Buerk "For many women, mathematics is a collection of right answers with correct methods and exact symbols. While this view may provide security to those who can correctly use the symbols" (1985, p. 59) Indeed, the sense of security that this image of mathematics provides seemed to be part of the appeal for several of the participants. There are however important sites of negotiation and difference from this image that I will showcase over the course of this theme.

In the case of Rebecca, her comments on the nature of mathematics serve as an illustration for some of the back and forth negotiation of contradictions that each participant engaged in when trying to define mathematics. For Rebecca, mathematics is both something that can be fun, and is necessary for many facets of modern life. She describes it in terms of being both a language and a tool;

> R|15:06|: =that's how it is mathematics is it's own language (.) that's ah- its not like plain english and easy essay writing you have to- there's much more to it you have to understand how the numbers work and the symbols and everything (.) but i feel like generally a lot of people do like computing math because sometimes they find just the- solving math problems is easier than doing a- an essay:: or presenting in class because i just wanna get to the point {*laughter*} just want an easy mark

This comment illustrates one of the more common dynamics described by participants, in which mathematics is simultaneously simpler and yet more complex than a language such as English. At times, she cast it as more complex, here this is suggested by both her contrasting mathematics with 'easy essay writing' as well as adding on the fact that there are more symbols to learn. Yet in turn, she described mathematics as simple or easy;

> R|17:21| personal definition ok um mathematics to me is a **tool** it's definitely a///yeah it's like it's a tool for science it's not it's own thing (.) but a- in the end um even though it's a tool it's an amazing field once you get good at it it- it either helps you for computer science=just understanding how the **graphs** work or for economics for when your doing ah like ah you know interest rates or things like that to know how you implement a policy so **yeah** that's how i see math it's a **tool** for a lot of things in life it doesn't have to be super complicated it could be something as easy as (.) **accounting** just knowing math so

> it's a **very** important language in life and-and it comes in many different shapes and forms(.)yeah

In this instance Rebecca makes reference to a specific type of mathematics, accounting, as being easy. This is also just one example of her stressing that the importance of understanding mathematics does not necessarily mean that everyone needs to understand it at an advanced level. Rather, that it is important enough to everyday life that a basic understanding of mathematics is a necessity. I feel it is important to note that Rebecca appeared the least enthused about mathematics itself and was the only participant to categorize it as "not being its own thing," her perception of mathematics focused more on what mathematics could be used to do in terms of real world applications rather than the subject itself. This apparent lack of precision regarding a definition of mathematics did not seem to impede her ability to explain what mathematics could do, or what she found appealing about the subject

> R|6:06| ah well (.) doing both e- economics and mathematics is very the- they- they compliment each other it makes you a very strong competitor in the market and i just thought- i didn't just choose ma- mathematics just for that i also- like when you add an- a joint you have to do- you have to do it because you **like it** (.) not a lot of people **like** math s-i'm like one of the rare- one of the few who likes it um: i'm doing also mathematics **not** for the **theory** of mathematics but more for the statistics///

> R|9:10| =oh yeah actually after i started excelling in- in it i enjoyed it a lot more and sometimes ah at first ah it sounds like its so- it's just so tough and you wanna give it up and just makes you **stressed** but when i started getting the hang of it i found it more **fun** to solve problems (.) or sometimes i would end up solving the problem without referring to how to do it because you just get good at knowing what they're asking from you

These two comments exemplify Rebecca's attitude towards mathematics, as a subject that was fun, albeit sometimes stressful, and then as a highly practical choice. She repeatedly emphasized the importance of choosing a degree that would result in good job opportunities after finishing university and perceived economics and mathematics as a particularly good field in terms of future career options. While she oscillates between describing mathematics as easy or hard, she was consistent in her appreciation for the challenge it could present and of its value to society. Though her descriptions were perhaps less vivid or passionate than subsequent participants, her emphasis on the importance of mathematics was readily apparent. In her figured world then it seems as though mathematics is cast as a very practical subject as well as being something she enjoys, and something that she intends to use moving forward in her life.

Throughout the interview, Amy was very clear in what the appeal of mathematics was to her, although if she struggled to define clearly what it was. When I asked her how she might explain mathematics and what it does to someone who had no experience with the subject:

> A|39:05| uhm what- what is math um (.) math is just a language or a tool that you can use to (.) understand concepts around you better (.) because like as you would know its like you cant do anything without math so um cause math is just so broad like so broad ok you can do statistics you can do probability you can do number theory you can do analysis you can do algebra you can do **anything** so from that everything you can explain everything///
>
> CF|40:22| its like explaining the world around them
>
> A|40:23| exactly but explaining it in a way that's (.) so rigorous and so (.) factual yet- in that your proving everything you can't just say that yep i'm- i'm saying this (.) why? you have to prove it and people have to be able- people have to look at your proof and yeah and agree that this is a good proof and something like that/*follow up to her describing mathematical principles in physics as an example of what math did*/

Much like Rebecca, she seems undecided as to whether the term language or tool is better suited to describe mathematics and while Amy provides some examples, her definition of mathematics still feels rather nebulous. While her approach to explaining the importance of mathematics differs from Rebecca, she also stresses the critical nature of mathematics as she understands it. Particularly in her comment at 39:05, it seems as though mathematics is not merely a valuable subject, but rather a way in which the world around her can be interpreted and understood. In her assertion about what mathematics does she appears to tap into what Burton (1995) among others has discussed as a very Eurocentric and male dominated system of interpretations as to what counts as rigorous or proven in mathematics, rather than an understanding of mathematics as a socio-cultural phenomenon. Amy carries through with this view when it came to explaining what about mathematics she found appealing, much of what she said continued to focus on that idea of mathematical truth and certainty

> A|5:17|///so right now i'm doing my foundations class which is my second year class and i love it cause it's just little proofs but its just really interesting and and that's what makes math so powerful and strong and formal is that everything is proven and no one can argue with you on specific (.) points or something///
>
> A|7:22|the appeal was how much of a formal science it was (.) given that like i just said when you prove something you know its going to be true all the time because you just

> proved it was true {*laughter*} so um it makes it **really** strong but um i don't know what really drove me to mathematics other than the fact that its just really complicated (.) puzzle but that type of puzzle in my opinion you don't see it until your second year where you're like starting from scratch and you're like okay let me define this set and this set has like specific properties if that has specific properties it's a group oh! well from that you can derive this and it's really a puzzle of oh were like putting everything together///and then it's just (.) the beauty of it and the fact that it's always true and (.) yeah
>
> CF|8:44|theres like a consistency there=
>
> A|8:45|=yeah it's like really consistent it's- it doesn't depend on the weather or how you're feeling or stuff like that its is just always like a **fact**///

Amy made it abundantly clear that her passion for mathematics stemmed at least in part from her love of its structure as she sees it, which is complex and so provides a challenge which she described as akin to solving puzzles. Further, the certainty she associates with mathematics appeared to form a large part of its appeal as she reiterates several times in different ways over the course of the interview, as when I asked about how she would relate to mathematics:

> A|41:25|///for me it's interesting to have something that is always **true** so like going from psychology where it's like ok well **that** study showed that in that population there is that thing its like *K* but there are so many different factors and like especially when your doing like psychology it's just like we are like really unpredictable beings like in our behaviour in our habits in our everything and then- but when you do math it's like you know what your doing is always true that what you want to get to and um (.) so yeah so that's my how i relate to it that at least when i do this if my proof is well like well written if my proof is perfect and i know that who will read it will be like yes okay you just proved that///but you- you just prove that and the your like yeah that's perfect like everyone can agree on this like this is- you cannot find a counter example because you just proved that there are no counter examples that they don't exist and stuff like that so it's for me like having (.) as much certainty (.) as i can in something (.) that fascinates me given that we are so uncertain as beings we can create something that is certain
>
> CF|43:00| mhhm given like the sort of (.) vol- fairly volatile nature of human beings=
>
> A|43:05| yeah cause like we were able to create something that has like the- literally stood the test of time and like *K* like this has been proven by someone like a few hundred years ago and it's still working it's still true and we're still basing stuff on those (.) so yeah

Particularly in this comment, her appreciation for the consistency in the structure of mathematics shines through. There is almost the impression that mathematics is creating order in what is otherwise chaos, and this certainty perhaps provides a sense of security for Amy. This consistency is translated directly to logic and fact, which are common associations with the idea of mathematics in a more general sense. Her emphasis on this view of mathematics not only echoed this broader social perception but brought to mind the work of Elizabeth de Frietas "Mathematics and its Other: (dis)locating the feminine" (2008) in which she uses research fiction narrative to discuss the experiences of a Canadian student she calls Agnes. At one point in the narrative Agnes describes mathematics as a domain where "assumptions were spelled out, and where statements were necessarily true, not just here and now, but true in all possible worlds." (2008, p. 284) Amy's descriptions of mathematics were not limited to just these representations of mathematical certainty, when I asked her about what had initially sparked her interest in mathematics,

> A|9:09| i honestly wouldn't know because me being me math has always been- like especially like in primary school and in high school has always been hr- ugh it's has always been easy and i've always been fairly- it's always been fairly- i've always been like a fast learner when it came to math///but then when you get to university you kind of get like a bitch slap no you don't understand anything which is what really drove me to like **keep** pushing it's really like i don't understand this but this looks really beautiful therefore i'm really going to push and try to try my best to understand um which is also why i'm i so enjoy math classes is that it's the beauty of **not** understanding something///but when there's a problem and then you can solve it using your knowledge then there's like a certain satisfaction of like i just proved something and anyone like around the world will be like yes that is really good it's the fact that it's an international language of logic but for me it's also just like a culture thing like for me:: just being able to have that knowledge and that background in math is just like um (.) just a culture thing ///its just gives you like a certain knowledge to just- personally it makes me feel like i'm more like grounded person///we've been doing math ever- ever since we've been doing philosophy which has been for a long time so (.) yeah {*laughter*}

For Amy, some of the draw of mathematics seems to be framed as a way of relating to others, both to our past by her reference to philosophy but also to others around the world as she believes it is an 'international language of logic' where things such as mathematical proofs can be replicated and agreed upon across the globe. Further, her descriptions on the beauty of not understanding are reminiscent of Epstein et al.'s discussion of popular perceptions of

mathematics as "a secret language, mystical, even magical, difficult and aesthetically satisfying to those (few) who understand it" (2010, p. 47) Amy's image of mathematics feels very much in that vein, as well as connecting back to ideas of certainty as when she speaks about the satisfaction of proving something she links this to anyone being able to verify it. I found it interesting here to consider too that her definition of mathematics seemed imprecise, forming some level of contrast with her understanding of mathematics as certainty and permanence.

In the case of Kim, she places a similar emphasis on the centrality of mathematics to everyday life and its ability to generate an understanding of the world around her. When I asked her how she would define or explain mathematics,

> K|9:27| i **guess**- it's **hard** so///so she's doing like functions and things like that and she constantly asks me like but like what does this function **do**? like **why** am i **doing it**? am i- we're doing this graph and plotting this function like what's this gonna serve me? uhm (.) and i guess it's hard to- to understand it but like those functions they kind of represent **everything** i feel like **everything** in the world from like me sitting on this chair to like this this recorder here is kinda like built around math whether we want it or not uhm (.) i- yeah because like everything everything are structures right? as a civil engineer everything is a structure and so every structure has to be balanced and **how** it's balanced is based on math and then like everything is **living** and every living thing kind of this all chemistry but chemistry is really just math so math i feel is just like kind of like the point zero and everything stems from it so for me it's kind of like necessary for people to- to i guess get a bit of an understanding of math even if it's just like high school (.) basic because (.) it's just (.) yeah it's just everywhere really yeah

Like Amy, her reply focuses on defining mathematics as a way of explaining or representing 'everything', though what constitutes this 'everything' is not discussed further by either participant. Her examples are naturally different as she approaches it from an engineering-oriented point of view, but the emphasis on the need for mathematics to understand the world around you and as necessary for everyday life echoes that of Amy. Kim tended to take a slightly more philosophical view of mathematics than the other participants,

> K|43:56| i guess **mathematics** is really close to philosophy for me like if you think of like very core mathematics for me it's just like a way of like seeing something so like i don't know if you see a bird and then you see it fly so like someone might just say like oh hey it's a bird its fly like evolution or something like that and they stop there where as someone in math is like ok **how** does it fly? how can it fly? why does it fly? and so instead of just like answering that with- or like uhh a philosopher would be like ok its flies because of this and because it wants to go somewhere and i don't know what a

> philosopher would answer {*laughter*} ahh a mathematician would be like ok it flies because ahh the force that the air puts on the wing is- is larger than the one that it puts **down** and so they would invent equations for this and then with those equations that they build boom we have airplanes and things like that so it's just like- i guess it's just ahh (.) i don't know it's just something that they **have** to do they have to like understand it like to like the **furthest** point that you can understand it///*part of a reply on what a mathematician does/*

This comment on a philosophical connection to mathematics exemplifies how fundamental it is to how she perceives and understands the world around her. This more philosophical approach to the purpose or role of mathematics did not mean however that discourses on mathematics as rational, logical and true were absent from her descriptions:

> K|12:44| yeah ^it was different^ i was for sure one of those students especially until like grade eleven that was just like ok this is the way i'm supposed to do it so i'm gonna do it this way and i'm not going to ask any question kind of thing i didn't really **see** math as this thing that was like **all** around us all the time i **loved it** from a young age- it was just like a puzzle and i always loved i guess any like **logic** or strategic thinking? or like way of doing things so i still loved it but ahm in grade eleven we had kind of like a seminar with this professor who was from the university um and it was about how math is all around us so he talked about uhm kind of like fibonacci and then like the golden triangle and everything that and then- and how **that** applies to nature and that really like- what opened my eyes and made me see like yeah like this is true that this is everywhere that's what gave me the idea of doing this but also this is super interesting and this could be applied to a lot of things uhm so i guess yeah **younger** for me it was just like fun {*laughs*}///
>
> CF|46:29| yeah ok so it's like less like less prone to error? i guess like more consistent?
>
> K|46:35| yeah///but if you ask a math student like ah what your opinion on like does two plus two equal four like if they say like it's **false** like i don't think they'll be able to prove it but like {*laughter*} you have to be able to prove it and if you can't prove it then you're **wrong** its just (.) i- it- your- you have the correct answer or you have the **wrong** answer///
>
> K|1:34:17| yeah for sure i guess it's- yeah the certainty and i guess the rationality behind it i- i don't know if you've seen that there like this group of people in like (.) communities that think that the earth is flat (.) in my mind i'm like this is not **possible** like it's literally impossible (.) gravity like circular motion satellites {*laughter*} to me it's- it's like ahh for me it's not about making sense it's just about it being **right** and being correct and being (.) yeah and being scien- scientifically correct that's it i feel like it's just the way it is and i feel like there can be changes in like biology like if they- if there- there's these or even in chemistry or even in physics there can be some little

> changes or something that they were like ok it might not really be this way it's kind of **this** way kind of like shifts uhm but in math there cant be like there's never there never anything that has been proven in math that has been like back proven wrong it like it's just it's always certain like it's always right {*laughs*} yeah

Especially in the comment from 1:34:17, towards the end of the interview, she had made comment shortly before in which she mentioned the importance of 'scientifically proven' facts and this was her response to my follow up as to whether being scientifically correct was part of the appeal. Of note, there seemed to be a small contradiction to some of her previous comments when she says "for me it's not about making sense it's just about being right" yet many of her descriptions of mathematics depict it as a way of interpreting or making sense of the world around us. However, this does suggest how powerful the imagery of mathematics as an absolute truth can be within Kim's figured world. This impression of her view was furthered by her comment on "never anything that has been proven in math that has been back proven wrong". The certainty she places on mathematics seemed to generate a sense that mathematics to her is a very unshakeable, bastion of truth that underpins everything around her and perhaps lends a sense of security. Although her definition of what precisely mathematics is comprised of, is rather vague, in no way does that appear to diminish her beliefs as to what it can be used for or how powerful it can be.

Megan was the only participant in the study who had experienced a significant shift in her beliefs about mathematics over time, from a strong dislike of the subject to a keen interest. Even with this distinction, where her understanding of mathematics and certainly her opinion as to its appeal had changed, she still defined it in similar terms to the other participants:

> M|34:52| oh boy okay math is i'd say the foundation of ah concepts and reasoning and ah a basis of other (.) things (.) shouldn't use things in a definition {*laughter*} uhm
>
> M|36:26| oh math is applicable to just about anything in your life in=different ways and what you do and how you do it uhm and so if you're like you know painting your walls you need to figure out the amount of paint you need///it's as simple as knowing module twelve you know when using twenty four hour clocks or whatever else to figure that out or as simple as figuring out time changes between different countries and if you're in here you're somewhere and your friend som- somewhere else what time it is where they are as compared to where you are
>
> M|37:28| probably i think growing up math was just this series of numbers and equations and you just do a whole bunch of computations and you come up with a number that's

> meaningless right but if it gets you a mark you know good- good job where as now: over time seeing how math is about in absolutely everything ah and how diverse it is and how applicable it is to just about everything ahh it's certainly changed over time

Here too we can see the imprecise nature of the definition of mathematics, though Megan seemed to be slightly more aware of that than previous participants. Her interpretation of mathematics at a younger age was as an abstract and meaningless set of numbers, but this understanding has since been replaced by one reminiscent of the other participants in that mathematics is seen as all around them and is necessary to understand the world they live in. Towards the end of the interview I made a point to circle back to this idea of defining mathematics, given that we had now been discussing mathematics over an hour, to see if her answer would be any different

> M|1:13:26|{*faint sigh*} well there's math to society and then there's math to me and math to **me** is umm (.) is a process of (.) problem solving umm either in concrete math problems or in day to day life that i thoroughly enjoy umm and that i hope to spend the rest of my life doing in different ways umm (.) it's a- it is a um (.) a **subject** of education- of learning but it's (.) more than that in the way that umm it isn't just sitting in a classroom and writing out solutions to meaningless problems it's a applicable to everyday life phenomena

> M|1:14:45|{*laughs*} uhh math is a subject of education it is a:: (.) {*sigh*} a: umm title given to the (.) study of ah problem solving of (.) ahh of def- i don't want to say defining world oriented problems but of relating to? them i guess umm it involves a lot of numbers {*laughter*} and a lot of symbols and a **lot** of processes

From these comments, her perspective on what mathematics does, primarily problem solving and explaining the world, is made even clearer yet her definition remains relatively unchanged. She too echoes the other participants particularly in her emphasis on mathematics as a means to make sense of the world. Her perspective on what made mathematics appealing seems to follow this same trend:

> M|5:43| ///but math is (.) it's so objective which is what i love about it it is the way that it is and you can't really argue from one side or the other and so it's easy to (.) ah i want to say it's easy to learn there are challenging aspects of it but it's easy to argue your point in math um and i also work with patterns and structures and everything so math is something that i easily understand where as history i can't do {*laughs*} whatsoever so yeah

> CF|6:45| fair enough so its the sort of objectivity that's appealing sort of that permanence almost?
>
> M|6:52| yeah yeah like it's been the way that it is and sure over time we've developed and we've learned more things and we've proven more things that we just took as fact before actually knowing but its always been the same it's just our knowledge of it that's developed
>
> M|8:40| i liked the structure and the reasoning of it uhm its very organized its um (.) what i **love** like solving problems is that there's only one answer usually most often uhm{*laughs*} and so you have to work towards that one answer instead of in other subjects where you have you know look at this problem and what's your solution to it? there are several different ways depending on people's backgrounds so i love working through a problem i love the ah excitement when you get the right answer that compares um after all that work and it's just- it's i've always worked with patterns everything's patterns///

Despite arriving at a love of mathematics later in her educational career, the aspects that she describes as appealing seem to align with those of the other participants. Megan seemed to particularly enjoy the 'lack of argument', this sense of security in knowing she is guaranteed to be correct once she has the 'right' answer and no one will be able to disagree.

Overall, I believe that the title 'Sure, Structured, Strong' encapsulates much of the participants' perspective regarding mathematics. While each participant struggled to provide a clear definition of what constitutes mathematics, as Damarin among others has noted, there is often a lack of consensus on the definition of mathematics and that "Whatever mathematics is…mathematicians are the recognized authorities, and they determine what gets counted in" (2008, p. 116). What implications might that have on others who are asked to provide a definition, such as my participants? Rather than try to describe what is included or counted as mathematics, participants general opted to provide explanations and examples of what mathematics does. For the majority of the participants, the understanding on mathematics that they describe, and the features they describe as appealing, borrow from popular discourses which frame mathematics as "a secret language, mystical, even magical, difficult and aesthetically satisfying" (Epstein et al., 2010, p. 47). Rebecca, who did not describe it as explicitly in these terms as the others did still use some of this language especially relating to the depiction of math as difficult though she does exhibit some contradictions on that as well as she attempts to negotiate how she narrates her own experiences. The participants portrayed the role mathematics in their narratives as holding a position of near omnipresence in their lives, as a way in which

they can understand and interpret the world around them. In reviewing the transcripts, a pattern emerged as mathematics was established as if it formed the bedrock of understanding, where mathematics was cast as certain, complex, and critical to the daily lives of my participants. As the participant in de Freitas' (2008) study does, they appear to draw a sense of grounding or comfort from this idea of mathematical truth and constancy. I believe that in exploring the participants' perspective on the definition and function of mathematics, I furthered my understanding of their figured worlds in the sense of better grasping what they value about mathematics. This theme was placed first not only to set forth a definition of mathematics for each participant but also because in doing so, I believe it provides a much needed basis for a better understanding when interpreting the participants comments throughout the interviews.

Binary 101 – STEM vs. Arts

Having set forth examples of how my participants understood 'what is mathematics, and what does it do?', I will now turn to my discussion of their views on 'who does mathematics' which took many forms. Several themes within the thesis will be devoted to varying aspects of this discussion, of these, STEM versus Arts was one of the most prevalent discourses across the four interviews. This particular binary, in many ways appears to have replaced an outright masculine/feminine binary yet very clearly parallels it, and these rigid dichotomies "…Western binary ways of thinking are inadequate for understanding our world because they subordinate, separate, or devalue everything female." (Walshaw, 2001, p. 476) As discussed extensively by Heather Mendick in *A beautiful myth? The gendering of being/doing 'good at maths'*

> the fragmented, contradictory and fluid identifications of learners with mathematics are constituted through patterns of sameness and difference: the samenesses/differences between mathematics and *other* subjects, and between mathematicians and *other* people. Key features of this are the ways that students position themselves/are positioned within a series of inter-related binary oppositions: maths people/non-maths people, mathematics and sciences/languages and arts, ordered and rule-based/creative and emotional, fast/slow, competitive/collaborative, independent/dependent, real understanding/rote learning…in each pair the two terms are unequally valued, and the term with the higher value is associated with masculinity and the second with femininity (2005b, pp. 212–213)

Each of the participants in my study framed portions of our discussions on ‘who does math’ in one or more of these binary patterns as described here as they attempted to negotiate their narrative and perform their identities during the interview. Due to the extensive nature of some of these discussions, I have elected to separate this theme into two sub sections. The first section will discuss the plethora of ways in which the participants used the STEM versus Arts dichotomies, and the second will showcase instances of direct conversation around gender in STEM fields. This is not to suggest that the participants simply put forth these binaries in an unquestioned fashion, and in the sections I have pulled from the transcripts I have endeavored to highlight not just simple examples but the moments of tension and contradiction that often occur as they attempt to negotiate the line between themselves being considered ‘mathematically-able’ and themselves as ‘feminine’. The stories they shared about themselves and others, and the ways in which they negotiate categories of me or ‘us’ versus the ‘other’ highlight the complexities in trying to negotiate their identities.

In discussing the implicit binaries embedded within STEM versus Arts, I will begin with Rebecca. Throughout our interview, when asked about her experiences within mathematics compared to other subjects or to describe students within her program, she often depicted them in binary fashion, a few of which I have collected below;

> R|48:32| to be honest i- i can’t really tell i feel like the ones that find that- that it’s very boring tend to do degrees that are more: (.) in the arts ah faculty:: more languages studies or international studies like things like are more (.) **social** or **creative** things like that that don’t involve math or: economics (.) like things like complicated or dry material
>
> R|54:23| =its a lot yeah the sense of independence coming from people (.) like every person for themselves that’s what i’m like **feeling** the vibe i’m getting which doesn’t really help because i’m the type of person who likes to- who learns better when i explain things to people (.) so yeah there definitely an everyone for themselves attitude
>
> CF|55:47| uh so like what- what kind of (.) umm what degree or courses would you associate a more i guess almost more social? tone with?
>
> R|55:57| uh (.) i mhhh i don’t **know** maybe in my first year of economics when you have to take **english** classes that was more social///*on the vibe from students in her faculty*/
>
> CF|58:52| As for the:: sort of like oh my god its kind of hard comments (.) where do you feel like those come from?

> R|59:01| i think- i just know the one sure thing its coming people who don't study a program that's- that's necessarily like numbers or anything like that they just study- they just prefer a program that's more **language** based and that's something easier for them maybe like a communications degree polysci or um (.) international studies so it could be people who have a **passion** for the world but just in a different way and that doesn't have to do with numbers (.) things like that///*on reactions to finding out she is in a mathematics program*/

These comments serve as examples for some of the more common binaries that Rebecca, among others constructed when speaking about people who 'do math' versus those that choose not to. Among the most predominant of these constructions is the juxtaposition of STEM program students against students in arts or language-oriented degrees. As noted by Mendick (2005b), this binary parallels a masculine/feminine dichotomy in which the term associated with the 'feminine' is not equal but rather holds a lesser value. Some of that positioning can be seen in the comments from Rebecca, perhaps most obviously in the statement "more (.) **social** or **creative** things like that that don't involve math or: economics (.) like things like complicated or dry material" This casts the 'complicated' mathematics as superior to the more 'social' programs which are implied to be easier. This depiction of mathematics is consistent with her portrayal of the discipline as discussed in Sure, Structured, Strong, and perhaps given the importance all of the participants placed on doing mathematics what may be going unsaid is a sense of being in some way superior to those who choose not to engage with the subject. This is not to suggest that this is a conscious effort on the part of any participant to be derogatory towards others, but rather that this discursive positioning is based off on discourses of which the participants are already aware. As per Wetherell and Potter "discourse become implicated in the very instantiation and maintenance of social and economic relations...discourse is active, compelling, and a pervasive part of the fabric of social life." (1992, pp. 60–61). These dichotomous positionings then become part of this work on social relations as the participants negotiate the complexities of social positioning and that of their own identities. Reflecting on this further, Walshaw (2001) discusses the back and forth between positionings of a participant she calls Donna, who at various points casts herself as knowledgeable and then as 'blonde' or lacking. I believe that this serves as an important reminder of the importance of exploring the contradictions and seeing in a Foucauldian sense how people can move between positions of powerful and powerless as they attempt to make sense of their reality and their place within it. Returning to Rebecca, diving

deeper into these dichotomies we can see instances of struggle, for instance when she speaks about others in her program or the general feeling she speaks of an everyone for themselves competitive environment and then confesses that she struggles with that as she feels she benefits from collaboration. While it is another binary that follows the classic views of mathematics, in this instance she places herself on the 'lesser' side, as opposed to her general view on the STEM versus Arts divide in which she places herself on the 'stronger' side. This can also be read a way in which she may be trying to perform femininity, as this alignment with collaboration which sets her apart from the grouping of the other competitive students sets her apart in a way which evokes the idea of traditional femininity. The lines between the binaries are not always firmly drawn, as seen in her comment at 59:01, where she specifies that the programs without mathematics may just be easier for them perhaps in the same way as mathematics is easier for her and that they too are passionate about the world even if they have not chosen to express it in the way she has. In doing so, there is a sense of blurring or softening of the dividing line between 'us' and 'them' that some of her other comments evoked. Further, Rebecca offered another binary pair framing that appears infrequently in the interviews of the remaining participants and in doing so also highlighted another way in which topics of identity intersect across far more fields than simply gender. Rebecca spent a good deal of time on the binary of fast/slow, in which she repeatedly stresses that she is 'slow' but that speed should not be a factor in who does mathematics.

> R|39:33|/// i want to prove that anyone can **learn** math it doesn't matter if its quick or slow and i even met with someone who:: she made me feel **bad** in a way because i was studying a degree that was economics and mathematics and **she** was doing financial mathematics and economics and they're **both**- both are very hard to get degrees but she made me feel as though as if if i can't understand concept in math like that fast w-why are you in th-the program? (.) and that's something i really didn't appreciate because you can't assume every student- like you can't assume that just to be in this degree you have to be as **fast**- a fast learner to be in this degree like anybody even a slow learner can be in this degree (.) everyone learns at their own pace i don't feel like you should **discriminate** that (.) especially cause there **are:** X(academic accommodations) students y-you have to take them into account too some of them are- you know they learn really fast they have that gift and some of them they just need more **time** and uh you- and depending on what sort of learning i don't want to say **disability** but that's what its called some of them have to repeat a course to get it///

CF|41:32| that's fine (.) um although i did have a question about you-your last statement you said that you didn't **want** to say disability?

R|41:42| i- cause its **not really:** a disability like just to have brain that functions just a bit differently: now there are things that i would **consider** a disability but if you have something like *ADHD* that to me is **not** really a disability it just means you have a different way of learning and it makes you uh and once you understand it you actually use it **faster** you-you start learning it faster (.) so there- i- i don't know but th- normally it's called learning disability uhm(.)///

CF|42:34| mhhm:: no thats true(.) umm(1) would your impression **be** – because i think you've mentioned it once- or like a few times of- you feel (.) that you learn it slower?

R|42:54| yeah it depends on the content if it's a- if it's a math class that has- that will use calculus as a base it won't be that hard for me to learn but if it's a class where (.) it does use it but then there's something entirely ne::w and i'm not grasping it that fast that's when i learn a bit **slower** cause sometimes i really wanna know what they're talking about (.) so i can end up not performing that well but i know when i redo a class again i usually perform a lot better that's the trend i have with me

CF|43:27| do you mind if i ask just- s:low in relationship to:: wha:t?

R|43:34| (1) i think just slow in understanding (.) the concept some students they- they understand it faster some students they get it quickly (.) and they-and it shows when they perform on tests- they perform they get a higher mark than **i do** just because for me: i might have not understood it (.) at all and i s-and i will do: like my own research at home but i might find that it's too- so new that its hard for me to grasp it (.) like i need more (.) **time** for it to register with me

CF|44:02| ^ok^ and do you ever get the **feeling** that there's a lot of- or that there's some degree of- of pressure in mathematics to do it quickly?

R|44:11| a lot of times you can feel discouraged i- i would have to admit i've felt discouraged a lot but i- i try not to let it get to me (.)cause(.) you should love what your doing and you shouldn't let something like being discouraged prevent you from pursuing it (.) so yeah there are **times** like especially my mathematical economics class umm i- i had to drop it because it was going **way:** too fast for me it was too much stuff- like i- at the same time i was understanding it but it was going so:: fast that i can't remember it i can't (.) retain it so i had to drop it and i said this is a course i would have to do on its own just to learn it so (.) yeah i've- i've had times when it was going by too fast

Here, for Rebecca, is one of the greater challenges to her pursuit of mathematics, as she shares that she makes use of the university's academic accommodations in order to write her exams to support an unspecified learning disability. The section of the transcript above is just one instance

of our discussion on this point over the course of the interview. So, this is an important intersection between discourse on disability and mathematics and how these can be negotiated. This does not exclude the possibility of gendered implications that may be reinforcing the fast/slow binary as well but it is necessary to acknowledge that while this study is focused on issues regarding gender and mathematics, that discourses and identity are far too complex in nature to be limited to only two categories. Rebecca seems to be aware of the association of speed with mathematical ability, and as such engages in a complex negotiation with regards to her learning disability as she works to reject the connection between speed and mathematics success as she tries to perform an identity as mathematically able.

For Amy, the most frequent binaries were based around ideas of mathematics as rational versus emotional or social and STEM versus Arts.

> A|8:45|=yeah its like really consistent its- it doesn't depend on the weather or how you're feeling or stuff like that it's is just always like a **fact** it's just you can do something on the real numbers because it's a field and then like ok that's it you just you just take it {*laughter*} =
>
> A|9:09| i honestly wouldn't know because me being me math has always been- like especially like in primary school and in high school has always been hr- ugh it's has always been easy and i've always been fairly- it's always been fairly- i've always been like a fast learner when it came to math///
>
> A|36:19| yeah exactly definitely not especially just coding cause i've always been (.) not (.) good at um learning languages like spanish i've took spanish since like- from like grade six to grade twelve and i honestly can't speak spanish (.)but my brain just doesn't retain language so when you're coding in my opinion it well i mean it is a coding language but my brain ^just doesn't^ doesn't see the patterns as much or it doesn't recognize something (.) its just there
>
> A|1:23:23| but um (.) but yeah just the fact that now i know for a fact i'm not a hundred percent sure of it that there is an infinite amount of things that i don't know (.) you- i'm pretty sure you could prove it ^mathematically but let's not go there^ um but yeah just the fact that i- i feel like i don't know anything and that everyday when i'm (.) going to math classes i'm really learning something new and its really fascinating and satisfying and fulfilling fulfilling yeah because that's what people ask me why i went to math after doing psychology as it's just that when i was in psych i just didn't feel like it was fulfilling (.) its just- it just felt too like easy or (.) meh cause going to class someone telling me something like yes i understand what you just said and that makes sense is not the same as like ok today we're going to prove this and then you're going to be like able

> to solve/// it really puts you like (.) it really without it sounding like condescending it really puts you in your place so you're like ok i'm really stupid actually but like **we're** not and they don't want to make you feel stupid but its just when you realize that you don't know **anything** (.) i don't know if it makes you- it's humbling {*laughter*} i think that's the word for it yeah (.) {*laughs*} but yeah

These comments illustrate these binaries and some of the negotiations more specific to Amy. As discussed in the previous theme, her categorization of mathematics is super rational and ordered, as she puts it "it doesn't depend on the weather or how you're feeling" a statement which sets up mathematics in opposition to flexibility and emotion. Particularly noteworthy among these comments is at 9:09, as this is one of the only instances in the entire interview where she comes close to identifying as 'good at math' and even this is framed as being in the past. This may be a reflection of what Rodd and Bartholomew noted amongst some of their own participants, that their "early identity was embossed with a self-conception as mathematically superior, special, chosen" (2006, p. 41) although they struggled to claim current successes. Interestingly, part of this 'good' seems to be accompanied by the association with being able to learn or do mathematics quickly. This relates not only to the construct of fast/slow but also I believe to the understanding of mathematics as something that is 'easy' for some people, perhaps rooted in the popular notion of 'math brain' as this is often linked with that specific subset of people 'who just get it' doing mathematics quickly. Examples of this can be seen in discussions such as that of Epstein et al. (2010) as they speak about how student imagine mathematicians, with many suggesting images of geeky eccentrics who seem to just understand something in a few others do. Furthering this impression of a firm divide between those who can and who cannot, is how she speaks about her own difficulties with languages, which she casts in the role of the 'other' to contrast with mathematics. In fact, she explicitly frames it as her "brain just doesn't retain language" which would seem to be another fairly stark binary opposition. However, for Amy, mathematics is not always cast on the side of easy, for instance in her remark from 1:23:23, where she says that psychology had felt too easy and therefore was not fulfilling, implying that mathematics is more challenging and accordingly more satisfying to engage with as a subject. This negotiation between mathematics as 'easy' and challenging became a pattern from Amy in particular as she navigates between representations of mathematics as a difficult subject, and as easy to help perform an identity as mathematically able.

Kim displayed several dichotomies outlined at the beginning of this theme, which can be seen in the selection of her remarks below. She made perhaps the most extensive sets of distinctions between mathematics/mathematics students and the Arts or Humanities students out of all four participants and several are included here.

> K|4:15| i think it was also:: just always interested i guess uhm my **dad** really loves math too uhh he's: a fireman but he was in mechanical engineering before- technical mechanical engineering and so:: he's kind of like (.) i guess given that passion to- to me from there umm but yeah yeah i just remember like it- it was always kind of like easy i guess? math always found it interesting ah yeah {*laughs*}

This comment is one of few from Kim that classified mathematics as 'easy' albeit in a rather tentative fashion, she would go on to focus on the complexity and depth of mathematics for much of the interview. She tended to avoid discussing ideas on mathematical skill but tended to frame things in terms of being able to understand or as different ways of thinking. Like Amy, this reference to mathematics as easy is in the past, Kim follows that trend.

> K|7:38| yeah and- this teacher we had in gra:de eleven ah for the last math class that was mandatory for every student so after that class you could choose to continue math or not um and **he's** known to being super strict he was a university teacher before so that's how he's known to teach his **classes** so kind of like he:re's the things you have to learn now like you have to be i guess autonomous and do your own work uhm and that was never a problem for me

While Kim did not spend as much time on this dichotomy as other participants, she too does occasionally bring in the pair seen here at 7:38 for example, independent/dependent as we discussed her earlier experiences with mathematics. She spoke about being successful as she was able to work well independently while recalling that many of her classmates struggled "because they're used to just teachers kind of like holding them by the hand"/7:38. She continued on to what would become some of her most frequent dichotomies short after;

> K|32:24|/// **but** math students and the physics students a **lot** less it's- it's very **different** i guess and (.) it's just i guess- i guess they're more **organized** in a way that is different from (.) other people and it's just the way that uhm (.) i guess you organize your thoughts i don't even know it's just **strange** sometimes///
>
> K|34:36| **yeah** yeah i guess it **might** be when i think about like my language classes and i took a bunch of like geography classes and things like that where it's more just like read and learn and just like learn by heart and things like that i guess it's more **memory**

based? uhm where as math it's a lot more- you have t- its kind of like you have to go deeper///but there's no like **one** way to solve a problem especially when you go into like more advanced math so:: it's- it's like **how** do i solve it **how** do i apply what i learned to kind of like (.) come up with the solution **myself** it's- it's- it's a lot more thinking i guess it's a lot more (.) yeah {*laughs*}

CF|51:08| ok and do you feel like that's like a different way of thinking than (.) than like other well i guess like types of people or other ways of thinking? like is it very- like distinct to that do you think?

K|51:20| yeah yeah for sure i- i mean like everyone thinks a different way uh i guess it's a more:: (.) ah- um not really **abstract** but more:: just like spread **out** way of thinking instead of just like going to the direct kind of like finance like what do you mean *X* is there? what do you want me to do kind of thing it's more of like ok *X* what could *X* be? just- so i guess it's a lot more uh like i- i- i think about people who **really** like uh humanities classes in general and things like that **except** for the fact that they love like everything that has to do with communications or the world or business or things like that uh they also **love** kind of just like (.) learning things by heart and really learning them and they're already like there and that's already what you need to **know** and then you go on your exam and you say like ok yeah now i know these things and then here they are i just write them down and that's all i do kind of thing whereas **math** is like ok i've kind of learned how to do these things but like (.) i don't know the answer you show me this i've never seen this equation before like you have to **come up** with the answer on your own and kind of like learn how to **do** it before you- you even learn ^the answer really^///

CF|52:35| is it like more challenging do you feel in a way?

K|52:38| in a way (.) i guess i don't find as much pleasure in- in just learning things by heart just because if it's something super interesting but if i'm learning about i don't know **history** there's like who is the nanana who invented the nanana and=your=just- i'm just like ok this has already been invented this person is probably dead like **why** am i learning this? whereas math is like ok **coo:l** this is my equation and i'm learning how to **do** this and now i can **solve** it and this is going to help me do **this** and for me it's just a lot more i guess application towards what i'm learning in math versus what i would learn in- in another class where it's just like some (.) things that i learn by heart of course like if you're thinking like **biology** or chemistry and things like that and things **there** that you have to learn by heart i guess **that** is super useful i mean everything is useful but its just for **me** its not as fun to- to do just to learn something and then just like regurgitate it on a piece of paper whereas to- to practice something and then to actually **do** it and like make it yourself and- and like finish the exam and then feel proud that you just like did all this (.) and yeah

In these passages, some of the binaries that Kim would frequently reference are made quite clear. The first is real understanding/rote learning, as she attributes real understanding to the field of mathematics while framing rote learning or memorization as a property of humanities such as history. While this dichotomy is displayed throughout these comments, the unequal value placed on 'rote learning' is perhaps most in evidence in her comment at 52:38, particularly "**history** there's like who is the nanana who invented the nanana and=your=just- i'm just like ok this has already been invented this person is probably dead like **why** am i learning this?" which leaves the impression that this memorization of historical facts is, to Kim, boring or perhaps pointless. This idea would seem to further support the overall sense of the STEM fields as superior to the Arts. Another binary that appears in this selection from the transcript is order or rule based/social or emotional, as she speaks about the tendencies of mathematics students as being highly organized while humanities students "they love like everything that has to do with communications or the world" which would seem to cast them as being more social in nature as she cites communications and 'the world' as examples of their priorities. These binaries are not all clear cut, as seen in the comment at 52:38, where she acknowledges that some other fields do often rely on memorization and that these can be very useful and concedes that everything can be useful. Although she does immediately return to her preference for doing mathematics which she casts as more challenging and as more engaging. To follow up on that comment, I asked her to clarify based on my impression during the interview;

> CF|53:40| so:: (.) and like correct me if i'm wrong but it feels like you- math is a very like sort of like active thing for you
>
> K|53:49| yeah yeah it is yeah because for me its just like you don't just (.) it- you can't go on a **math** exam or test or even homework and be like ok i'll be done in like two minutes and you just need to like write the answers like if you go on a **test** and they ask you something in a math test and it's like a ten point answer and you just write the answer they wont give you any points that's=just worth zero point five points what is worth the points is the actual kind of like (.) the road that you took to get to that answer so for me it's just like the (.) i guess the challenge and the pleasure in finding that answer and in **doing** that and it's so fun too because you would look at- at two different exams and two different people who found the same answer but used a different road so that's what- what's interesting too about that is kind of-you can keep thinking your own way and solving your own way as long as you get like the proper answer at the end which is not worth that much (.) yeah

This dichotomy was a rarer one and is only really brought up directly by Kim here, namely that of active/passive. To some degree this binary could be read in some of the comments regarding the deeper understanding/rote learning as these are typically described in active/passive images, where they describe 'doing mathematics' and working on problems whereas rote learning is framed as more passive reception and regurgitation of the same information without the need to work on it further. However here Kim makes this particular binary clearer, as she delves further into producing an image of 'doing math' as challenging, engaging and time consuming, in other words something which requires you to be very active in order to work through to the answer. Overall, her descriptions of mathematics in contrast with its 'other' the humanities, paints an intriguing picture of Kim's figured world as she negotiates between discourses surrounding mathematics. To Kim it seems as though those who do mathematics are people who value a different way of thinking that prioritizes deeper understanding and requires active engagement to solve challenging problems. While she does at some points attempt to soften or blur the dividing line between the qualities she sets up as 'superior' and those 'lesser' qualities, for much of the interview the contrast seems stark and she typically placed herself within the grouping for the higher values although it is important to note that when speaking more specifically about herself rather than more generally about people in mathematic that these lines become increasingly blurred.

Megan made use of a number of STEM versus Arts binary constructions but among the most prominent for her was the dichotomy between competitive/collaborative. From my own impressions of the participants, she appeared the most competitive, a tendency which she acknowledged and sometimes wrestled with as she tried to negotiate her identity within her narrative.

> M|13:58|{*laughs*} no:: and i think again that's just society of you know the stem subjects are difficult and they're challenging and i think that just varies on how your brain works of what comes easily to you what teaching styles work for you uhm and so: yeah a lot of people were like ugh it's math class and i'm like it's math class! eight thirty in the morning on monday like let's you know jump to it but yeah
>
> CF|14:27| mkay so did that change like the vibe a little bit like thinking about when transitioned to like the grade twelve where everybody was enjoying it?

> M|14:31| a little bit but i ah i almost fed off of their disappointment by being more excited right like it was let me show how different our opinions are///in fact i'd say almost i was more excited about math in grade nine than i was in grade twelve just cause by grade twelve everyone's at more or less the same level of excitement and so there really like your kind of i don't want to say you're dragged down to their level cause that sounds bad but you know you're like at the same level as everyone else so your- you're just you know settled where as when there was a big different i was like you know let me tell you how great math is cause you don't understand
>
> M|17:31| so because were all more interested i feel like we didn't have to prove to the other people that we were interested so we didn't **focus** as much on how interested we were uhm and so i think for other people it was better for **them** to be with like people who all had the same ah interests but for me i needed like a project its gonna be bad to turn a person into a project but you know someone to convince or to help or to ahh assist in so not having that (.) created you know issues for me in just the enjoyment of the class but overall i think they were still some of my favorite classes cause the- they were math {*laughter*} sit there and learn math
>
> CF|18:18| ok so like what were interactions with your classmates like then?
>
> M|18:21| i'd say they were more minimal because we all: had an idea of what we doing we all could figure it out on our own there was less collaboration and there was less interaction ah there may also have been some slight competitions which depends on who was getting the higher scholarship and who was getting into the better program and who was right not necessarily a math program right but who was going further than others so i think that created a bit of tension too as compared to in grade nine uhm but yeah we all: for the most part kind of did our own thing sometimes we would work together on projects when we had spares together but for the most part it was more i'm doing my own thing and i wanna only worry about my own knowledge and ability so

Throughout these statements, Megan both embraces and struggles with this image of herself as competitive. She seems to thrive on the competition but seems aware that it may not 'look good', for instance "i needed like a project its gonna be bad to turn a person into a project but you know someone to convince or to help or to ahh assist" Here she attempts to reframe her more competitive stance that thriving on telling others why they were wrong to not enjoy math, as she seems to feel that that does not sound good and switches to saying she was helping them. This change falls very much along binary masculine/feminine lines as she switches from competitive (masculine) to the more feminine collaborative and nurturing role of teaching or assisting. This challenge for Megan's identity negotiation continued throughout the interview. Accompanying this, she also made use of the independent/dependent view of mathematics versus humanities

> M|21:42| {*laughs*} so i went from a small high school///to {*laughs*} university uhm (.) and it was fine for me ehh socially because i'm mostly introverted and so i'm ok not talking to a single person all day long and i'm ok i- i'm able t- to disappear in crowds if that makes sense so i'll be in a crowd but i'll feel like i'm not **there** right and then you make eye connection with someone that you know and you're like oh right i'm actually here in the present um and so going to classes of really like really large groups i would simply sit on the end or the front or the back right or like somewhere on the outside and i usually wouldn't talk to anyone which was fine by me umm and i was able to focus more on the academics
>
> M|23:35| yeah yeah it was a lot less community and a whole lot more this is your future and you need to just you know figure it out on your own

The environment she describes here is as some of the other participants have said, a very much 'everyone for themselves' feeling which evokes not only a sense of competition but independence. Megan's comment from 21:42 brought to mind the discourses of the participants in a study conducted by Rodd and Bartholomew *Invisible and special* (2006) in which they speak about how women in undergraduate mathematics programs seemed 'invisible' and that this was not merely a matter of their being ignored but that some women may have adopted this as a form of defense. While it is possible that Megan's comment is simply an expression of the independent or more isolated image she paints among the mathematics students, it may also be a way in which she can navigate challenges that may be presented by being a woman in an undergraduate mathematics program. Building further on the climate she describes, Megan leans on another binary, namely order or rational/emotional or social.

> M|40:10| uhh in some of them yes i think chemistry and math were similar because they're both very ahh factual based right and chemistry involves a lot of math or at least a lot of structure uhm where as i also took business courses english courses criminology courses and those were a little bit less structured///and some of those classes ah i noticed the behaviours of the students was different too ah in chemistry and math people were more serious about what they were doing they were paying attention in class they were actually taking notes down where as in some of my other classes i noticed people online shopping watching soccer games right uhm not writing down notes um sometimes not even showing up for classes///so i think that could just be personal preference of people but i think in the stem field it's more structured there's links between things ahh students take it more seriously i don't know if that's a good thing or a bad thing but it's just something that i've noticed umm and yeah sometimes this might be bad too and it might vary on the classes i can't say i've you know seen a lot um but the professors in the stem fields i find are more prepared for their classes um

> M|42:55| i think it attracts the type of person with a particular learning style///but i think people in the stem field are more structured they're more (.) ah pattern based right they ahm (.)th- they're not always organized but like they have that aspect of the ability to be organised umm (.) and i think people in humanities or other such things may be more creative ah they may be more flexible they may have umm a more general idea of different aspects of ahh certain things and i think um sometimes people in the stem field can be more this is what i want to do in my life where as a bunch of the humanities ah i'm thinking of like global interactions and stuff like that they're more world as a whole what can i do so i think that goes to what you want to do what your vocation is what ah how your brain works right and all of that
>
> CF|44:30| so do you feel like there's like certain elements of brain function in a way? or?
>
> M|44:39| yeah i don't know if it's like if it could be scientifically proven as like how the brain functions but i feel that people in more structured subjects are more structured mentally umm not say that they're more intelligent but just that their brain works a different way than other people who may be more creative or more artistic or more you know able to adapt to different things so

This remains one of the most prevalent ideas across all the interviews, establishing STEM versus Arts and the divide between the two along the dichotomy of rational/creative. Often, as Megan does here, participants tried to soften the sense of Arts as lesser by saying things to the effect of that's how their brains work, that everything is important, or that they simply have different passions. Megan's commentary that makes use of STEM versus Arts binaries tends to place her on the 'higher value' masculine side of the binary pairs, although as discussed above this position is not stable and is subject to repeated contradictions as she negotiates the representation of herself.

Overall, in exploring these implicitly gendered binaries of STEM versus Arts/Humanities as representing terms which have been classically cast as being masculine/feminine, I deepened my understanding as to how each participant worked to negotiate their own positions as someone in mathematics and how 'their' group was framed in contrast with its 'other'. Having established a sense of each participants' view of what mathematics is, the intent of this theme was to open up the investigation as to who, in a broader sense, does mathematics. While each participant offered a slightly different take on STEM versus Arts, each takes up this discursive framework as they try to establish characteristics of people, themselves included, doing mathematics. These binaries are not easy to navigate, and so participants do not always position themselves on the 'higher value' masculine side as they work to balance identities as both mathematically able and

feminine. These struggles highlight some of the difficulties faced by participants in these negotiations, and how they take up or reject elements of the STEM versus Arts binaries in order to position themselves within their figured worlds.

Binary 101 – Men vs. Women?

As the first section of this theme explored the implicit gender discussions with the participants through their construction of STEM versus Arts binaries, this section branches into the explicit discussions I had with participants on gender. While there was significant overlap in the descriptions of mathematics and mathematics students across the interviews as participants negotiated themselves versus 'others', there is in contrast, relatively little in common across the interviews when speaking specifically about gender. One of the very few commonalities was an idea that there might be biological forces at play in the learning of mathematics, although interestingly one of these was presented as males possibly having an advantage, the other was made as women having an advantage. The concept of underlying biological differences as an explanation for mathematics performance is far from new, as Paule describes them "some historical 'truths' which persist, not always as dinosaurs lumbering around in anachronistic and highly noticeable ways, but as more pervasively entwined into the discursive DNA of gender and learning" (2015, p. 744). This seems an especially apt way to sum up the continuing fascination with the idea of a 'math brain' that has been widely discussed in the literature. I had direct conversations about gender with three out of the four participants, Amy was the only one with whom the topic did not make an appearance as a discussion.

As Amy did not really engage with this topic except in passing, I will address her comments first. She did ask about the other participants, wondering how many people had responded which lead to a brief exchange right at the end of the interview:

> A|1:28:39| no cause i'm- i'm just- i'm just curious as to how many people are in math and how many girls are in math cause that is a wil- that is a wild concept for me {*laughs*}
>
> CF|1:28:49| girls in math?
>
> A|1:28:50| no:: well i: just say that because were so:: little and then (.) we're not a lot in math and then like how many girls do you see? its like well i don't see anyone realistically cause were like 9 in class

> CF|1:29:03| is there like a big gender disparity?
>
> A|1:29:06| i- i wouldn't think so cau- so in my math class there's in real analysis i think were at eight or (.) like eight or nine and i would say like it was like three four girls and like four five boys so it's like
>
> CF|1:29:21| not like a huge imbalance
>
> A|1:29:22|yeah exactly it's just that no one is in math so ^like^ i'm just interested by- but yeah {*laughs*} yeah (.) so yeah

Amy did comment frequently on the small number of people engaged in mathematics programs, and as she seemed disinclined to continue this discussion I did not push further, particularly as this was at the end of the allotted interview time. Her perception of this exceptionally small number of students may have been influenced by the fact that she was doing her mathematics courses in French, which may have had a smaller number of candidates than the English stream. Given the brevity of this exchange, these comments will not be discussed further.

Rebecca was the only student who said that she was unaware of the stereotypical "belief that boys are more mathematically capable than girls" (Piatek-Jimenez, 2008, p. 634) and indeed said that she had heard the opposite:

> R|1:05:34| no i've actually never come across that sometimes i start to see boys are not as smart as girls at math {*laughs*} but that that can't be true either but that's just my experience from school i find that the girls have an easier time understanding the concept than the boys but that could just be also because of how- how the brain functions of a guy and girl are- it's ah it's- you know it's kind of true that maybe males learn a bit different than females females learn differently from males you know we all have our biological makeup that makes us more advantaged in this and that so um (.) like for example it's a fact that guys have more muscle build than a girl that doesn't make it- that doesn't mean a girls weak it just means- that's just a **thing** its just- its **there** guys have- they're more built to have more muscle while a girl is meant to have more **fat** to carry a child (.) mh so that's what i'm trying to say i'm not trying to discriminate oh that's preventing you from doing anything{*laughs*}///all i'm trying to say is **maybe** i'm noticing boys learn (.) slower? at math they just-they -they need more time to grasp it but that- i don't know if it's like i cant say it's the same for everybody i mean my dad's an engineer i mean he's- and uh (.) yeah i thin- i feel like i- i don't see the stereotype where- where boys are better than girls at math i've seen a lot of mathematicians that are women too that are let's say high up in politics you know member of parliament and even for science i think there's a **dean** for science here who's a female [might have been in the news somewhere ahh (.) i think there's also a vice dean for economics whose a female we have- we have a lot of

> those we have a lot of vice deans in economics that are male and female so (.) i feel like both genders are just as capable

Here, Rebecca is referencing biology, specifically the brain to explain observed learning differences from her perspective between men and women. However, rather than the gendered stereotype that has been discussed throughout much of the dissertation, she instead leans towards the suggestion that women outperform men. This belief may stem from more recent trends towards the discussion of education and how boys, particularly in reading but overall in school are at a 'disadvantage' or struggling compared to girls educational achievement (for examples see (Buchmann et al., 2008). This may be what influenced a statement which occurred shortly before:

> R|1:02:41| mathematics is actually the same there's a **lot** of females and a lot of males sometimes there could be more females than males it's just if er if you went- if you go back to elementary school like or high school and who does more math classes and there's always like this (.) there's **dominating** females in the class (1) ^i don't^ (.) so but so far i've noticed there's a mix i haven't seen (.) which group is more than what

While she does stress that biological differences that provide various advantages/disadvantages she also makes sure to emphasize that she does not wish to discriminate and that both genders are capable. This concern about the speed at which one acquires understanding not reflecting on the eventual success at the subject that here she associates with boys is interesting as she often referenced her own struggles with processing new information which she links with her learning disability. A portion of her comment from 1:05:34 that I found intriguing is her assertion that she knows of women who are mathematicians, and yet none of her examples, perhaps barring the vice dean of economics, are directly or explicitly to do with mathematics as her other examples consist of a politician and a dean of science. This is not to say that those women are not mathematicians, but rather to draw attention to the fact that the connections are less direct and are somewhat tentatively put forth. Some of her struggle may be due to the fact, as she explains here:

> R|1:04:23| ///i haven't ah come across any ahh ah a female teacher in mathematics yet so: (.) no no not yet well i coul- i could say in economics like mathematical methods one and two i've had female teachers but **they're** more special- they're specialty is like statistics in economics so i don't know if i could consider them a math teacher but they have like a professional business look attire

Rebecca's difficulty in naming female mathematicians might in part be attributed to her apparent lack of female mathematics teachers, however, there may be influences of gendered discourse on mathematics even if she is not consciously aware of them. Upon further reflection, her statement from 1:04:23 may suggest this, as she says that she has had two female teachers from the economics department teaching courses called mathematical methods and yet is still not certain she could consider them to be mathematics teachers. That may be due to the often unclear definition of what is and is not considered to be mathematics as I discussed in Sure, Structure, Strong but if so, that is still rooted in gendered notions of what counts as mathematics and who is permitted to decide what is included or excluded. Her choices of examples may have been influenced by other portions of the discussion on for instance future careers as she expressed interest in both statistics as well as an eventual career in politics. Overall, Rebecca did not appear to have gender at the forefront of her mind throughout our discussions. Rather, when asked questions about courses that might attract a type of person that was intended to discuss personality and indeed that was how other participants interpreted it, she instead spoke about the ethnicity or domestic/international student status. Rebecca was the only participant who identified their ethnicity and who discussed programs in terms of appeal to non-Canadian students.

> CF|51:09| yeah do you ever feel like it attracts like a certain type of person? or::?
>
> R|51:17| ahh i don't wanna say anything but this is what i'm noticing from **my** class for instance economics it attracts and this is a **fact** now a lot of international students///i've seen it i'm in the class it **attracts** a lot of international students and (.) i think it's:: becau:s::e well i don't wanna give a reason why i don't really know **all** of them and their- their reason for pursuing economics but i think (.) from what i know and i- my family i- are immigrants too cause that- immigrants in **general** they like to:: (.) pursue things that lend them a successful con-career and they're known to be hard workers i'm not saying all immigrants are like that but this is just from my experience (.) and i've noticed **that** the majority that make up my economics class are either they're european looking or they're very uh korean japanese uh uhmm **asian** looking so: we have like a **split** and there's a minority like arabs like me:: [{*laughs*} you know some-sometimes i'm the only arab in the class

This took place during a conversation on how people viewed mathematics as we had been discussing the reactions people had to finding out she was in a mathematics program. Admittedly, while 'type of person' is somewhat vague I had not anticipated it would be

interpreted as asking about the ethnicities represented in the student body or domestic/international student ratios. This brought to the forefront once again the multiplicity of identities everyone is negotiating, and as she continued to bring in similar comments periodically throughout the course of the interview my impression of her figured world was that ethnicity had a more prominent role in her identity negotiation than gender may have, particularly regarding mathematics. This may relate to observations by Archer et al. in their study on girls with science aspirations in which

> South Asian students (i.e., students of Indian, Pakistani, Bangladeshi, or other South Asian heritage) had stronger aspirations in science…their families espoused cultural discourses that value science as an appropriate and desirable career route (for girls and boys), which renders careers in and from science as highly "thinkable" (2012, p. 980)

Although Archer et al. (2012) was focused on science, it is possible that given the importance of mathematics within many scientific careers and the degree of overlap between discourses on science and mathematics, and so Rebecca may have been exposed to a different cultural discourse on mathematics than other participants.

Megan presented the most contradictions when speaking about gender directly, which was a portion of the conversation she brought up without a specific mention as seen at the beginning of the passage below:

> CF|45:10| ok so what kind of (.) so how would you describe then the people that generally go in- into the stem programs from what you've seen like from your classmates?
>
> M|45:22| so majority are male {*laughs*}
>
> CF|45:25| ok
>
> M|45:26|which {*laughs*} makes sense umm but i think (.) sometimes we're more set on one path of we know generally what we want to do um i was talking to one of my friends who was already looking at masters degrees programs and where he wanted to go and what he wanted to do and i'm like you haven't even completed second year like {*laughter*} slow down you're making me feel bad about myself but um i think we have a more direct path where as i think some other ah students in different fields are more well i'm interested in this so i wanna learn about this///but i think we have a more focused view of um what we want to do what we're interested in where we're headed where as some other ahh faculties they're:: still open to a bunch of different options ah to do for

> the rest of their life and i think that can show through in what you do as extra curriculars what you do ahh how your personality works how you interact with people umm yeah

While most of her comment at 45:26 was focused primarily on discussing personality, during which she referred back to a dichotomy of STEM versus Arts represent here in terms of structure/flexibility, I was intrigued by her suggestion that although there was a gender gap, that this gap 'made sense'. In the follow up discussion, Megan appears to both believe there are things that discourage women from STEM fields but also that no one is pushed in a specific direction anymore.

> CF|46:56| ok umm there's a couple things i want to ask about with that you said the majority are male but you also said that that makes sense why is that?
>
> M|47:08| ahh i think in the this is history repeating itself now umm i think it's common for a lot of guys to go in to stem field i don't think that right now in society that's you know pushed to go either way i don't think its an intentional gender gap i think it's a:: uh rational and understandable gender gap umm based on now most people depending on high schools and grade and whatever else can go do what they want to do and so:: and there isn't i don't think i personally haven't experienced any uhm like shepherding into one thing like i haven't experienced any pressure to go into one field or a different field i haven't had anyone you know be disapproving of what i've decided to do so (.) a- i think with university people should get to do what they want to do umm and i think for the most part females don't want right like i don't wanna say as a whole but just in general overall ah i think that mor- more women would go into other things and that doesn't necessarily mean that's good or bad right um and maybe over time we'll see a difference umm because i know the history you know women were not encouraged to do such things so: in a hundred years it might look completely different based on society and stereotypes and everything else but right now i don't think people are told one way or the other what to do but ahh subconsciously its you know still a difference so
>
> CF|49:07| so what're the sort of what're the kind of subconscious things that you think might be making a difference?
>
> M|49:12| well i think because (.) right if we just go back only one hundred years you know women were not in math and so i think society is as a whole doesn't see women in math or in the stem field in general umm an i (.) i don't wanna say that's a good thing or a bad thing right it's just this is how it is umm (.) but ah (.) i think it's just everyone's different and everyone has their **own** umm experiences everyone has their own goals and so i think everyone should be given opportunity to do what they want to do and if that ends up with you know classes having gender gaps then as long as everyone's where they **want** to be or they think they want to be then it's ok

> CF|50:00| ok so you mentioned (.) stereotypes what kind of stereotypes are you thinking about?
>
> M|50:08| uh well there's a couple ahh the stereotype of a male dominated stem field the stereotype umm of sometimes being difficult as a woman to get certain jobs in certain fields when employers are worried about maternity leave and other such things umm i'm thinking about the stereotype of women going in to more ah non=stem fields of really any other sort or going into umm biology or chemistry or to become a nurse or that kind of idea ah which i think is just something that society was and so it's still slowly affecting but i think that will stop over time
>
> CF|53:46| ok so it's not so much that people outright really have ever told you no you can't do that but there is still kind of that perception that's maybe its just even that people don't even think of it as an option because when they picture what that is it's some old white dude and you really don't care
>
> M|54:05| yeah so its just that subconscious perception that sometimes you don't even realize that you have so just to you know ah create the ability for them to see things in a different way and see themselves in a different way

This passage from the transcript emphasizes the struggle participants can face when trying to navigate gendered discourses as they move through their lives. While Megan does not feel that she has faced direct forms of discrimination based on gender, she also acknowledges that the ongoing stereotypes surrounding women and STEM are likely having an impact on the number of women entering the field. Heather Mendick (2005a) noted a similar reluctance to read the influence of gender on her educational choices from one of her participants. Perhaps, as Mendick suggests, if a participant is engaged in representing an autonomous self, this "compels her resistance to connecting being female to lacking power and to disadvantage in her own life. Instead she attaches these to generalized others and to the impersonal realm of reports, statistics, and theories" (2005a, p. 245). This 'illusion of choice' that is free from influences may be what Megan is trying to evoke in how she narrates the story of herself 'choosing mathematics' while it is others who may have been subconsciously led around by the influence of stereotypes. Earlier in the interview when she was describing her high school experience and classmates:

> M|19:29|{*laughs*} it was kind of just a thing that we laughed about it um because we had kind of foreseen this happening right a lot i was in a grade of mostly girls so it was kind of impressive we joked it was the one class where there were more guys than girls in it um because our classes as a whole were a lot more girls than boys ah it was about three to one ratio but a lot of the girls were into more humanities or the english right like that side

> of things so it never really affected our interaction with each other for the most part we'd all been there since grade nine so we knew each other really well and we were all close friends so it never created drama of any sort uhm it- it was it was just kind of i felt a little bit prideful that i was one of two girls right? uh {*laughs*}
>
> M|20:25| i think it was just the interests of the people in our grade right grade twelve math wasn't something that you had to take you only needed three maths and in grade eleven we had a middle math option which counted as a credit but wasn't the university level math right so a lot in grade eleven there was also a lot less girls i think that's just what the people in our grade had intrests in i don't think we were ever really discouraged? as girls going into the stem field but it certainly was rare for our grade so
>
> CF|20:59|ok did you ever feel that there was like (.) any of the stereotypes that might have affected people?
>
> M|21:05| it's possible um i think by grade twelve people had figured out where they wanted to go and what they wanted to do and if math or chemistry biology etcetera didn't fit into that or wasn't necessary for that then they didn't do it right they focused on what they needed to get good marks in for university ahh certainly there's stereotypes everywhere that affect everyone in different ways um but i don't- i don't think anyone felt pressured into or out of anything so

This reluctance to acknowledge the potential of stereotyping as a barrier is repeatedly framed by Megan as women simply choosing to enter other fields or having different interests, she hedges by conceding that it is possible that they impacted choices but insists that she doesn't think "anyone felt pressured into or out of anything". Perhaps, as suggested by Kao (2015) there are mathematically able female students who reject some gender stereotypes such as women not being suited to STEM fields, while still accepting other stereotypical images to varying degrees. It is also possible, that more women choosing to go into STEM fields or the idea that women were forced to not choose STEM, would negate some of Megan's feeling of being 'special' as she says she was proud of being one of two women who continued mathematics. As Rodd and Bartholomew (2006) noted in the narratives of their female undergraduate mathematics students, there were expressions that being a woman in mathematics was 'special' or different and that this was important to the students' self-concept. Given her competitiveness, it may be that for Megan, any notion of 'going against the grain' may have proved to be further motivation to press on rather than discouraging. Whatever the reasoning behind the way in which she speaks about gender, these excerpts from the transcript illustrate Megan's struggle to negotiate the idea of stereotypes as potential influences to her own life as she narrates it. As discussed in Part 1 of this section, each participant has been influenced in some ways by gendered discourses, particularly

surrounding mathematics as they each speak about mathematics in ways which parallel a masculine/feminine binary. Yet when speaking about gender and mathematics directly, the stories become increasingly confused and contradictory as participants negotiate their stories and how they themselves feel impacted or not by issues such as stereotyping.

Kim had plenty of commentary regarding gender and was the only participant to link this directly to her own experiences in the classroom. She described people's reaction to finding out she was in engineering as often being one of surprise, which she attributed to the small number of women in engineering though she did say she felt that was changing. When I asked a follow up about the apparent gender dynamic, she replied:

> K|1:01:11| oh yeah for sure especially ah (.) most of the engineering class i would say like one tenth is taught by a- a woman but the rest by men uhm so you see that they- they make a lot of effort ah when they talk to make sure that it's not a like solely like ah generalized towards men but sometimes it happens that they're like ok yeah so you know like when you'll be working on the field with all the **guys** and then they just be like (.) and women {*laughter*} or or there was this teacher the other day ah in my highway engineering class he had like the example on the board and the **whole** example was written with female pronouns like this engineer she was driving and she saw this traffic jam and she started she she she **everywhere** and he started just like ok so we have this example- he talks with a very monotone voice so we have this engineer so the **guy** he's driving and he's {*laughs*} i'm just like **literally** on you slide it says she everywhere ah for me it- it just should be gender neutral they should use **they** and just not but (.) yeah yeah it's still: is a thing {*laughs*}

Although throughout her comment she laughs and rolled her eyes, seemingly at how silly she found some of the behaviors she was describing, there is still an undercurrent of annoyance and frustration at the apparently 'token' gestures of faculty members to include women in the lectures. Kim left the impression that she felt very much on the margins, that she seemed almost to be an interloper into this field. Interestingly, she said that this was not as much of an issue in mathematics:

> CF|1:02:20| did you find that- was it the same way in like the maths department or was- was it more even?
>
> K|1:02:26| it was still a bit more guys in math actually than- than boys than- guys than girls but it was not **as**: i guess uh culturally (.) it was not the same i guess? i don't know just like the feel of **being** in a room i- i had an engineering class last year that i was the only girl in the class so it was a very like super like all the guys and then during the labs i was the only girl and the- whereas the math classes it's just like i- i feel like people don't

> care as much? i guess maybe because it's not so much of like a hands on career and there's not as much kind of like- because in the engineering world there's a lot especially like even in like the management or if you go work with a firm and things like that ah there's still kind of like the stereotype like that the girls they stay in the **office** and the **men** they go in the field with the construction guys or whatever where as in math you do math right? so it doesn't really matter even if there's a bit less: ah women than men in the field it's not the same feel as in engineering at all (.) yeah
>
> K|1:05:52| yeah its just because i feel like engineering is kind of like seen as (.) a ma:n job because its a lot of- you have to like not only do the calculations but you have to go in the field and get your hands dirty and pour some concrete and ah like solder some things if you're in mechanical engineering whatever they do there and work with cables and stuff so an- an you have t- you can't work alone in engineering it's not something that you can do you have to work in a team ahm so a lot of the- the men that you'll go and work with- the senior engineers are usually men so when y- you- because (.) even if **now** there's maybe five to ten engineering girls in a degree back then there was maybe one so there's even **less** so where you go to work (.) like people are more and more acceptant of like women in **any** field and men in any field of work but (.) maybe the people that are still working in engineering now or the older people are **not** where as in math you can kind of do math- its not as much as like a team **thing** like if you do math and you're good at math people will let you do math ^kinda thing^ where as if you're in engineering and you're good in engineering well you have to go work with all these people who are also good in engineering and expect you t- to kind of like be good in engineering but they also expect another thing kind of the image of- of the man engineer ^i dunno^ yeah {*laughs*}

Kim seem to attribute the less intense feeling of 'otherness' or lower degree of hostility not with any action on the part of the mathematics department necessarily but rather to the apparent nature of mathematical careers as more isolated. Her comment here appears to draw not only on her own experiences but echoes some of the stereotypes about mathematics and mathematicians as loners. She seems to convey a sense that mathematics work is not as involved in the same office dynamics as engineering, as it is "not so much of like a hands-on career" which seems to invoke the idea of mathematics as a more solitary pursuit as it is so often depicted in popular culture. Further, her comments on "in math you do math" and that "people don't care as much" about gender may be a reflection not only of the 'less social' view of mathematics but perhaps a link to the idea of mathematics as an all consuming work or passion and as such people are simply less interested in the others around them due to their intense focus. These images of mathematics and mathematicians are widespread and persistent, even amongst students who are aware that they are stereotypes, as discussed by Epstein et al. (2010). As Kim had said that mathematics was not the same feeling as engineering, I invited her to elaborate on how she felt:

> CF|1:03:27| so like what (.) what is that feeling?
>
> K|1:03:31| mhhm its just- i guess its just the feeling that you have to **prove yourself** once you prove yourself to- to the guys they- they see you as i guess an equal uhm but before that its a lot of like **doubting** i guess? so if we're- we do a lot of group projects right? and so in the group projects its just the fact that you **have** to go for it and be like ok i'll do the calculations even if you don't wanna do it and then just because you can show them that you can do them right and you'll get like a hundred percent on them and then they'll be like ok yeah she's good she's ok like she- she can do this uhm but that's like in first and second year and then once they get to know you then- then it's ok but (.) yeah its just the fact that you have- you have to i guess (.) be like ok i'm here and i deserve to be here ^just like you^ i guess {*laughs*}

This was the most overt expression by any participant of the issues and discrimination they still face as they navigate the complex path of identities between feminine and mathematically able. While this is occurring in her engineering program, the degree is mathematically intensive and as expressed here by Kim, mathematics appears to be key to belonging. She recounted the doubt of her classmates, and that to be seen "as i guess an equal" by the male students she specifies that the calculations for the project need to be done even if you do not want to. Further she describes the need for not just a good performance on the calculations, but a hundred percent and this perfect score is what 'proves' she deserves to be there. Kim is describing the very real obstacles she still faces in pursuit of her engineering degree, that there is a need for her to prove herself before she will be deemed 'ok' by the other students, as if she had not earned her place in the program as they did. For women entering 'male domains' there is often pressure to not only perform well, but it is almost a requirement to excel and perform higher than the average man in order to have even a chance at being taken seriously. This creates an additional pressure on female students, while STEM programs are often seen as difficult or grueling on their own, this need to prove yourself to be taken seriously by other students adds another complex layer to navigate as women try to pursue degrees. Kim continued speaking to the challenges she saw as a woman trying to enter engineering:

> K|1:08:54| probably yeah yeah probably does uhm (.) i guess in school i've had a lot of like (.) my engineer friends that are guys that were- that i asked why'd you go into engineering they're like you know well i was in school and i was good in math so i just went into engineering kind of like that's the logical thing to do kinda thing like as a man where as if: i speak to the- to my **girl** friends in engineering a lot of them actually switched programs **in** to engineering ah so one of them is like yeah i was good in sciences so i went into bio medical like bio medical science to- to go into med school

> after i don't know and become a doctor uh but then i realized that i really loved math and physics more so i switched into engineering but i guess maybe it's not something that they think directly like **i'm** going to become an engineer but more and more though {*laughs*} i go to school fairs now and a lot of- of girls are like yeah engineering i really wanna go in- in- in that subject mhhm

I feel that this comment speaks to the power of popular perceptions and the potential influence of available imagery on career choice. While this is evidently one student's account of what others have told her, there is a wide array of literature on the impact of 'imaginable' or possible images on student course or career choices such as Archer et al. (2013), Epstein et al. (2010) and Piatek-Jimenez (2008). While Kim expresses her belief that there is an increase in the number of women who want to go directly into engineering, it seems from her comment on her own experiences and that of her peers that many women switch into engineering after trying other programs initially, suggesting that in contrast to the male students this is an option that this is not a 'logical' next step for them even if they too are succeeding at high school mathematics. Overall, while Kim often tried to laugh about some of the challenges she faced as a woman in engineering it was an awkward, and rather frustrated laughter. Her descriptions left the impression she felt as if she was still very much on the margins, as in the following:

> K|1:04:37| ^no^ in math it was just really not as (2) like in- in- in a i guess you could say in a numerical point of view you can see that like ok there's ten guys and there's five girls but it was really not as (.) ah like in engineering where your like oh my god look at this class there's only three girls i wonder what it's like for them girls in engineering like you know there's so many programs about like girls in engineering and bringing girls to stem but i feel like even if stem represents mathematics its more so putting girls into technology and engineering then putting girls in math because i- if to me it's just like you're doing math like there's not much (.) even if the- there is may- maybe a stereotype if you imagine a mathematician you imagine a man uhm like (.) i don't know it's just different its- its strange {*laughter*}

A portion of this comment that struck me as particularly poignant on the note of feeling 'outside' the group was "in engineering where your like oh my god look at this class there's only three girls i wonder what it's like for them" this marveling at the presence of women and wondering what it must be like feels almost akin to people staring at a strange specimen in a zoo rather than an observation of a classroom. While she reiterates that this feeling is not as heightened in the mathematics program, this comment still suggests a discomfort, a noticeably smaller number of women, and a still present male mathematician stereotype which does not sound as if the

environment is more welcome as much as it may be less overtly hostile due what Kim seems to feel is the more isolated nature of mathematics as people will be largely left on their own. In Kim's figured world then, there are certainly more obstacles to her participation in her field than are faced by her male classmates and that while this may be changing for girls in high schools now, it seems as though the image of engineering had not appeared to her as an option initially despite her passion for mathematics. Having to negotiate this extra barrier to participation adds yet another layer to the complexity in trying to perform identities as both female and mathematically able.

Overall, I believe that these direct discussions on gender with the participants provides an opportunity to see a range of ways in which they interpret the world around them regarding issues such as stereotypes. While the first part of this theme highlighted several similarities in the use of gendered binary pairs when discussing mathematics through the lens of STEM versus Arts/Humanities, explicit discussions around the gendering of mathematics instead showcased the different views and strategies implemented by participants when narrating the role of gender in their stories. Although during the interview with Amy there was not much opportunity for that discussion, Rebecca, Kim, and Megan all provided unique views on how gender has or has not impacted their experiences with mathematics. From Rebecca's rejection of gendered influence, as she says she has in fact heard the opposite of the gender stereotype of men being better at women than mathematics, which seems to stem in part from the fact that race/ethnicity is a much more salient topic that she navigates in her narrative. Megan negotiated a difficult back and forth on whether gender played a role in her story, acknowledging that subconscious elements such as stereotyping remain and can be problematic for others in trying to choose programs or careers yet insisting that she never felt pressured and did not feel that others were. Navigating between awareness of the gendered 'societal' norms and her own experiences as someone who is behaving in a way that is contrary to those ideas is not easy, and I believe it provides an excellent example of one in which women who persist in mathematics continue to face greater difficulties in negotiating identities as mathematically able. This is not to imply that mathematical stereotypes and gendered views of mathematics do not negatively impact male students, they undoubtedly do, but rather to illustrate some of the ways in which it is even harder for women to grasp identities as mathematically able than men as the connotations of mathematics and mathematicians continues to be significantly masculine in nature. These additional challenges are

not only shown in the discussion with Megan but emerge in sharp detail in Kim's accounts of her experiences in mathematics and engineering. While Kim does describe the mathematics department courses in terms which might suggest it is a more 'welcoming' environment than her descriptions of engineering, this appears to be rooted in how she perceives mathematics as more isolated and so people doing mathematics will be left to do mathematics in peace. Her depiction of her experiences in engineering however, showcases one of the ways in which discrimination against women in STEM persists as she describes needing to prove herself to her male classmates before they will accept that she belongs in the program. Interestingly, the 'proof' Kim identifies as important is the performance of mathematics in the form of calculations, suggesting that mathematical ability which is stereotypically masculine, and a performance of this ability is what determines whether she will be deemed 'kind of an equal' to her classmates. The stories of my participants as they narrate their experiences with gender as it relates to mathematics demonstrate the complexities of navigating their choices and engagement with mathematics as someone interested in performing an identity as feminine.

Freaks and Geeks

In Sure, Structured, Strong I explored the participants' own definitions of mathematics, then throughout Binary 101 parts 1 and 2 I dove into how they spoke about who does and does not 'do' mathematics. In this section, entitled Freaks and Geeks, I wanted to further consider the participants views on those who 'do' mathematics and how they choose to describe those engaged with mathematics both as individuals and as a generalized group. I was surprised to find the extent to which participants' descriptions of mathematicians reflected popular stereotypes surrounding the field and those who engage with it. An element that drew my attention during the interviews was the fact that each participant mentioned the word nerd or geek in reference to themselves, friends, or the department as whole. While the extent to which they made use of that specific vocabulary varied greatly by participant, the stereotypical image of the 'math geek' manifested particularly when participants tried to engage with ideas of who 'does' mathematics. This is not to say that the participants simply accepted the stereotype, each had a different way of engaging with it and sometimes tried to refute some of the associated connotations while at times

appearing to embrace others. Much like the participants described in Epstein et al. the participants often appeared "embedded in notions of mathematicians as socially inept, obsessional, and definitely rather different than most people. The fact that they themselves identified their images as cliched and stereotyped did not enable them to develop other, different images" (2010, p. 54) The pervasiveness of this imagery regarding mathematicians was certainly evident in the interviews with the women involved in my study, and so presented another opportunity to explore the figured worlds of the participants as each negotiated their position or an aspect of their identity as it related to the idea of 'nerdiness' as a standard for mathematicians.

Out of my participants, Kim was the only one who directly addressed the idea that the term 'nerd' held negative connotations and in fact her only use of the term nerd or geek came during the exchange in which she expressed a reluctance to use that word as a descriptor due to the connotations:

> K|38:11| ahh i guess a little bit especially like the- the math professors like (.) they all seem i guess i don't wanna say- i don't want to say nerd it's kind of like it has a bad connotation but they **do** they're all like a bit elderly: and they're just- i had like one math teacher he was **adorable** one of my first year classes and he was like a- a bit like ahh (.) i guess a bit larger and he was just like he had glasses and **super** messy hair {*laughter*} and he- he would write his thingies and then he- he would write something down like an equation and this when you put with this and then it gives you the- isn't that **amazing**! {*laughter*} so- so cute your like- and then he would draw something else **look** at this this is so **pretty**! {*laughter*} and he would just be in awe by what he was doing in that way /// i guess one thing i would say about those teachers is that they're bit less like personable than teachers that i had when i took classes in like geography and things like that///but like the math teachers they do the math and if you have questions they answer your questions but apart from that

While here she does acknowledge the fact that the term nerd does hold negative connotations, she immediately follows this apparent rejection with an emphatic insistence that her mathematics professors do in fact, fit the stereotypical image for mathematicians. As described by Epstein et al.

> Related to the secrecy of the language of mathematics, are discourses concerning its difficulty, intellectual nature and, sometimes, its aesthetic beauty. These are connected to representations of mathematicians as being highly intelligent, unusual in their genius (if eccentric with it)…Einstein - white, old, looking a bit mad with

> his fly-away hair - is the iconic genius of mathematics and science…Most popular texts that feature mathematicians (or people good at mathematics) show them as exceptionally intelligent if somewhat eccentric, odd or unusual. (2010, p. 50)

Reflecting on Kim's commentary about her professors, it is easy to see the elements of stereotypical imagery as she describes a professor's untidy hair and his awe at the beauty of mathematics. Further, her characterization of the mathematics professors as less personable than those of other department and in particular that the mathematics professors just "do the math" and while they would answer questions they would not engage with students further outside of specific mathematics questions which may reflect the obsessional and isolated nature that many associate with mathematicians. Later in the interview during a discussion on stereotypes and their potential impact or influence, we had this exchange:

> CF|1:07:16| right so you feel like that's sort of stereotype of like the you know eccentric male mathematician is like fading more? or it just doesn't- because math almost like more- more isolated i guess in a way but it doesn't have as much of an impact?
>
> K|1:07:37| yeah (.) i feel like (.) so i feel like what we imagine when we imagine a- a mathematician or a scientist is what we've seen our kind of like the more prominent scientists and mathematicians of the past right? so newton and mueller and einstein which are all men there's been a lot of great women mathematicians and scientists but let's be real probably because they couldn't be mathematician and scientist they're not as prominent as the men and so i feel like that why we **imagine** those mens as being mathematicians and scientist um but i feel like even if it is so more and more it's not because you imagine a certain kind of career path a certain gender that it means that- that only gender gets- that can become that same thing for nurses right during the war the only nurses were the women and the men were at war and so like when you think of a nurse you think of a woman but there's a bunch of man that can become nurses ^so i guess it's just a^ like you kinda have to break down those barriers of like- yeah maybe you think of a man when you when you think of mathematician but it can be anyone

I believe that these two comments from Kim help to illustrate the ongoing and pervasive nature of stereotypes surrounding mathematicians, as well as how as suggested by Epstein et al. that despite an awareness of the image of mathematicians as stereotypical there is a struggle to find other ways of speaking about them. While in both the passages from the interview, Kim acknowledges the struggles with stereotyping and potential negative impacts thereof, this does not mean she did not make use of those same stereotypical ideas to describe both herself and

others in mathematics. In the first excerpt this is evident regarding her professor however she also framed herself on some occasions in stereotypical fashion:

> CF|31:22| ok (.) do you feel like it's (.) like (.) ahh attracts like a certain **type** of person or like way of thinking that finds like math more appealing or that tend to end up in mathematics programs like did you notice that in your classmates or your friends?
>
> K|31:42| yeah! yeah for sure uhm so (.) i don't know i don't wanna like (.) put people in like **boxes** but for me and most of my friends that we all like love math and things like that it was that we're all more like **introverted** i guess so we don't tend to really like **go** out we're more like **if** we **do** something its more like just like playing boardgames or like watching movies or doing fun things like that playing videogames where as like my sister and her friends i remember when i was in first and second year i hung out with them because i **knew** them from my home town but- they would go out to clubs and pubs and party and things like that umm it's different i mean engineers party a lot {*laughter*}

Here too, Kim seems to hint at the idea that she does not want to 'put people in boxes' as a way of acknowledging the rather stereotypical image she then presents of her and her friends as introverts who are less interested in going out and instead prefer things like videogames. This image is given in contrast with her sister and her friends who she had already explained are not in mathematics, having chosen non-STEM fields which she has categorized as more social and are now described as continuing in that vein in the form of going out to parties. As such this comment may be read as a performance of a mathematical identity as Kim describes herself in a way which showcases tendencies or behaviours that stereotypically associated with mathematicians. Further, this position is not one that she appears to occupy easily as she adds that she did go with her sister to parties and that engineers also party a lot which may be an example of what Walshaw (2001) describes as moments of competing and contradictory discourses operating simultaneously, perhaps as a way of balancing the 'mathematician' image of herself as an introvert against a more 'feminine' image of sociability. She continued:

> K|32:24| **but** math students and the physics students a **lot** less it's- it's very **different** i guess and (.) it's just i guess- i guess they're more **organized** in a way that is different from (.) other people and it's just the way that uhm (.) i guess you organize your thoughts i don't even know its just **strange** sometimes
>
> CF|41:07| ok so: when you think about (.) ahh let's- let's say a mathematician then like what is it that you picture?
>
> K|41:20| ahh (.) for me i just picture a **person** an::d (.) ahh this is kind of it's- it's strange because i've looked and i've read a lot about i- i don't know if your familiar with like the *M B T I* personality typing (.) yeah so i've like done a lot of kind of like looking into that because i find it **super** interesting uhm and for me so when i think about people that are in math i think of people that are more of like the- the they call it like the intuitive type?

> so they- they learn things by kind of like always looking for more instead of basing towards what they already know so like where as like i would think of like my friends that i would try to explain math to them in high school and they would be like but we haven't learned this like i don't know how to do it i haven't learned it kind of like where as i feel like someone who loves math and who's really interested in math is like ok yeah i haven't seen this but like how can i learn what i- or use what i learned and then use it to kind of like maybe advance towards what i want to **do** kind of like in more of like an intuitive sense uhm so i **think** a lot of- when i think of people in math and i think of most of the friends that i have in math that's kind of like how they think? they're like ok so this problem is super hard i've never seen this in my life let's try and do it! and then they kind of like (.) and then it just like happens uhm (.) and **yeah** i guess more: organized than other people? although i still have friends in engineering that are super disorganized and like their life is a bit of mess but a lot like it's actually when i think of the couple who are math majors uhh all super organized like notes super intact super like i'm- i'm very uhh i love **lists** and organizing and cleaning things and everything being like ooo super straight uhm and i guess i've noticed that with ah especially the math majors and a couple of my friends in engineering too yeah

Perhaps one of the most intriguing elements from these passages is that each time she refers to mathematicians more directly, the more stereotypical the images become. Particularly towards the end of the comment at 41:20, when she mentions that some of the engineers are more disorganized but that the mathematics majors are all highly organized and that while this is then extended to a few of the engineers it does seem as though order/organization is framed as especially prevalent among mathematics students. Further, in referring to herself, she describes a passion for lists, cleaning, and things being 'super straight' which may be a way of trying to perform a mathematical identity as a more rigid and nearly obsessive focus is often attributed to mathematicians (for examples see (Mendick, 2005b). The narratives that Kim is presenting here brings to mind those discussed by Solomon, Radovic and Black (2016) regarding the stories presented by the participant in that article named Roz. Notably, the notion of personality typing presents itself, as Roz describes herself as a systematizer who struggles with social cues (Solomon et al., 2016) while Kim describes herself as primarily an introvert who loves organization. For both of these women there is an attempt to hybridize these more 'masculine' mathematical identities with a more feminine image that they associate with being more sociable. So for Kim this back and forth between the acknowledgments of the stereotypes and their use in her own descriptions as well as her negotiation as she presents images of herself behaving in ways that invoke associations with both 'mathematical' and 'feminine' concepts and shows ways

in which she struggles with and constructs her image within her figured world. I believe that exploring these moments of contradiction helps to illustrate part of the incredibly complex identity work that occurs as women try to hybridize identities as both feminine and mathematical, and the influence of popular culture stereotypes on this process. This struggle not only impacts women but can create challenges for men as well. While I did not interview male students for this study, other studies have reflected on the potential impact on men as well, as in Mendick's *A beautiful myth* when discussing the accounts of mathematicians from popular culture

> the stories of mathematicians in this section help to maintain rationality as masculine and being 'good at maths' as a position that few men and even fewer women can occupy comfortably…they persist in constructing the mathematician as something you are naturally. Thus they support a key feature of the 'nerd' stereotype (2005b, p. 216)

In the excerpts from my interview with Kim, I have endeavored to show some of that discomfort and struggle to perform an identity that hybridizes elements of the 'nerd' stereotype as perhaps a way in which she maybe seen as more of a 'mathematician' with an identity that is more 'feminine'.

Megan, as I have noted previously, was the only participant to describe a very large shift in attitude towards mathematics over the course of her school career. Yet, even with her later 'entry' into a love mathematics, she too seemed to struggle with the stereotypical images of mathematicians. As with Kim, she only made direct use of the specific term, in this case geek, once and this was applied to herself

> M|14:31| a little bit but i ah i almost fed off of their disappointment by being more excited right like it was let me show how different our opinions are umm yeah no one was really surprised when i went into math {*laughter*} i was kind of- i was a math geek at high school but i was- i was happy with that right?/*on the change in vibe when transitioning to grade 12 where there were only interested students remaining*

While this is her only direct use of the word geek, there is a hesitancy in this description as she moves to say that she was happy with that yet does not sound entirely certain. Although it is impossible to determine why she may have been hesitant about that, one possible explanation is that this is prompted by some of the negative social stigma that is typically associated with the term geek. Despite this instance being the only one in which she applies the explicit vocabulary,

as with Kim, the ways in which she characterizes people engaged in mathematics along fairly stereotypical lines are expressed throughout the course of the interview. One such example came when I asked her about how she interacts with mathematics as part of a discussion on how she would define it;

> M|35:45| {*laughs*} ahh well in daily life you- i often use math in baking so in using um the measuring cups and spoons in a very efficient manner {*laughter*} which my mum jokes that i become obsessive over///

Once again, the notion of using mathematics is presented with not just an example of a regular activity but included with that image are some of the characteristics associated with mathematicians, namely obsession and efficiency. However, this particular moment can also be understood as a way in which Megan negotiates and hybridizes identities between one which is feminine and one that is mathematical. Her chosen example of a mathematics related activity in everyday life is baking, which its typically stereotyped as a more 'feminine' activity and then uses that opportunity to balance that image of traditional femininity by performing behaviors associated with mathematicians, whereby she obsesses over the efficiency with which she uses the measuring utensils. This was not the only way in which Megan navigated the complexities of living as someone performing identities as both 'feminine' and mathematically able, as shown in the following excerpts;

> M|21:42| {*laughs*} so i went from a small high school of about a hundred and fifty to {*laughs*} university uhm (.) and it was fine for me ehh socially because i'm mostly introverted and so i'm ok not talking to a single person all day long and i'm ok i- i'm able t- to disappear in crowds if that makes sense so i'll be in a crowd but i'll feel like i'm not **there** right and then you make eye connection with someone that you know and you're like oh right i'm actually here in the present um and so going to classes of really like really large groups i would simply sit on the end or the front or the back right or like somewhere on the outside and i usually wouldn't talk to anyone which was fine by me umm and i was able to focus more on the academics

> M|23:58| they were ahh so in high school they were a lot more (.) i don't want to say open but you know there was a lot more communication between students and professors uh teachers and there was a lot more- it was more relaxed right it was smaller it was you're more familiar with each other where as in university it was larger there was more of an invisble aspect right? of you feeling like you weren't actually there

Like Kim, she is a self-described introvert, however rather than trying to temper the image of the introvert as Kim did, Megan has adopted a different strategy. She speaks about the feeling of disappearing, being invisible and not quite in the present. While to some degree the lower degree of interaction between students and professors as opposed to students with their high school teachers is to be expected due to the significant difference in the number of students in the classes, this feeling of invisibility is not limited to that classroom setting. The way in which Megan described this invisibility and her position on the periphery of the classes brought to mind the work of Rodd and Bartholomew in "*Invisible and special: Young women's experiences as undergraduate mathematics students*" (2006). In that article, the authors present the idea that

> we began to regard this invisibility not simply as something that was imposed upon the young women we were studying (though this is undoubtedly part of the story), but also as something they actively took up as a defence. This is the 'fiercely held modesty' of Serafina Pekkala, and it is manifested in these women's positioning of themselves in ways which render them invisible (Rodd & Bartholomew, 2006, p. 39)

While Megan addresses this much more directly than any of the students in Rodd and Bartholomew's (2006) study, where the researchers inferred the participants invisibility based on observed behavior and accounts from the students, this does not discount the possibility that her desire for invisibility comes from a similar place. Megan seems to associate this feeling of invisibility with her more introverted nature, and perhaps with the change in environment between high school and university which is substantial and may lend itself to feeling more removed but this does not remove the possibility that she may have embraced the sensation as a way to help negotiate the complexities of being a female student in mathematics. Megan was also quite aware of stereotypes surrounding mathematicians,

> CF|50:56| mkay so: when you think of the people that do math so mathematicians what do you picture?
>
> M|51:06| {*laughs*} umm so immediately i picture a ahh a professor right so that idea of someone who's older someone who um uses really big words uses very small gestures umm stands very straight right you know your kind of stereotypical older gentleman using you know the thing that you don't understand umm (.) but thinking more about it mathematician is technically anyone who does math so um you could think of a grade two student right doing math and you could somewhat classify them as a mathematician right even without a *PHD* in math umm and so i think there is the stereotype in math of old guys using big words {*laughter*} that you don't understand um but i- i hope that over time that will change ah i think society **wants** that to change umm and so i think yeah

> that- that is initially what you picture when you think mathematician but i think that should be broadened over time

While Megan did not feel that she had been particularly impacted by such stereotypes herself, she laughingly admits that her own immediate picture for a mathematician is highly stereotypical as she describes an elder man engaged in something so complex that it is difficult for others to comprehend. However, I found it interesting that aside from the initial reaction, on thinking more about it her definition of who counts as a mathematician is quite inclusive, and moves away from the idea that to be called a mathematician would require degrees in mathematics although she is tentative on this as she says 'somewhat' classify. Perhaps, like the women in Piatek-Jimenez's (2008) article where she describes them as finding it

> difficult to define the term ''mathematician,'' they easily came up with a number of personality traits they believe mathematicians possess. The most frequently shared personality trait believed of mathematicians was that mathematicians are exceptionally intelligent people. Some of the most common words or phrases they used to describe a mathematician were: ''knowledgeable,'' ''logical,'' ''theoretical,'' ''a thinker,'' and ''uses sophisticated language.''(2008, p. 638)

Megan may have struggled to adjust the definition of who counts as a mathematician, as it is generally not clearly defined and 'who counts' as a mathematician varies greatly depending on who is asked. While she clearly acknowledges the stereotypical nature of the image of mathematicians, like Kim she appears to struggle to describe people in mathematics in ways that do not reference the nerd or geek image. However, it is possible to see throughout the interview moments where she challenges this identity as well as where she identifies with elements of it and as I have demonstrated here, works in various ways to hybridize identities as 'feminine' and mathematically-able and cope with that struggle in her figured world.

Turning to Rebecca, who during our discussion made use of the specific term nerd more than both Kim and Megan combined, which is to say it appears in the transcript a total of three times. For her, the term is something she applies in passing to herself once and then to people in mathematics in general, as seen in the following,

> R|9:37| so i- i liked that and sometimes i can be a **nerd** about how to- where this equation is derived from cause i do tutor in math [and i like to give good explanations to the (.)students i tutor=

> R|14:31| um:: (.) i'm not very good at recalling my childhood{*laughter*}[but i think i saw mathematics maybe if- if you really liked it you were like a **nerdy::** person for it i thought- you know someone who was good at=maybe that was just me as a kid i thought someone who was really good at mathematics is always like really **smart** and has the brains that's not always the case but{*laughter*} **yeah** i saw mathematics as- as very **complicated**

In both comments, the word nerd is associated with a those who have a deep interest in mathematics. She first uses it to describe herself as she talks about diving deeper into mathematics in order to provide the students she tutors more robust explanations, and then again for people who enjoy mathematics in general although this may be somewhat softened by that being a view she held of mathematicians as a child. In her comment from 14:31, there is also the appearance of some of the other vocabulary which often accompanies the image of 'nerds' as she says she also equating liking mathematics and being good at it with intelligence and that the subject was very complicated. In the final instance in which the word nerd makes a direct appearance, she is opposing its association with people in mathematics in a very interesting way when answering who she pictures when she thinks of a mathematician following a brief discussion of stereotypes;

> R|1:03:29| any kind of person? ah they- they don't necessarily need to look like a nerdy person um if you study mathematics you would see there's a lot of good looking men and women

Rebecca hones in on the association between the idea of nerds and being physically unattractive, as noted by Mendick, amongst others, that there is the image of the "soft, flabby body of the nerd" (Mendick, 2005b, p. 214). She rejects this aspect of the stereotype by asserting that it is not necessary to look like a nerd and that in fact there are many good looking people within her program. Despite this rejection, in the next comment she makes she draws on the same stereotypical image, this time regarding a professor as she describes the economics department students as being more professionally dressed, she turns to mathematics

> R|1:04:23| yes dress shirts! dress shirts long sleeve shirts and pants and then for the women it's like ah a nice blouse but in the mathematics department it's really casual looks **espec**ially my:: calculus teacher he comes in shorts he comes in sho:rts and hawaiian shirt yeah! it's happened

As Rebecca described the outfit chosen by her mathematics professor she seemed quite amused, as if this choice of clothes was odd which would return to the stereotypical image of eccentric mathematicians. Once again, I believe this to be an example the pervasiveness of the stereotypes surrounding mathematicians, to the extent that despite Rebecca's focus on rejecting the appearance of 'nerdiness' she soon after presents an image that shares a more stereotypical view. While Rebecca said that she was not aware of the stereotype of men being more successful at mathematics, she does seem to be quite aware of the stereotype surrounding mathematicians as nerds. Within her figured world, Rebecca appears to be trying to strike a balance between associating herself with the term nerd when discussing her interest in mathematics, while working to reject some of the negative connotations, in her case by countering the idea that mathematicians need to appear 'nerdy'.

Amy took a very different approach to the idea of 'nerds' than the other participants, so much so in fact that in one comment alone she uses the word nerd three times, matching the total for Rebecca's entire interview and overall she exceeds uses of the term nerd or geek more than the three other participants combined. Amy used the term to describe herself, her friends, and mathematics professors, as seen here:

> A|43:52|///oh yeah the um no cause i- i only know like a few profs but it just feels (.) like they're are just like ah honestly i don't know how to describe it but its the kind of (.) nerdy people you would expect to find like i don't know how to explain it {*laughter*} but it's just like yeah like yeah sometimes it's just like the jokes they make or by what makes them laugh y- you can tell that they're all just a bunch of nerds and going in- especially me and my friends we- you can tell we're just like a bunch of like nerds we're just like really enjoying like really (.) lame things {*laughter*} but we are not lame okay? but no we just- i don't know it just a different type of people i honestly don't how to explain it but it's just but yeah i don't know

This is perhaps one of the clearest examples across all four interviews of how difficult it can be to talk about people engaged with mathematics in non-stereotypical way, as Amy struggles to find the words to describe them and ends up characterizing everyone involved in mathematics that she mentions as different and nerdy. As Mendick describes this stereotype "This dominant discourse around mathematicians in popular culture depicts them as boring, obsessed with the irrelevant, socially incompetent" (2005b, p. 214). Amy does challenge one of the elements in that description, namely she emphasizes that despite describing enjoying 'lame' things that she and her friends are not lame which would seem to be in response to the idea that people who are

nerdy are boring. As we continued this part of the conversation she continued to struggle to provide descriptions:

> CF|45:22| so like what- what type of people(.) do you find that it like attracts then?
>
> A|45:26| i don't **know** cause we're all different were like- me and all my friends we're (.) all really different because- well it just depends because one of my friends is in computer sciences and he's really (.) i don't want to say he has a computer for a brain *{laughs}*but it really like(.) like i don't- i don't know how to describe it because he's real straight with everything and once- once i made a joke and then he (.) i don't know i guess that's my joke and then that where- no that's his head and that's my joke and it just went way over his head {*laughter*} and i'm just like gosh why are you like this? but um i don't know it- it really depends on- again so this is really not math because it really depends on the day and how you're feeling but i honestly don't know how to describe **us** were just
>
> CF|46:15| are there like any personality traits in common or like shared interests?
>
> A|46:19| math {*laughter*} cause you're not- you're not in third year math if you don't have an interest in math um {*laughs*} no but- and then it depends with which friend (.) but just i don't know if it's just i feel like it's just pure luck that we're all in the same classes together and we all have similar interest so we can talk about **anything** really but it's just that (.) we (.) honestly i- i- i don't **know** it's just we're all (.) nerds i don't know *{laughs}* we're all lame we have a bad sense of humor um {*laughter*} um yeah honestly i'm sorry i wish i had a answer for you but i really don't know=

Here, Amy makes another attempt to speak about her friends in mathematics, and seems to find it difficult to describe them, as she repeatedly returns to 'i don't know.' While she explains that all her friends are different, the one she chooses to describe, if somewhat reluctantly, as she says she does not want to say that 'he has a computer for a brain,' perhaps as this stereotypical presentation of someone in mathematics may hold negative connotations that she does not wish to attach to her friend. Her anecdote about her joke 'going over his head' (which was accompanied by hand gestures to indicate the relative position of his head and the joke) seems to play into the lack of social skills often attributed to mathematicians. Further, when I prompted her about shared interests she immediately says math, and does not offer other examples and instead only vaguely states they she felt they could talk about anything. This may be a way of presenting a more mathematical identity as mathematicians are typically described as mostly interested in mathematics and little else. Amy then returns to describing herself and her friends as nerds, and even goes so far as to contradict her previous assertion that they were 'not lame'

and says ‘were all lame’ instead. At the end of the interview, I was surprised at how often she has used the word nerd and so I circled back to try to better understand why she did so and how she saw the word nerd

> CF|1:25:00|yep makes sense (.) um so that like the last sort of full question there’s just a few things that i want to- that i wanted to ask just to help me clarify my understanding uhm (.) so you described both about yourself and your friends at times as like nerdy what do you- like what do you mean by that because that’s a very kind of nebulous concept
>
> A|1:25:28| yeah i want to say- i don’t know i think it’s just like a **gut** feeling it’s just yeah i- i do feel like we are nerds and- in the fact that like we really (.) like the feeling of not understanding and being taught something completely new (.) completely (.) useless on a day to day basis okay? (.) but it’s just we really like this and then (.) we just have that interest and yeah we both really like- like that kind of weird messed up shit we’re learning but that’s just who we are and then just that drive to like keep going? cause none of us know what we’re doing **but** we know that we like math and we find it interesting so we just (.) keep going if that make sense but i don’t know from like the nerdiness would just be defined as like a very general type of like- the definition is just like yeah we’re (.) yeah (.) we’re like **good** nerds we’re very lame but like in a good way {*laughter*}

While Amy is not particularly clear on the definition she seemed to imply that she understood it as the stereotypical image that I have described throughout this theme. In this comment, she adds that the mathematics they are learning is ‘useless on day to basis’ and as ‘weird messed up shit’ which would certainly fit with the generalized idea many people hold regarding mathematics. She specifies that they are ‘**good** nerds’ as way to seemingly perform an identity as ‘nerdy’ that she seems to view as almost inseparable from mathematicians, while pushing back against some of the potential stigma as she stresses the word good as if to counter the assumption that being a nerd would be bad. Amy appeared to be more amused by the label of nerd than concerned, although as noted by Archer et al. (2012)this more ready adoption of a ‘geeky’ identity may be rendered more ‘thinkable’ for women in the upper middle class as they tend to attend schools where performances of geeky femininity would be less vilified. Amy would likely fall into such a category as she describes attending a private school, and that she was in a stream within her school geared towards science. While she is certainly the participant the most at ease with the term nerd, and with identifying as such, as I have demonstrated in the passages from her interview, this identity is not always easy or assumed without some struggle. For Amy’s figured world, this performance of identity as a nerd seems intimately connected with those who do

mathematics, from professors to friends and to herself and so in claiming this identity she is able to perform an identity that is understandable to others as a signifier of someone who is mathematically-able.

In exploring the accounts I have presented in Freaks and Geeks, I aimed to better understand how the ever-present image of mathematicians as geeks or nerds had influenced the figured worlds of my participants. While the overt use of the terms geek/nerd varied from the single uses of Kim and Megan to the frequent use by Amy, the underlying stereotypical image of mathematicians appeared on many of the occasions in which we discussed 'who does mathematics,' whether or not the participant used those words directly. Although initially it was the terms nerd/geek which caught my attention, I was still surprised, as like Epstein et al. I "knew that images of mathematicians and mathematics were widespread in popular culture, but even so we were surprised at just how ubiquitous, and yet simultaneously seemingly invisible, they were." (2010, p. 48). Each participant engaged with the images of mathematicians differently, finding unique ways to negotiate performances of some elements of 'mathematicians as nerds' while rejecting others. Adopting some of the characteristics or behaviours associated with this popular image of mathematicians, such as a tendency towards introversion, an obsession with order, love of the irrelevant, and just being 'different' than others, is a way in which the participants can perform an identity that is understood by others as 'mathematical.' These performances are negotiated and balanced against the negative connotations that the stereotypical image of mathematicians can bring with them, and I have endeavored to show how each participant chose different elements to dispute or reject as they work to make sense of these images and how they relate to them within their figured worlds. Not only do participants struggle to balance this image and potential connotations, but they also work to negotiate this image with performances of a 'feminine' identity and in doing so are confronted with a further challenge to balancing a mathematical identity than male students would be. This additional identity work and the challenges it poses for the participants will be discussed further in a subsequent theme, Good at Math?

Sharing is Caring

The title of this theme 'Sharing is Caring,' stems from the fact that each of the participants expressed an interest in helping others to learn mathematics. While I had anticipated

that some of the participants might discuss some interest in ‘caring’ professions based on trends in the literature, I had not quite anticipated that it would be so prevalent nor that it would specifically relate to the idea of teaching. Nevertheless, when different iterations of such a similar concept appeared in all four transcripts, it was clear that this was a topic well worth exploration. Critical to my understanding and analysis of this how these statements reflect on the figured worlds of the participants. As Holland states

> By “figured world,” then we mean a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others…these collective “as-if” worlds are socio-historic, contrived interpretations or imaginations that mediate behavior and so, from the perspective of heuristic development, inform participants’ outlooks (2003, p. 52)

In discussing their future with mathematics, I had the opportunity to gain insight into how each participant imagined themselves in the future, and why it would be important to them to achieve that imagined future state. The discourses they employ to discuss the reasoning behind the suggestion of teaching, or other ways of performing a ‘caring’ image of mathematics provide participants to hybridize identities as feminine and mathematically able as they talk about ways in which they can use mathematics to help others. Prior to continuing with my discussion of these comments and their potential significance, I believe it important to note that suggestions of teaching as a career may not have been without a reason for appearing in every interview. Each of the participants involved in the study was aware prior to the interview that I was from the Faculty of Education and as such, the participants may have been consciously or subconsciously been in some sense making an attempt to ‘tell me what I wanted to hear’ a problem with interviews mentioned by Creswell (2013) among others, or to simply have had the idea of education already in mind because of this. However, this certainly does not exclude genuine interest, particularly as each participant also expressed their enjoyment and satisfaction with having assisted friends with learning mathematics during high school or within their undergraduate degree, it is certainly within the realm of possibility that these remarks on their futures are entirely genuine or simply a combination of these. Given the importance of this theme I returned to the literature and both revisited literature I had previously reviewed and expanded my reading. In doing so, I noted why I perhaps ought not to have been surprised by these discursive positionings of caring centering on teaching, as in much of the literature (for examples

see (Archer et al., 2013; Hottinger, 2010; Walkerdine, 1998) teaching is referenced frequently as a future caring role for and by women. As discussed by Piatek-Jimenez (2008), 'traditional' feminine roles still frame women as more social, while mathematics careers are typically cast as isolated, which may render work in mathematical fields less appealing in some sense to women. Further, Piatek-Jimenez (2015) in her interviews with female undergraduate students in mathematics in the United States, there appeared to be a draw towards more 'social' in nature and in particular, those who expressed a desire to help others often listed teaching as a future career goal. While I had been aware of this in a more abstract sense, I was still surprised to see this iteration of 'caring' work present in some form during discussions with each participant.

Turning now to my own participants, I will begin the discussion with Kim's interview. Although she makes the smallest mention of a form of teaching out of the four, as she intended to pursue a career in civil engineering post graduation, when asked about whether or not she might continue in mathematics or if mathematics would ever stop being part of her life, she stated

> K|55:07| i don't think so like especially if i go and work in like the:- the field of engineering like math never stops you never stop using math when you're solving or designing or things like that so that for sure will never stop **there** uhm and i guess just like in life just like being surrounded by people who are learning math maybe who like math who just kind of like i guess: helping that- like helping them towards their journey in- in learning math so (.) so yeah i don't know i don't think so i just really like math ^so i'll always keep it just like yeah^ ///

While her description of a 'teaching' role here was what initially caught my attention, upon reviewing the transcript it became clear that this was not an isolated incident. Earlier in the interview Kim had certainly mentioned helping her sister and her friends with learning mathematics when they were younger, and was currently assisting her sister with a required mathematics course for her program

> K|9:27| ///she's in social sciences but she's taking math class because she wants to become a teacher///hasn't done math for like four years and so (.) i'm helping her and she's doing like gra::de twelve math i guess right now? so she's doing like functions and things like that and she constantly asks me like but like what does this function **do**? like **why** am i **doing it**? am i- we're doing this graph and plotting this function like what's this gonna serve me? uhm (.) and i guess it's hard to- to understand it but like those functions they kind of represent **everything///**

> K|1:25:54| i don't- like to be honest i remembering being in like grade eight? and having a math test and helping a lot of my friends that had hard time and just like sitting down with them and just **showing** them like ok you're looking at this ahh i don't now what it was like algebra so like i don't know something really basic like *X* plus three equals four and they're like i don't know what *X* is and just kind of like representing it in a way that maybe is basic maybe you think of like ok you have four apples and you have one apple and you have five and kind of things like that but it's kind of like it's very useful for people who **naturally** don't think as things as **visually** or maybe as kind of like you ask people who naturally like math is very useful to- to really go in detail///

Part of what caught my attention was that her desire to continue to assist or tutor those who were interested in pursuing mathematics brought to mind the work not only work of Piatek-Jimenez (Piatek-Jimenez, 2008, 2015) discussed above but also that of Cheryan (2012) regarding combining more 'traditional' feminine roles with STEM fields as a potential reason as to why some fields had already been attracting greater numbers of women. Particularly, Cheryan (2012) notes that some fields, such as medicine, where it was easier to relate what had been a masculine field to traditional feminine pursuits that focused on caring and community, had already seen more women entering the field than areas of STEM that were still stereotyped as leaning into masculine attributes and appeared less compatible with 'traditional' feminine roles. Perhaps this focus on helping others to learn is part of Kim's negotiation of identities, as while a career in engineering is still stereotyped as masculine, teaching is typically stereotyped as feminine. So, in continuing to help others with learning mathematics, she may be attempting to hybridize some elements of her future career goals of the more 'masculine' engineering with ones that are more compatible with a traditionally feminine identity. While her mention of this role as part of her future is brief, I believe it is no less important to understanding one of the strategies available in an effort to hybridize identities which the participant employed to work between holding identities as both female and mathematically able.

In contrast to Kim, both Rebecca and Amy had yet to decide firmly on a direction for their future and discussed a variety of options and listed teaching mathematics among potential professions. Much of the discussion around what careers were available highlighted that it was not always clear what jobs there might be for those with this degree, and that both participants stressed the importance of not working in isolation, or of wanting to help people. The suggestion of teaching specifically came as more of a surprise from Rebecca, as she had primarily expressed

interest in careers in statistics, government policy positions, and perhaps even in the long run a career in politics. However, when she spoke about why she was interested in those careers which on the surface appeared less 'caring' the reasoning behind them was certainly oriented towards the idea of using mathematics to help people. As with Kim, she also shared her enjoyment of assisting others in understanding mathematics and spoke on a few occasions about her job as a tutor:

> R|9:37| so i- i liked that and sometimes i can be a **nerd** about how to- where this equation is derived from cause i do tutor in math and i like to give good explanations to the (.)students i tutor=
>
> CF|9:48|=are you giving them like the background for it?
>
> R|9:50| ye-yeah like uh like why do we- why does this problem get to this answer how did- how did we get to this answer? so i like to give a thorough explanation because a lot of times people are just taught the equation and they don't know the **why** and a lot of people like to know the why

Later in the interview as the discussion came around whether she wished to continue on into a career that would be mathematics oriented:

> R|39:33| i'm kind of hoping so there- uh especially in the government they do have actuaries or ah- mathematicians///where basically their job is to:: analyse data and interpret it (.) and uh so that you know the government can **use it** uh in terms of other ideas i might have had i was kind of hoping maybe i could **teach** math cause i do like teaching very much and a lot of times i feel like teach- like students don't get as lucky as i do with a good teacher and they get easily discouraged and no longer pursue math ah- i felt like i really want to teach it because i want to prove that anyone can **learn** math it doesn't matter if its quick or slow///

Although Rebecca mentions a potential future in teaching here, she did not spend much time aside from this discussing it, seeming more focused on jobs in statistics or financial positions. However, it was not only the mention of teaching that caught my attention, but the framing she appears to be using for her motivation or interest in teaching. In saying that she would want to do so 'in order to prove that anyone can learn mathematics,' she seems to be creating a narrative in which the teaching of mathematics would represent overcoming some unnamed opposition or resistance to that goal. This brought to mind the work of Solomon, Radovic, and Black (2016) and the narrative created by their participant in the construction of her own journey through mathematics as 'succeeding against the odds,' which in some instances seemed to refer to the

struggle as a woman in mathematics. While for some I would be inclined to suggest that this obstacle may be a reference to gendered stereotypes about mathematics, Rebecca was the only student who claimed to be unaware of the gendered stereotype that men were better than women at mathematics and so I am more hesitant to suggest that as an answer although it is possible she is aware of those discourses in a less conscious fashion. However, she did spend a great deal of time about her learning disability, and her struggles with the fact that she often felt as though she took longer than her peers to absorb new information, that she was no less adept at using it once she had the opportunity to process it. Several times throughout the course of our discussion she reiterated variations of the statement that the speed at which one learns should not be considered a reflection on intelligence or capability, that no matter the pace at which you learn, you can be successful in your chosen field. One example of those comments was made after sharing that another student had spoken down to her "like you can't assume that just to be in this degree you have to be as **fast**- a fast learner to be in this degree like anybody even a slow learner can be in this degree" R/39:33 In light of these discussions, I am more inclined to suggest that this narrative of overcoming, of providing proof that anyone can learn math, is more likely a reflection of her concerns with her own learning experiences and difficulties she had encountered, that even if she learnt it slower than some of her peers she was still equally capable. Further, I believe that this may represent a potential moment of identity work as she negotiates possible options for her future life, in doing so she is seeing her figured world and imagining her potential places within it. For Rebecca's figured world, an important facet is that her future career involved helping people, as she described repeatedly that her preference for the economic portion of her program to the mathematics was primarily due to its more practical applications that could be then used in the real world to assist people.

> R|1:13:31|///i feel like another part of the journey is it will get me somewhere really important maybe in a political field and knowing how i could help the world with the knowledge i have because i wasn't really good at biology so i couldn't really help the world as far as being a doctor but someone who knows math and economics can do just as much as a doctor so i wanted- i wanted to do economics and math mostly for political reasons when i get involved in politics cause i would know what i'm doing and when i'd give out my own arguments i can back them up and i- and i would say why and why this makes sense and why what your saying doesn't add up

While teaching may have been a less emphasized option for her, it would fulfill her expressed desire to help people through her chosen career. As with my reflection on Kim's comments, this invoked some of the ideas expressed by Cheryan (2012), that her expressions of a desire to help people, to have a role in the community may be influenced by traditional gender role stereotypes. In emphasizing a more 'caring' or social slant to her future career options, this may be a way in which she can 'perform femininity' as she attempts to negotiate between identities as both 'feminine' and mathematically able.

Amy was less decided on one career path or field and instead wished to use her coop program as an opportunity to experiment with different roles to determine where her interest might lie after school. Amy was also engaged in tutoring of a young child and shared her enjoyment of helping someone to understand mathematics and tried to foster the same interest with mathematics that she herself holds. However, during a discussion on the generalized stereotype or stereotypical acceptance of people who say they have no need for mathematics, a concept which she found upsetting,

> A|1:13:42| umm well this is why for a lo:ng (.) like i'm kind of considering becoming a math teacher in high school it's just to like try to make people understand that math is nothing to be scared about (.) because it really **is** nothing- it's really like literally all fun and games ok especially what you learn in high school then when you get to university okay {*laughter*} okay it's not that fun and games anymore but it's just like when i explain stuff to the girl i'm tutoring and she understands it she's really enjoying it and really having **fun** and really seeing the merit in it and the value of it but its just like (.) if i don't explain it to her in like a way that fits how she:- how her brain works then she won't understand it and she won't see the point and she'll just dismiss it (.) and realistically i don't think people **should** be scared of math or should be like really stressed about it because it's really (.) it's:: like (.) such like an international language that (.) you really shouldn't like be scared of it because it's like (.) **so** important and it opens **so** many doors for you in my opinion just like understanding (.) those abstract concepts in my opinion would really help you in general like i don't know how to explain it but it's just that (.) it's really nothing to be scared of and just the fact that you are telling yourself that you're no good- not good at math is just closing so many doors because as soon as you will see like a math formula you'll start freaking out like what the hell does this even mean?///

At this point in the conversation we had been discussing typical social attitudes towards mathematics based on her own encounters with individuals during which she expressed

frustration with the common perception of mathematics as difficult and that most people did not need it. Here, she seems to be casting a different variation on the idea of overcoming an obstacle and using herself teaching as the proof, although here it seems to be implied that the obstacle is more public perceptions of mathematics or general fear of mathematics. While each of the participants may be referencing different obstacles I believe it is important to note that each is constructing a similar narrative, that there are thematic similarities not only in the expressions of teaching as a role, of a desire to continue sharing their knowledge of mathematics but in doing so would also be overcoming, succeeding against the odds. In speaking further with Amy on careers, she discussed some of the uncertainties around mathematics jobs

> A|28:13|yeah exa- exactly (.) no (.) but yeah so i do feel like if you're like a good student good at science and math then they will often push you in to engineering and no one will tell you go to math because the question that often gets asked by people when i tell them i'm in comp sci and math but i'm probably switching to math is like ok but what kind of job can you get with a math degree?
>
> CF|28:35|yeah like what're you going to do after school kind of thing?=
>
> A|28:38| yeah cause realistically (.)you- i do feel like people would expect me to do a masters ok but then what? do a *PHD* to be a prof?///
>
> A|35:07|i honestly i don't know because don't know what i (.) like i know what i **don't** like so i know i don't like computer science {*laughter*}///

Throughout my interview with Amy, she remained undecided as to her career choice and in her comment at 35:07 was answering a question on whether she would want to continue in mathematics after finishing her degree or if she might pursue something different. This left her comment on teaching as a career as one of the few mentions of a specific role she might hope to fill. This lack of knowledge on potential mathematics careers is not exclusive to Amy, and in fact is noted by researchers such as Piatek-Jimenez (2015) among her participants, in that particular article she also speaks to the fact that many of the students list teaching mathematics as a career that would combine mathematics with the social aspect they wished to have in future employment. For Amy, teaching would fulfill a role of not only allowing her to continue in mathematics but would allow her to share her enthusiasm with others and help them to appreciate the value of mathematics as she sees it.

Finally, Megan, teaching mathematics held the greatest interest out of the four students, in large part because her own love of mathematics had been inspired by one of her high school teachers. In fact, she mentions teaching in her very first comment in the transcript and continued to discuss it as a career throughout the interview

> M|3:31| alright so i am studying math ah i'm in second year so i haven't really gotten in to a lot of the more seperate or diversified ones i'm still with the calculus and linear algebra um which is fine: i am in the coop program so i'm hoping to see the different types of options out there for this degree but coming in i was planning on going into teaching afterwards which would be seven years but that's ok {*laughter*}
>
> M|56:07| yeah- yeah and so initially i thought it'd be cool to be in rehab right or physiotherapy or something along those lines where i wouldn't have to worry about guts and gore ummm but in order to get there in university i would have to take some of the courses where i'd have to experience that and i didn't want to put myself in the stressful position of am i going to pass out in class? right? {*laughter*} so umm i then- before i even got to math i thought about teaching because i'd been helping my friends with certain courses and things and i really enjoyed doing that um and then knowing that i- like in high school i would need two teachables the first one that made perfect sense was math and so:: it kind of evolved from there and i was positive that i was just going to get my math degree and that never really waivered and i- for the most part was encouraged///

During her interview Megan repeatedly mentioned her love of sharing her understanding of mathematics with others and brought up her desire to teach high school level mathematics on several occasions. Her discussions around her sharing role in high school, namely assisting her friends with mathematics, held an important place for her not only in terms of providing others with help but for her own personal motivation as she expressed a preference for working in environments where not everyone enjoyed mathematics. She appreciated the drive that the slightly adversarial nature of not only doing the work, but trying to convince others of the importance, value and beauty of mathematics provided additional motivation. When I asked her questions regarding what she hoped to be able to do as a teacher, she added

> CF|53:16| ok so if you were to go into teaching what kind of changes would you be sort of hoping to generate then?
>
> M|53:22| just that's its ok to have a five foot three female math teacher right? the:- the non stereotypical umm thinking process right of you know no matter who you are or where you are whatever you want to do you have the ability to do that regardless of what society says

This was one of the clearest references Megan made regarding gender-based mathematics stereotypes while not responding to a direct question on stereotyping. She was certainly aware of the gendered stereotypes regarding women entering STEM fields as we had discussed it shortly before,

> M|50:08| uh well there's a couple ahh the stereotype of a male dominated stem field the stereotype umm of sometimes being difficult as a woman to get certain jobs in certain fields when employers are worried about maternity leave and other such things umm i'm thinking about the stereotype of women going in to more ah nonstem fields of really any other sort or going into umm biology or chemistry or to become=a nurse or that kind of idea ah which i think is just something that society was and so it's still slowly affecting but i think that will stop over time

Her statement from 53:22 then, can be understood as wanting to embody the rejection of this stereotype regarding women entering STEM fields. Megan is perhaps the most invested in sharing her knowledge of mathematics going forward given her stated career goals, and often expressed that she wished others would care for mathematics and its capabilities as she did. As with the other participants she expressed how much she enjoyed sharing her understanding of mathematics with others, enough so that she hoped to make a career of doing so. However, it is important to note that Megan had herself considered going into nursing, and that the way in which she spoke about that choice was similar to the way she spoke about teaching mathematics

> M|54:49|///in grade ten ahh careers class right we all have that opportunity to figure out our personality to figure out what ahm professions we would be good in and to work off of that so in grade ten i was postive that i was going to be a nurse right cause i- i like the stem field and you know nursing i'd be helping people which was like the two things i love to do///

This comment makes clearer how Megan worked to hybridize identities, as she balances her love of STEM fields with the 'caring' profession of nursing which would allow her to help people. She frames her decision to teach in similar terms as she expressed having enjoyed assisting her friends with courses, and teaching mathematics would provide the opportunity to continue working in mathematics while performing a caring role. This is a way in which Megan may be working to balance the more 'masculine' image of working in mathematics with a performance of a more 'feminine' identity by emphasizing interest in caring professions.

Overall, I believe that the notion of 'Sharing is Caring' is evident in the narratives of each participant and is important to developing a better understanding their figured worlds by

exploring how they envision themselves in the future. While they each express it in different ways, sharing, in the form of teaching or mentoring others who are learning mathematics, is cast as a role that they wish to have in the future, that they value having opportunities to do so. The emphasis that participants place on using mathematics to help others, or that they wish to help others learn mathematics suggests that this may be a way for participants to negotiate between identities as mathematically able and 'feminine.' As Piatek-Jimenez (2015) discusses, the inclination towards teaching in particular may also be influenced by the general lack of awareness surrounding what careers a mathematics degree can lead to, something which several of my participants remarked upon as well. Each participant told stories about helping friends or working as a tutor, positioning themselves as both knowledgeable in mathematics (compared to others who do not do mathematics) and as enjoying assisting others. This positioning may have also represented a way in which participants could hybridize identities at younger ages in school by adopting the role of the 'sub-teacher'. As Walkerdine describes "By being like the teacher and sharing her authority, girls can be both feminine and clever" (1998, p. 108) As such, positioning themselves in teaching roles throughout their lives may provide opportunities for women to perform identities as clever or mathematically able and as feminine.

Good at Math?

The title for this theme is in part inspired by Heather Mendick's (2005) *A beautiful myth? The gendering of being/doing 'good at maths'* as the idea of asking the participant to see how they felt they performed at mathematics stemmed in large part from this research. In that article Mendick notes that not only were the female participants in that study reluctant to say they were good at math but went so far as to actively deny it (2005). I was intrigued when reviewing the transcripts that all four participants seemed to have difficulties when trying to describe their ability and particularly around saying they were good at math. While each employed different strategies when navigating that portion of the discussion, they can be more broadly characterized into two categories when asked directly about their ability. Either they appeared to dance around or avoid answering that question or if on some occasions they did say that they were good at math this skill was typically framed as in the past or in some way diminished by later repeatedly claiming the opposite, that they were not good at mathematics. On many of the occasions that they did speak about themselves in a way which suggested they were clever or good at

mathematics, they would attribute this to hard work. As Walkerdine discusses in *Counting Girls Out*, this idea is gendered as natural ability was more often associated with boys while;

> it was far more common for even high-ranking girls to be called *hard-working*. This was used in opposition to terms such as *ability* and *flair*. In other words it had pejorative connotations… This phenomenon—of 'downgrading' the 'quality' of girls' good performance because it is thought not to be produced in the right way—is extremely common (1998, p. 87)

As such, this downplaying of ability by participants regarding their performance in mathematics as 'just hard work' is part of the negotiation between identities. The struggle of the participants to maintain an identity as mathematically able may also reflect the "myth of the 'mathematical genius'" (Mendick, 2005b, p. 211) with whom they may find it difficult to identify. Throughout this theme I have endeavored to illustrate how each participant works to navigate these challenges as they negotiate their identities within their figured worlds.

Regarding the two overall strategies when asked directly about their mathematical abilities, Kim and Megan were more reluctant to evaluate how skilled they felt they were at mathematics and tended to hedge while appearing slightly uncomfortable during that portion of our discussion. Megan, when I asked about her mathematical ability said:

> M|1:06:03| eh uh it's gotten better? over time {*laughs*} umm my younger brother right now is doing grade ten math and i **love** to do his math and so: umm i- i enjoy doing math when i understand it (.) right? and so (.) i think **that's** been really good like my relationship with math is for the most part great umm (.) but yeah no it was- like math has always been the same it's just been my perception **of** it based on my understanding that has changed

Aside from the initial hesitant statement that she felt she had gotten better, which was vague at best, the rest of her comment makes use of words like enjoy or love and speaks to her relationship with math rather than her skill in the subject. Curious, I prompted her again by asking how she felt she was at math now.

> M|1:06:44| ^ah^ better than i was in grade eight umm (.) i think i understand- well i understood all of my math in like grade ten and eleven those were great years umm (.) and it has decreased? in university umm mostly because i'm figuring out how best to study now in university which is different than how best to study in high school uhh i'm figuring out the different marking processes of the different professors umm and what they **expect** (.) and i've also uh gotten like little hints an glimpses of different branches of math and so that has just made me realize how **small** i am and how little of math i

> understand as a whole so what i'm learning i'm getting a good- getting an aspect so i understand that but seeing how much **larger** it is makes me feel like i understand **less** if that makes sense

Again, she replies better, although now with a reference to a specific point in time yet follows that up by saying that it has decreased in university. That apparent decrease may simply be, as she suggests, due to having a better understanding of the limits of what she does know and the realization of just how much more there would be to learn. Although it is not clear if she considers this lack of knowledge simply things she has yet to learn or if she counts this as meaning she is less good at math. Throughout the interview she had described her passion for mathematics, how much she enjoyed it and found it interesting, she does not describe herself as good at mathematics despite this enthusiasm. I find it intriguing that she does not appear to identify as such, despite of the important role of mathematics to her figured world, especially as Megan was quite interested in potentially teaching high school mathematics which one could easily imagine would require at least some degree of skill and comfort level with the subject. Even when speaking about herself in the past, she did not seem to talk about herself as skilled

> M|38:15| umm (.) i: (.)trying to figure this out so in elementary school i did not do well in math at all i didn't care for math i didn't like it i do well in everything that i liked doing right like if i enjoy what i'm doing it then i do well at it ahm there are certain things in math that i really like i really like a lot of algebra a lot of trigonometry a lot of just numbers and equations and such where as ah i'm not such a big fan of the proof aspect of it or geometry was also not a subject in high school that i enjoyed uhm and so it's been abit of a back and forth where i really enjoy math if i understand it and i can see the beauty in it and the symmetry and how it all fits together uhm and it has not been so great when i'm struggling with it or i'm frustrated with not understanding something and that's changed over time where i used to just be frustrated with it and then there was parts in high school where i understood all of it and so it was really exciting and i had a lot of fun and i really enjoyed learning new things and applying what i'd learned and learning off of that uhm and in university it's been a mix of enjoying it when i can understand it and being frustrated when i don't

There seems to be a divide in her views where she will say she did not do well, but when speaking about more successful periods with mathematics rather than using word that might describe skill such as 'well' or 'good' she instead switches to framing it as enjoyment or fun. Out of all the participants, Megan was the student who appeared to have the greatest struggle with making any type of claim to mathematical skill or success. Further, regarding the association

people made between mathematics and intelligence, she was quick to shoot any suggestion that applied that connection to herself, when she encountered other people who thought she was intelligent when she told them she studied mathematics:

> M|58:41| its- it really never varies umm it's often a look of shock umm not in bad way but just a surprised way umm and then often they immediately connect that with me being really intelligent which i- which i quickly go ehh calm down {*laughs*} umm because i think for the most part because math is so different than some other things some people have a really hard time with it and so they view it as you have to be really really intelligent to understand it umm which if you just have a brain that understands the structures and remembers the formulas then it's actually a lot easier than some of the other ah subjects///

This comment highlights the complexity of negotiating identities as mathematically able, as she dismisses an association with mathematics and intelligence when made about her and frames peoples' connection of mathematics and intelligence as coming from the fact that mathematics is so different that many people struggle with it. Yet, she then moves to the idea that if you 'just' have the kind of brain that understands then mathematics is actually easy, setting up a division between the 'other' (non-mathematicians) and herself as she is included in that 'type' of brain as seen in the following

> M|5:43| ///so it's easy to (.) ah i want to say it's easy to learn there are challenging aspects of it but it's easy to argue your point in math um and i also work with patterns and structures and everything so math is something that i easily understand where as history i can't do {*laughs*} whatsoever so yeah

This back and forth between the representations of mathematics as challenging and easy, seems to reference the popular perception of mathematics as difficult, while providing space for Megan to make a claim to mathematical ability. This claim however, is not stable as discussed above, and makes a reappearance in an interesting fashion in the following passage

> M|29:53| right so calculus or algebra you're given the problem you have to find the solution where as in proofs you're given a bunch of criteria and the answer and you have to prove why it's true and so uh=that was difficult for me because in math you have to work through and you have to figure out everything to get the answer an so it's not like you can make any shortcuts or cut any corners ah where as with proofs if they given you the answer some times it's easy to make up a whole bunch of stuff to say and this is why this is the answer and so that's been challenging ah also just the lack of numbers or

> equations or right in high school its mostly plug and chug right you're given these numbers you're given these equations you put them in there's your answer///
>
> CF|31:02| mkay so do you find it like more or less enjoyable?
>
> M|31:05| i find it more challenging ah i also have a really hard time understanding it ah for my well for linear algebra **this** year has been very much proof based and so i've found because the professor gives us the notes ahead of time i like to write them out **before** the actual lecture and then just listen as he's going through it so that i can attempt to understand because if you don't know the meanings behind the symbols you can't follow the logic so it's been a lot of review a lot of going back to the very first lectures to figure out all of these concrete concepts first so it's been a lot more difficult i certainly don't enjoy it as much as i do some other math concepts but i think that it's important and i should understand it and it's a valuable aspect of math so it's important to learn as difficult as it may be {*laughter*}

Megan appears to be tapping into a discourse about stratification within mathematics, as noted by Walkerdine

> Success at Mathematics is taken to be an indication of success at reasoning. Mathematics is seen as *development* of the reasoned and logical mind. This is where the important issue of girls' success comes in. Those explanations which allow girls success at all say that it is based on low-level rule-following, rote-learning and computation, not on proper understanding. Hence they negate that success even as they announce it: girls 'just' follow rules. (1998, p. 33)

In Megan's commentary then, we may see that she says the concepts in her current mathematics classes are more challenging and harder for her to understand as opposed to the 'plug and chug' number and formula heavy mathematics of high school. She is also acknowledging that she needs to put in more work, and do additional review and preparation, which runs counter to the 'natural ability' so closely linked with mathematical success. In this back and forth between mathematics as easy yet at times difficult to understand, Megan may be expressing what Solomon, Lawson and Croft have called a 'fragile identity'

> Many learners may be successful in mathematics but nevertheless see themselves as existing only on the margins of the practice, or as lacking stability in it – in this sense, they have what can be called a fragile identity. Although this kind of relationship with mathematics is not limited to girls and women, they do appear to express such fragile identities more often or more readily (2011, p. 565)

In this interpretation, Megan's difficulty in maintaining a position as 'good at math' can be understood as feeling a lack of stability as she describes her university experiences as more challenging, and that she feels as if she understands less in some sense than she did before. As Solomon, Lawson, and Croft (2011) indicate, this difficult relationship with mathematics is not

restricted to women and indeed it is not hard to imagine that the very rigid definitions of what counts as 'good at math' poses a challenge to many students regardless of gender identity. As such, Megan's struggle to hold a position as mathematically able can be understood as part of the complex negotiations required to try to balance performing identities as both 'feminine' and mathematically-able.

Kim also struggled to describe herself as good at mathematics and seemed to dance around the question when I asked. She had brought up during a discussion of what people might do with a math degree going forward that entering mathematics programs may be less popular because people are not sure where they would lead and then spoke about what she thought others in her mathematics program had intended to do

> K|1:10:06| i think it's hard for people to decide to go in math anyways because it's kind of like **where** will that ^lead^ unless you're like a genius in math you can't really do **pure** math all your life (.) as a career **unless** you wanna go into teaching and become a university professor or even a high school or primary school professor um **or** you wanna work with like statistics///
>
> K|1:11:12| not as much um ^uh^ i remember there was there was this one guy that was super super smart who was probably the super- the smartest um he was probably the only one that when we're in actual lecture you could see that he was understanding what was going on while we were all just like ok well i'll look at that back when i get home uhm i think he mentioned once that he just wanted to do research just wanted to work at the university and do research but the others not really///yeah it is kind of like a strange field where it's like if you wanna go do math it's really to develop math but if you want to develop math more and if you want to kind of like (.) bring some advancements in mathematic you need to really really really have an understanding of it **not** just at the core level and not just being good at math but just really like **being** like **good** at math {*laughs*} yeah

In both of these comments, Kim makes reference to the idea of 'mathematical genius' as necessary for truly progressing in the field and indeed her example of the only student she knew of who might qualify is male and framed as the only person who was able to understand what was happening in the lectures without doing extra work at home. As with one of the female participants in Mendick's study, she seems to be "projecting onto her classmate the fantasy 'mathematical genius'" (2005b, p. 211) Taking the opportunity, I invited her to clarify what she meant by 'good at math,'

> K|1:12:48| so like uh the basic being good at math right is just being able to (.) solve functions and do algebra and calculus and understand all those things and i guess uh the grades that they- they give in school and things like that like kind of like how they (type) their students and grade their students being **really** good at math is ahh (.) is- is just ah it's being able to read a book full of proofs and understanding them and being able to apply them and (.) being able to like just **solve** a function and knowing why you can do all the single steps like it's- it's not for nothing that you can do one plus one equals two there's like a **bu**::**nch** of different theorems behind why you can do that addition so someone that's really really good at math will know by heart really all those theorems and know this is why i can do that i guess kind of thing so um it's just like a further knowledge of- of it yeah
>
> CF|1:13:43| so where would you feel you fall on that?
>
> K|1:13:47| ahh kind of like ah in ah i'm really **interested** in the whole theoretical part of it i'm just not that interested so it's like- like when i see a video about it or like i read about it i'm like ok yeah that's cool but i don't delve deeper uhm but i also just love math kind of like a- at even at the point of like a hobby just like i remember in first and second year when i was bored i was just like do examples just for fun kind of thing so i guess on like the (.) left kind of a bit lefter than central {*laughter*} yeah yeah

Kim then, is also relying on fairly vague descriptions of her skill, as she labels herself as falling to the left of the center on a scale of what is good at math which is not especially clear. Her first choice in response is to emphasize that she is very interested, that she loves it and that it is even a hobby. As Heather Mendick discusses, one of the dichotomies that participants engaged with in her work was really good at math/ good at math, a binary in which being really good at math would be associated with masculinity (2005b), and Kim certainly seems to be drawing on this when speaking about mathematics ability. Earlier in the interview when I initially asked about her interest in mathematics,

> K|4:15| i think it was also:: just always interested i guess uhm my **dad** really loves math too uhh he's: a fireman but he was in mechanical engineering before- technical mechanical engineering and so:: he's kind of like (.) i guess given that passion to- to me from there umm but yeah yeah i just remember like it- it was always kind of like easy i guess? math always found it interesting ah yeah {*laughs*}

At best, her assertion that she found mathematics easy feels quite tentative, and she quickly moves to using the word 'interesting' and attributes some of this interest to her father's passion for mathematics being shared with her. Like Megan, Kim enjoys the challenge of mathematics but in the following passage, it seems as if she too may be drawing on discourses that represent her abilities in mathematics as rooted more in rule-following

> K|27:34| yeah i guess it was a bit about the **challenge** too i've always loved a challenge i always say that like my favorite exams at university are the ones that are **not** too easy that you feel like you studied too much for and they're not the ones that are just like where does this come from i've never seen that in my life they're the one that like the good balance where you're like you look at a problem for like ten minutes you're not sure how to do it and then something clicks {*snaps fingers*} you do it and then you're like really proud of yourself for doing it so it was kind of like the same thing in math in high school just like- it was just like the basic problems and it was like super repetitive and things like that it was fine but after a while it became a bit like i guess tedious but when i came to like doing extra **things** finding extra cool things and doing like extra work than i guess then it was more fun that way ahm (.) yeah {*laughs*}
>
> CF|28:19| yeah so it was very much like ahm more of like a problem solving?
>
> K|28:24| **yeah** it was more of like i guess the professor is like ok do like chapter five numbers i don't know five to fifteen i finished them i go see him and then he's like ok well now try this one which is like an extra one and like the most difficult part so i try to do that one maybe i don't understand it go and see him he explains to me so- so more things like that

While Kim narrates a story in which she asks for additional work, as she find the problems they have been doing repetitive which could imply that she is 'good' at mathematics, when she is given a more difficult problem by the teacher, she says that she may not understand the more complex problem and so returns to him to ask for help. This may be read as a moment in which she is negotiating between a 'mathematically able' identity as she finds some questions easy enough that she goes in search of extra work, but balances this with images of female success in mathematics as more based in rule following as she requires help with the more complex problem. Kim did in other instances make more claims to mathematical abilities as she distinguishes herself from her classmates

> K|6:17| ///umm i remember like especially myself i never found it like becoming **harder** for me it was just like building **on** what i learned and then you learn new things and it was never really harder///**especially** when we started working with like more (.) i guess it was like algebra so anything that had like *X*s and *Y*s and then when we went into like trigonometry and those things them i remember like a lot of people being really **confused** but i remember just like understanding it i feel like it was never:: (.) i don't know never really hard so::

Most of these claims however are related to the past and are often used to distinguish between herself as someone who can do mathematics and others who do not. For Kim and Megan, direct questions about their skill in mathematics were uncomfortable, and they opted to evaluate

themselves using vague terms and laughed awkwardly as we spoke about it. While they do make claims to mathematical ability, these are carefully negotiated and often framed as in the past, in comparison to people who do not engage in mathematics or seem to imply that any ability is due to the more 'feminine' hard work and practice.

In contrast with Kim and Megan, Rebecca and Amy more readily stated that they were good at math. However, throughout the course of the interview they would repeatedly offer up comments that appeared to detract from the previously claimed ability. For Amy, this contradiction was quickly made apparent, as in her first response on the transcript, when I asked her to tell me about her program was:

> A|3:12| okay so i'm in my third year (.) university (.)during my first year i was in psychology///i took math classes as my electives mostly because one my mom told like me you should still do math cause i g- going into my first year i wasn't really sure what i wanted (.) to do in university i was like okay ill go into psychology but i've always been good and interested in math (.)so um so yeah so i took some math classes as my electives liked them more than my psychology classes so:: (.) and after my (.) first semester i decided to switch into math

Amy switched into mathematics and computer science in her second year at university, having decided she much preferred mathematics to psychology. Here, right at the beginning of the interview with no prompting about skill she identifies herself as good at math. However, throughout the rest of the of the interview, she struggles to maintain that position and often insisted that she was instead not good at mathematics

> A|9:09| i honestly wouldn't know because me being me math has always been- like especially like in primary school and in high school has always been hr- ugh it's has always been easy and i've always been fairly- it's always been fairly- i've always been like a fast learner when it came to math is just like oh were seeing this okay it makes sense okay absorb it but then when you get to university you kind of get like a bitch slap no you don't understand anything which is what really drove me to like **keep** pushing it's really like i don't understand this but this looks really beautiful therefore i'm really going to push and try to try my best to understand///
>
> A|15:29| yeah it's a smaller group and then the prof gets to know **you**///plus in math i really do feel like often office hours are very useful cause when i was in psychology and now when i'm in computer science its like (.) you i don't for maybe that's just me personally i just wouldn't feel as comfortable going to to office hours because i could i could very much (.) i wouldn't feel like the prof would necessarily know who i am and

when you go see someone to ask for help help specifically it really helps if and it's really useful when they actually know who you are and (.)so for example i've had (.) up until like (.) end of um winter semester last year i had ten math classes total and i had four with the same prof///so he kind of(.) he:: knows me and knows how my brain works and stuff like that so when i write exams so like you know i've been i've been saying like i'm not good **really** not the best but he knows what i'm capable of so if i go during his office hours and asking questions he'll know how to explain it to me while to like my best friends who are incredibly smart might explain it in a different way///

A|30:01| exactly (.) and then so for me the ke- my current situation is my grades are **not** good {*laughter*} like really not good but it's just the fact that i'm so interested and (.) i want to say- i won't go as far as saying i'm passionate about it but just the fact that i'm **really** interested and then i just keep working and i keep pushing (.) for a lot of my math profs that's (.) alot so:: for example um last summer a prof he wrote an email saying that oh like you did very- exceptionally well in one or two- or more of my classes and i'm like (.) i don't know why i got the email cause realisticlly i got probably a *D* a *C* and a *C* plus {*laughter*} so i that's not what i call remarkably well (.) but um (.) the- its just the fact after i- we- we talked and it's just that the fact that i was **so** interested going to his office hours asking questions like actually showing up to class and actually doing something just like- yeah just shows that you're interested and also it shows that you can do///

A|49:04| well just no one goes to math because maybe it's not advertised enough or maybe (.) it's too hard? because it- it really is hard {*laughs*} um (.) yeah i don't know ah i'm really **not** sure but it's just (.) cause no one **is** in math and then (.) whe:n people- when i tell people that i'm in math they think i'm some type of genius when i'm really not like i'm really **not** {*laughs*} it's just that i- i just tell them it's- i'm not genius i'm not smart i just have different interests than they do (.) and then me being me i just really push myself to like (.) keep going cause i mean i- given the grades i've had i could have easily given up on math just in general you know i suck- i clearly suck at this **but** i could have given up like really easily and really fast {*laughs*} but i didn't i don't know why (.) but i'm still here {*laughter*} and i'm going back to just math next year so {*laughs*} so yeah i don't know (.) but yeah don't tell that you're really good at math because i don't wanna hear it cause it's like yeah we- we all used to be **really** good ok? now looking back- back at like past tests in high school it's like yeah i should have gotten a hundred on that it was so easy *{laughs}* but that's everything in life isn't it? like ugh i used to be really good {*laughter*} ^great^ we all used to be really good

A|52:19|=but like usually when i tell people i'm in math they're like oh you must be super smart (.) maybe i'm a bit smarter than the average? i don't know? maybe? like i don't think so but its just ah i don't know what to tell you

> A|1:21:06| uhm (.) its been a really (2) being in math for me personally has really grounded me to being like **hey** listen you're really stupid {*laughs*}///its just that i **know** that i don't know **anything** (.) which is truly fascinating to discover that that you're like wow realistically i don't know anything there is so much for me to learn out there and then for me being such a like a really big nerd ^be like ok^ knowledge time it is! *{laughs}* and then you're just like ^just like try to get as much as you can^ so yeah that's my journey in math is going from i think i'm like really good at math to like wow i'm really terrible at math to like wow oh my gosh i don't know **how** i'm going to survive this to like ok i can make it probably not like the best but i can make it ^so yeah^ it's just a really long journey to discover yourself and what you are actually capable of compared to other people which i know is not good to compare yourself to other people but we still all do it

Throughout these comments, Amy's struggle to negotiate a position as 'good at math' becomes evident as she has difficulty claiming to be good, especially in the present. Even within one comment, for example 9:09, she begins by saying she had found mathematics easy and then seems to struggle for a moment before she says she was a fast learner which draws on the association with mathematical ability and speed but then she describes university as a 'bitch slap' and she is now just trying her best to understand. Amy does say that she 'used to be really good' and that she thought that she was good at mathematics but as she speaks about the present, she stresses that she struggles to understand and that her grades are not good. Even when she recounts how a professor emailed saying she had done exceptionally well, she says that she does not know why she received that because her grades were not what she would consider remarkable and then settles on attributing this to her persistence and interest in mathematics. I believe that it is important to note that 'understanding' was not clearly defined and that this apparent struggle to understand may be influenced by gender "undergraduate women are likely to berate themselves for not understanding at levels which are in fact more demanding than those that their male counterparts set for themselves" (Solomon et al., 2011, p. 569) Amy frequently returned to the idea that while she may not be 'good at math' she found it interesting and so she persisted, which she often attributed in part to having the support of friends and professors. At 52:19 she appears to reject the association between mathematics and intelligence, however this connection, when we continued speaking about mathematicians more generally became more complicated to navigate

> CF|57:17| and if you were to think of- about like a mathematician or the kind of people that do math what pops into your head?
>
> A|57:25| i don't know (.) perserverant people? {*laughter*} people who can perservere cause wow um not but like yeah honestly i don't know i would probably say really smart? but given that i hate it when people assume that i'm really smart but i mean if you **do** finish a math degree i would consider (.) you to be very smart because wow you were able to push through something (.) that difficult and that (.) difficult to understand and grasp///its just the fact that math is so abstract and like you need have a next level kind of brain to like really grasp all the like abstractive- how abstract it is (.) so yeah that would be my stereotype it's like yeah your probably decently smart as a person {*laughter*} and driven

Here Amy struggles to connect with the myth of 'mathematical genius' as necessary for succeeding in mathematics and seems to link success more with perseverance and 'pushing through' which feels as though she is focusing on the idea of hard work leading to success. While Amy does finish the comment by saying that her stereotype would be that you are 'probably decently smart as a person' is if you can do a mathematics degree and so seemingly makes a tentative bid towards presenting herself as within the group image of mathematicians she swiftly adds 'and driven' that may a hybridization to include the need to push and work for the degree. As with participants Kim and Megan, Amy appeared more comfortable portraying herself as 'interested' in mathematics rather than 'skilled' and while she is able to make some claims to an identity as 'mathematically able' these are complex and often contradictory.

Finally, Rebecca was the student who expressed that she was good at mathematics most frequently during the interview but even these claims to skill were somewhat tempered by other comments that seemed to detract from her success. Early in the interview she began by saying

> R|7:09| **no** i did not{laughter} (.)well in my first year i started just as an- a specialization in economics and then when i moved on to second year i tried doing a minor in life science but i figured i didn't really **like** biology=i did like chemistry but not really biology and uh: yeah (.) then i thought about it i said well i **really** wanna add something that benefits me and i will **enjoy** because sometimes economics can get very **dry** (.) and also i wanna be **stronger** in it so i knew i was always- i was always strong in mathematics=and i liked it///

However, like Amy, she quickly begins to have difficulties maintaining that position, as I followed up on her comment above by asking how far back her feeling of being strong in mathematics went

> R|8:01|: it goes back until=let's just say the last year of my high school i remember when i first did mathematics in high school well i've always done in elementary but in high school it was very **hard** for me i actually had very low grades even a failing grade but i'm the type of person who does not like to give up i studied **hard** and i had a good prof in my grade 12 year so after that i started really excelling in math- like started aiming for high marks um but yeah math was always a struggle for me but once you get to hang- the hang of it and once you start knowing how to approach a problem it becomes easy=an a lot of times a student like me is a **slow** learner so i know i'm **capable** for reaching it i just need more time but now mathematics some areas like calculus and linear algebra i'm very familiar with them but some areas like mathematical reasonings and proofs like where you have to prove the **theory** i am not familiar with it so it takes me longer (.) to learn it sometimes have to repeat a class too

In this one comment Rebecca swings back and forth between conflicting characterizations of mathematics as both difficult and easy, of struggling and slow learning to 'getting the hang of it' and excelling. The contradictions first showcased here developed into a recurring feature throughout the interview,

> R|10:42| uh surprisingly when i was- like- when i was young an- in elementary school i used to be **very** good at math that was one of my best subjects and then when i hit grade seven it plummeted for me because it was like a major **jump** in math and i could also say there were some external factor that affected me in grade seven like bullying and a bit of depression that kind of **discouraged** me from learning(.) so- but generally yeah my parents would even tell me i **loved** mathematics i loved solving problems it was my favorite class=i used to like doing bar graphs when i was a kid (.) yeah it was just a course i excelled in (.) pretty much
>
> R|21:02|///the way i feel about it is it's like a **journey** (.) you know your going to make a lot of mistakes sometimes it goes in your favor you- oh you get the *A* pluses you like cause it works out and sometimes you get a *C* and a *D* and you're like why is this happening (.) am i in the wrong program?{*laughter*} that's the question i'm going to be asking myself so it's- it's like a is a love and hate mostly love but sometimes hate cause it's just- it's unpredictable sometimes so right now the way i feel is i'm taking a calculus class **that's** going extremely well for me because that's something i'm good at and at the same time i'm taking another math class that is completely **new** to me and is frustrating me (.) because it's a lot of theory math and i'm not quite into theory///it's **so** new to me

> that i have to take it- i'm sure i'm going to be taking it again just to get **used** to it (.) because in high school we never learned theory math-like mathematical theory you've always learned how to compute it how to do linear algebra how to do calculus///
>
> R|39:33|///i felt like i really want to teach it because i want to prove that anyone can **learn** math it doesn't matter if its quick or slow and i even met with someone who:: she made me feel **bad** in a way because i was studying a degree that was economics and mathematics and **she** was doing financial mathematics and economics and they're **both**- both are very hard to get degrees but she made me feel as though as if if i can't understand concept in math like that fast w-why are you in th-the program? (.) and that's something i really didn't appreciate because you cant assume every student- like you cant assume that just to be in this degree you have to be as **fast**- a fast learner to be in this degree like anybody even a slow learner can be in this degree///
>
> R|1:10:07| i looked at math ah my *GPA* ah in my second year it dropped because of the minor in life science and also the econ courses did get hard so i added the math to help- not only to to benefit and complement my degree but also to **help** me cause i was good at math it's also to help me do academically well in school now for some people that's like the last thing they'll ever do {*laughter*} don't- don't do **that** add an easy minor (.) yeah i get it but that's- that's one of the biggest reasons why i have math is to help me do better in school

While the final comment I have inserted from the transcript is the final one from Rebecca concerning her skill in mathematics and thus bookends her self-description in positive terms, the other passages reveal an image of much greater complexity. Although Rebecca's contradictions on her abilities are perhaps less vehement than those of Amy, they nevertheless demonstrate that she faces some internal struggles to lay claim to being 'good at math'. In the passage from 10:42, she reminisces about her skills at mathematics as a child, saying she used to be good at math and that she had excelled at it, past tense, and recounts her parents' description of her love for the subject. Most of this statement came across as very nostalgic, barring of course her discussion of personal circumstances combined with a difficult year in school which negatively affected her performance in mathematics. So, within her figured world she appears to be able to see herself as successful in mathematics at some earlier point in her life, though this state has not been a constant as she herself notes the drop in her mathematical capabilities which she measures via grades. In the comments from our discussion at 21:02 and 39:33 more of her reasoning for the current struggle she seemed to be facing regarding saying she was good at math, where she explains that this is due at least in part to her concerns over the speed at which she absorbs new

material. At another point in the interview she attributes this ‘slowness’ to a learning disability, as she indicates that she makes use of the university’s accessibility services. This has a great deal of impact on Rebecca’s figured world, as at various points including at 39:33, she emphasises that speed ought to be irrelevant and that she believes that anyone is capable of being good at mathematics, when given an appropriate amount of time for their learning needs. In Mendick’s *A beautiful myth?* one of the male participants shares his diagnosis of dyslexia and uses this to legitimate his opting out of the fast/slow (good at math/bad at math) dichotomy and still identify as good at mathematics(2005b). Rebecca seems to be tapping into this same discourse in order to find a ‘work around’ to be good at mathematics without the association with speed. Further, in her comment at 21:02, she may be drawing on discourses that split reasoning/calculation as she describes struggling with the new theoretical work and yet was successful in high school when they had to ‘compute’ which is a gendered opposition as noted by Walkerdine (1998). However, as with the other participants, Rebecca frames her success as down to hard work and studying and like Amy she associates persistence with being successful in her program

> R|53:28| mhh (.) i feel like (.) uhm i feel like in economics you have a lot of the hard worker traits because: economics you have to work hard so i feel like the ones who stay are the ones who:: are still persistant and who work hard and then you have then a mix of the personalities in there just because you have a bunch of international students too i feel like there are the ones that are **very** confident in themselves they **portray** confidence in themselves maybe sometimes to the point where it gets too cocky you know when you try to talk to them and ask for help///

Here Rebecca speaks not only about being hard working, but also that other students can be cocky and are not interested in working collaboratively which participant 1 would go on to say that she prefers to do. This however, would run counter to the image of ‘mathematically able’ as effortless achievement and competitive and so Rebecca works to balance these claims throughout the interview.

Overall, I believe I have illustrated the extent to which claims to mathematical ability, of ‘being good at math’ are not simple, straightforward statements from any of the participants. Despite the fact that each student had chosen to take mathematics and would have needed at a minimum the requisite grades both to have been accepted and to be allowed to continue participating the range of mathematically intensive programs, they each struggle to maintain a position as ‘good’ at mathematics. For each participant this identity negotiation takes on a unique

form, whether relying on vague answers to avoid answering the question directly or claiming in turns to be both good and 'bad' at mathematics when discussing their capabilities. This highlights the complex nature of trying to form an identity as someone who is 'good at math', and perhaps as Damarin suggests "the category 'mathematically-able' is itself marked as deviant in many parts of society…and its members are often excluded from full inclusion in other groups" (2008, p. 118) which would render it difficult when trying to reconcile identities as both female and mathematically able. Each participant found their own ways in which they laid claim to mathematical ability and yet distanced themselves from the myth of 'mathematical genius,' often attributing their presence in mathematics to interest, persistence and hard work. Perhaps, like the female participants in Medick's *A beautiful myth?*

> It is clearer still in the ways that these young women write themselves, in Ling and Rachel's denials of intelligence; their denials derive their force from the strength of their investment in a femininity that is part of an oppositional gender regime (2005b, p. 214)

As my participants too often rejected the connection between mathematical skill and intelligence, preferring to talk about working hard and studying rather than ability and even when they spoke about mathematics being easy, this was often negotiated as just having 'the right kind of brain' or regarding a particular kind of mathematics. Despite these challenges, all participants still said that they were interested in and enjoyed mathematics, and as all of them planned to continue their programs, they are evidently finding ways to participate.

Participants vs. the World

Before discussing my final theme 'Participants versus The World' I believe it is important to return briefly to my first theme, Sure, Structured, Strong, where I discussed the participants' definition of mathematics. Through the use of Holland et al.'s figured worlds "By figured world," then, we mean a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (2003, p. 52) I endeavored to explore the significance participants attributed to mathematics as way to develop my understanding of their worlds. Although each participants' understanding of mathematics was unique, all four of them highlighted the significant value of mathematics and often did so by framing it as a way in which people could understand and interpret the world around them. Throughout the themes in this analysis, I examined not just their understanding of what mathematics is and what it does, but the

incredibly complex relationship each participant has with the idea of 'who does mathematics.' With the great value the participants assign to mathematics in their lives, their persistence in pursuing mathematics, and the myriad of ways in which they try to negotiate identities as both 'feminine' and mathematically-able in mind, I feel it is important to explore in this theme how they reflect on society's view of mathematics.

As I reviewed the transcripts while performing the analysis, I was struck in each interview by commentary made by each participant during the course of our discussions regarding the generalized view of society as a whole on mathematics. While the women in my study found mathematics interesting and often described themselves as loving the subject, "Many others, often for the reasons that I have described (and with the support of our culture), avoid mathematics- often with strong negative attitudes and feelings" (Buerk, 1985, p. 65). In my own experience this is something that has not changed very much since that article was written, it is still common to profess a hatred for or inability to do mathematics. With that in mind, I wondered how this would impact the figured worlds of my participants when they were quite invested in mathematics while many others professed negative attitudes. Indeed, I asked Amy if she believed those attitudes influenced how she interacted with others, and her vehement reply remains one of the most memorable moments from the interview

> CF|1:17:34| yeah do you think that's changed how you like relate with some people?
>
> A|1:17:37| ye:- well (.) i don't know probably? like i- i honestly really wouldn't- wouldn't know its just when someone's like ugh i hate math its like (.) {*sigh*} ugh that is **so** like (.) it's such a **general-** (.) hating math is really like not specific **at all** and (.) it would really- it annoyed me- sometimes it annoys me to the point whe- where it's like i wou- i get **as** annoyed with someone being like oh i hate math as like i hate women its like **you** just hate everything that **you** (.) that h- humanity has learned or discovered during the past (.) centuries cause it's really like h- you cannot say you hate math okay it's like okay you hate how it was explained **to** you (.) you hate the relationship you have with it but like (.) **math** has **never** done anything to you other than (.) make- help make computers or phones or anything else but its just like how- yeah for me it doesn't make any sense that you can say like that-

This struggle with the commonplace nature of people hating mathematics is brought up by participants repeatedly, but one feature of this particular comment that has stuck in my mind is her stress on the fact that she believed that one cannot hate mathematics itself but rather that

when people say they ‘hate math’ that this is actually a reflection of the fact they hate the relationship they have with the subject rather than the subject itself. As someone who had long struggled with mathematics, this hit particularly close to home, as I discussed in the positionality section of this thesis and I have little doubt that at one time or another expressed a strong dislike of the subject. In fact, the key realization that lead to my change in opinion was precisely as Amy describes, that I did not hate mathematics itself but rather how I had been taught resulted in the negative association with mathematics. Thus, in Participants versus The World I wish to explore these moments of tension as a way in which we may better understand the figured worlds of the participants as they narrate stories about the many people around them who do not share their appreciation for mathematics.

I will begin this discussion with Rebecca, for whom mathematics was particularly important as a way in which she could make a difference. Even early in the interview there were suggestions that she was aware of the fact that mathematics was sometimes seen as an ‘unpopular’ choice, as she mentions

> R|6:06| ah well (.) doing both e- economics and mathematics is very the- they- they compliment each other it makes you a very strong competitor in the market and i just thought- i didn’t just choose ma- mathematics just for that i also- like when you add an- a joint you have to do- you have to do it because you **like it** (.) not a lot of people **like** math s-i’m like one of the rare- one of the few who likes it

Rebecca emphasizes that she is a rarity in being someone that enjoys mathematics, seemingly in reference to the general societal perception that mathematics is, as Rodd and Bartholomew describe “a troublesome subject: it has an aura of being important, hard, boring, high status and challenging” (2006, p. 35) When I first asked her to describe mathematics, she began with

> R|17:09|: **hhmm** (.) well i feel like it’s- it’s **many** things because that’s how people feel about it {*laughter*}yeah

While we did then proceed to discuss how she would define mathematics as I have discussed in other portions of this analysis, I found it interesting that her initial response to describing it was to indicate that it is many things because people feel many different ways about the subject. Later in the interview as we discussed various reactions people had when finding out she was in

mathematics, provided further insight into the range of ways she believes people feel about or see mathematics

> CF|50:07|: do you think that a lot of people view math like that? as sort of you know something scarier or very difficult?
>
> R|50:12|: uhmm i- i can't **obviously** not everybody sees it like that (.) there's- i guess there's certain types of people or groups of- or if you classify by what they study i guess some people they – yeah i would say they see math as scary they don't want to be near it ever again some people they, they're comfortable with it and- but not to the point where they're going to do a degree in math and then there are people that obviously they- they **appreciate** math and how it can help them and (.) i think on another group would be the ones who use math just because it gets them a good job {*laughter*}

From her descriptions of her own views of mathematics, Rebecca would fall into both the categories of someone who appreciates mathematics and sees the benefits of it in terms of future career options. She certainly invokes the idea that those who do not enjoy mathematics typically express very strong feelings 'they don't want to be near it ever again' and while she did not continue the idea of grouping reactions by what people study here, elsewhere she attributes finding mathematics difficult or boring to those in more 'creative' fields. Shortly before, I had asked whether she got any odd reactions from people when she told them what she studies, to which I received an emphatic yes

> R|47:16|: oh yeah i **do** a lot! because economics and mathematics when you hear it it's like ooo that's very hard or that's boring or that's dry so i get a lot of those reactions and i'm- i'm not offended by it usually laugh cause i know it's not for everybody i get it yeah ///sometimes the impression i get from people is like oh my god that's really hard it's not for me or that's really boring i tried one year and i just said no no no it's not for me (.) so yeah i get- i get those reactions

While she indicates that she laughs off these comments, I found it interesting that the first reactions she described hearing seemed to reflect the broader societal stereotypes surrounding mathematics and that these reactions were frequent. However, as Rebecca values mathematics so highly and finds it interesting, laughing these comments off may be a way in which she copes with many people dismissing the subject in which she is so invested, although it is not possible to truly know why she reacts in this way. Reflecting on this apparent conflict between the stereotypical view of mathematics and the way in which Rebecca views mathematics,

particularly in interpersonal interactions prompted me to follow up on these instances further in subsequent interviews.

Megan was the quickest of all the participants to bring up society's stereotypical view of mathematics, as I followed up when she mentioned people were surprised that she enjoyed mathematics

> CF|5:39| what do you mean it surprises people like do people react funny or something?
>
> M|5:43| they do and i when i tell people that i'm a math major they're kind of shocked um and i think that might be because it isn't a very large field like its if i told people i was in engineering of some sort that might make more sense umm but because it's just pure math they're unaware of that and i think society also just has a view of math being difficult and so: they don't know why id spend five years just doing math

Megan would continue to reference the small number of people in mathematics throughout the course of her interview, and as she does here, she attributes some of this to an apparent lack of knowledge about the possibility of pursuing a mathematics major and what sort of careers you might be able to do with a mathematics degree. Further on in the interview I had the opportunity to discuss the types of reactions she received again,

> CF|58:29| ok and sort of since then what are kind of reactions like when you tell people that you study math
>
> M|58:41| its- it really never varies umm it's often a look of shock umm not in bad way but just a surprised way umm and then often they immediately connect that with me being really intelligent which i- which i quickly go ehh calm down {*laughs*} umm because i think for the most part because math is so different than some other things some people have a really hard time with it and so they view it as you have to be really really intelligent to understand it umm which if you just have a brain that understands the structures and remembers the formulas then it's actually a lot easier than some of the other ah subjects and so:: ahh then often it will be well i'd never go into math but someone has to do it right {*laughter*} so you do it and then i don't have to kind of idea umm and no one has for t- overall it's all been very encouraging and that might just be because i'm very confident in it and i don't go well i'm in math but you know this or that i'm like i'm a math major yeah uh {*laughs*} uhh but yeah often people don't expect that so

There are several elements of this comment that caught my attention, the first of which was Megan's assertion that the reaction never varies and is a look of surprise upon finding out she is in mathematics. Although it is of course impossible to know, I did wonder whether this reaction

may be so prevalent because Megan is a woman, and it is interesting to contemplate whether this shocked reaction would be as frequent for male mathematics students. Here too, we see in what Megan reports of the comments she receives more of the stereotypical response to mathematics which is often avoidance. Particularly interesting is the fact that she attributes the largely encouraging responses of others to possibly being 'just because i'm very confident in it and i don't go well i'm in math but you know this or that' and it is not entirely clear if what she feels people do not expect is the fact that she is a mathematics major or that she is confident about it. That she specifies that she just says she is a mathematics major rather than 'well i'm in math but you know this or that' did, when reflecting on the transcript, make me curious as to whether downplaying a mathematics major is a common response among other students in her program for Megan to have remarked on the difference. From here I asked more about these reactions and this led to an interesting discussion on how others may see mathematics

> CF|1:00:09| so like what is that response? like- like what do they actually say? i'm trying to picture it like what {*participant laughing*} what is this reaction?
>
> M|1:00:18| ahh it can be as simple as well you must be really smart or something along those lines umm and that's usually just c- coming from people who struggled with math in high school and then have never done it since right? umm and it was interesting because i was sitting in my music class yesterday an::d the two students in front of me one of them told the other you know you're planning to be a teacher right? and she says like you know now you have to take a math test right? and that was stressing them out and so i think in general math just kinda has this connotation of being really challenging so
>
> CF|1:00:55| mkay so yeah is that- is that the sort of description of math is this sort of like very hard subject people just kind of are only ever like hmmm
>
> M|1:01:03| yeah and it's one of those hard subjects that's like well known right like if you just say the word organic chemistry to someone they're gonna think that that's really difficult but its not like you don't learn organic chemistry in elementary school where as you learn math in elementary school right so it's i think one of those well known everyone understands **what** it is and so they think of it this way even though there's probably a lot of university subjects more challenging
>
> CF|1:01:33| ok no that's fair but there's that sort of general perception that it's just this hard thing that not a lot of people do
>
> M|1:01:42| yeah {*laughs*}

> CF|1:01:45| umm do you ever get the impression that some of them are kind of like almost scared of math?
>
> M|1:01:52| yeah? yeah umm i think like people in high school or higher grades of elementary school where they have to take math they're scared of those math courses umm (.) i think the ahh more older people who i've talked to about this its less of a fear and more of a:: well i don't understand any of that so were going to change the topic umm so i think for sure a lot of people are scared of it but that's more the younger age groups that need to deal with it ah if it's not- if the difficult challenging aspects of math are not a part of their everyday life then it's not really something that you're in tune with and so it doesn't scare you as much

Megan here, and throughout her interview tended to link people's avoidance or fear of mathematics with the stereotypical view that mathematics is difficult and that if they had struggled with the subject that many of them had 'never done it since' and so perhaps become the older people she mentions avoiding the subject because they don't understand. In contrast she views mathematics as an integral part of life that is applicable in some way to nearly everything and intends to continue having mathematics in her life in some capacity moving forward. This rift in the understanding of mathematics between Megan and the generalized view of society was something which she acknowledged towards the end of our interview

> CF|1:13:03| ok so (.) now that we've sort of discussed it (.) a little bit more if you were to look at your (.) definition of math again (.) what for you is: (.)- what is math?
>
> M|1:13:26|{*faint sigh*} well there's math to society and then there's math to me and math to **me** is umm (.) is a process of (.) problem solving umm either in concrete math problems or in day to day life that i thoroughly enjoy umm and that i hope to spend the rest of my life doing in different ways umm (.) it's a- it is a um (.) a **subject** of education- of learning but it's (.) more than that in the way that umm it isn't just sitting in a classroom and writing out solutions to meaningless problems it's a applicable to everyday life phenomena

However, Megan was not so much frustrated by the general attitude of society and its divide with her own understanding but rather to some degree appears to have taken this difference as a challenge. When speaking about her excitement for mathematics classes in high school,

> CF|14:27| mkay so did that change like the vibe a little bit like thinking about when transitioned to like the grade twelve where everybody was enjoying it?
>
> M|14:31| a little bit but i ah i almost fed off of their disappointment by being more excited right like it was let me show how different our opinions are///i'd say almost i was

> more excited about math in grade nine than i was in grade twelve just cause by grade twelve everyone's at more or less the same level of excitement and so there really like you're kind of i don't want to say you're dragged down to their level cause that sounds bad but you know you're like at the same level as everyone else so your- you're just you know settled where as when there was a big difference i was like you know let me tell you how great math is cause you don't understand
>
> CF|15:20| yeah there's sort of almost that challenge
>
> M|15:23| yeah yeah

Megan was the most vocal about being competitive throughout her interview, and this certainly applied to her dealing with her views of mathematics compared to others. She appears to have used the conflict between her opinion of mathematics and her classmates as a form of motivation, fueling her own enthusiasm. This way of dealing with the divide between her understanding and that of society's in general is unique to Megan and appears to be spurred by her more competitive tendencies and her confidence in pursuing mathematics. In Megan's figured world it seems as if the conflict between her opinion of mathematics and that of others has become a way in which she can assert or perform her own identity as mathematical as in these moments her love of mathematics is thrown into contrast with the disinterest or dislike of those who do not.

During the beginning of my interview with Kim, as we were speaking about her early enjoyment of mathematics, she recalled not just her own attitude towards mathematics but included in her narrative what she saw happening around her with other students

> K|6:17| yeah i remember it being different a lot especially the classes like in primary school of course it's a lot more as you said manipulative and then in high school it's just like more ahh i guess like you delve deep down into like the:: theory of- so like **algebra** and calculus and all those things (.) umm i remember like especially myself i never found it like becoming **harder** for me it was just like building **on** what i learned and then you learn new things and it was never really harder umm but i remember my friend- my friends that loved- well not loved but they didn't hate math before started hating math uhm and then like helping them in high school in classes and something like that **especially** when we started working with like more (.) i guess it was like algebra so anything that had like *X*'s and *Y*'s and then when we went into like trigonometry and those things them i remember like a lot of people being really **confused** but i remember just like understanding it i feel like it was never:: (.) i don't know never really hard so:: i remember my class getting smaller and smaller///

While this story serves as a way for Kim to narrate her identity as 'mathematically-able' from an early age, it also shows the gradual loss of other students from mathematics as her friends began to dislike mathematics. The low numbers of people in mathematics was something she remarked on throughout the course of the interview, and often as she does at 6:17, she links this absence with a lack of understanding. As we continued our discussion, she spoke about mathematics in a way that seemed to suggest a divide between her interest in mathematics and her friends

> CF|29:12| ^nice^ so: you mentioned ah hanging out with your friends and that's sometimes being somewhat seperate from your- your math interest is that (.) like for a particular reason?
>
> K|29:30| it's just because i guess it's like the truth is in life not a lot of people like math uhm like myself maybe two of my friends in high school were kind of like the only ones that like math and then everybody else didn't like math which i **understand** i guess like i- i don't **like** chemistry that much like it's just like ahh a preference **thing** or like what you understand what you don't understand everyone is different and so: everyone that came to university with me from my **home** town including my sister and some of my **best** friends they all went into psychology and into communications and all those programs there ahm so when we hang out after class together they talk about their psych class and their french class and all those classes and i was just like in math {*laughter*} so i guess like i didn't want to bore them and talk to them about what i was learning in my statistics class so like there's really **no point** about it i guess?///
>
> CF|30:31| yeah did that change how you like related to them at all? that separation?
>
> K|30:37| not **that much** i guess like i **love** that about university that you can just like choose what you want to do and that's **all** that you do so: its like i understood that did- didn't take my classes and i guess like a little bit sometimes i want to be like oh my god like we learned this in class today and it was so cool and the response is like uugghhh {*laughter*} stop talking its like it's become a bit like of ahh so but i would like talk to like one of my- the friends that i- in high school that also loved math they went to like a university in X and stayed in Y **but** they were in similar programs engineering programs or just science programs so i guess i would talk to them sometimes ahh about what i was doing and what they were doing and we would like help- help ourselves solving problems and things like that

Although Kim says that this division has not changed how she relates to her friends 'that much' there does seem to be a sense of not being able to speak about a subject she is quite passionate about as she says that she does not want to bore them by speaking about her classes while they discuss theirs. This divide is furthered as the story moves beyond 'not wanting to bore them' to actively being shushed on occasions where she does try to talk to them about mathematics.

Instead, she reaches out to two friends at different universities who are in mathematics related programs about what she was interested in from her courses as well as providing an opportunity to help each other with problems. In many ways Kim's friends' reactions to her talking about math, that they would either see it as boring or actively want to avoid discussing it would seem to represent that general 'dislike' of mathematics which is in contrast to her enthusiasm. Instead she speaks to other friends who themselves are involved in mathematics related programs and share her love of mathematics, so those who understand mathematics. There is a sense that her inability to speak to her other friends about mathematics may be causing some tension, and while many perform different aspects of their identities when around different people, with how important mathematics is for Kim, not speaking about mathematics would seem to be something that may be difficult or frustrating. These negative reactions to mathematics are not confined to participant 3's friends, as she too describes people being surprised by her program

> CF|58:31| ok (.) so (.) y- you kind of like mentioned various friends i kind of want to just revisit that for a second because ahm you've described sort of like people in- in general not liking math you- in your own journey being quite- quite involved with math like have- do you ever feel like anyone has ever reacted differently to you or strangely based on like what you study if you like tell people?
>
> K|59:04| yeah for sure! like everytime i go somewhere i=dont=know- the dentist and they ask me like oh so are you a student i'm like yeah and then they're like **oh** what are you studying like oh i'm in civil engineering and then they're just like (.) **wow** and ok when i was in **math** and i told people i was studying math and like why? {*laughter*} like a lot of people were just[like *pourquoi*? i was just like because i like it? and they were like oh my **goodness** like they **couldn't** believe it that someone was studying math uhm and i- i do campus tours also uhm and (.) when i **was** in math and i was doing my campus tours and i told that to people a lot of people were like why? but then there was sometimes a science students or the engineering students ^that was like^ really? oh my god i **love** math! and it's kind of like a- a kind of like a bonding thing oh you love that too oh my god i love that too and it's kind of like a- a ^little thing there^ uhm but yeah i forgot um the question now
>
> CF|59:58| just like based on like peoples like reactions like wha- what kind of reactions do you get?
>
> K|1:00:05| so yeah it very- it varies from like oh my god i love math too and starting to talk about math and our favorite math things and ^things like that^ to like oh my god i **hate** math///i feel like for those people who- who don't like it or dont enjoy it i guess it's just like a **task** that ex- extra step that you have to do to solve it is just i- it's extra work that you have to do and it's not **fun** uhm (.) but yeah i guess it depends the reaction is

> usually positive uh obviously sometimes especially in engineering there's a lot of i guess surprise from the fact that there's not as many women in engineering which is slowly evolving to becoming more and more but in most of my engineering classes we're three and like twenty five guys {*laughs*} so yeah yeah there's that too {*laughs*}

Kim shared stories of differing types of reactions to her involvement in mathematics related programs, the first of these she describes as occurring any time she sent somewhere such as a dentist's office. She describes the reactions to her being in a civil engineering program as being met with a 'wow' but when she was in the mathematics program and shared that, she was instead met with 'why?' and adds emphatically that they could not believe someone was studying mathematics. Kim goes on to mention that she also received that reaction when doing campus tours, although she shares that when there were students in mathematics intensive programs that there would be moments of 'bonding' over the shared interest in mathematics. Although she does not connect the surprise or disbelief that someone was studying mathematics as having a gendered element, she explicitly cites gender as part of the reason she felt many reacted with surprise to her engineering program so it is worth considering that this may have influenced the reactions to being in mathematics as well. Kim also recalls reactions of people going 'oh I hate math' which she seems to explain that for those who do not enjoy mathematics, the extra steps would seem like a task and so they do not find mathematics fun. While Kim categorizes her experiences as 'usually positive' though the fact that this statement is immediately followed by her explanation that she believes much of the surprise about her being in the civil engineering program is gendered shows some of the tensions that are present. Towards the end of our interview I returned to the subject of how she sees mathematics and asked her how she thought her views of it differed from the 'average' person

> K|1:21:54| i guess i see it (.) ah in very much of a: (.) i would not say useful just like fascinating way for me math has always been **fascinating** it's always been like it- it does so many things and it applies to so many things and (.) even if i- i don't really understand everything about it i know that i- i **could** ah also very like overwhelming kind of like i don't know **books** or music you know that there's so many books and so many songs you'll never be able to listen to all of them or read all of them kind of the same thing with math there's so much about it you'll never be able to- to learn everything there is to learn about math uhm that's the way i see it kind of like fascinating and overwhelming and fun uhm where as i feel like **average** people more sees it as maybe (.) convenient that they- they learned math like i- i'm thinking like as an adult umm also: convenient but also maybe an obstacle like if they had a bit of a hard time in math then it **might** lead them to maybe like they're having a hard time i don't know with like the basic examples of doing

> their taxes or maybe like planning a trip and doing their budget for that trip or something like that or even like i don't know if- if they're working for a business and they have to analyse something then analysing that thing like i- i just imagine team of about forty on campus had like some quizzes and i just like went on excel did it in excel sheet plotted a graph averages and standard deviations and things like that and i understand all those things and i sent it to my supervisor and he was like thank you i don't really understand what you did but it- it's great {*laughter*} so it's kind of like- kind of like that so yeah i would say convenient yet an obstacle umm probably maybe brings back bad memories for people so it might be a bit of a- a stressful thing i guess when you think about math it stresses them for me it just brings me back to a good time which is doing math problems for fun yeah listening to rock music and just like doing calculus {*laughter*} yeah
>
> CF|1:24:07| bu- what- what do you think causes that fear of- of mathematics almost?
>
> K|1:24:12| it's for sure just the point that they had this class a:nd they had to do math and they did a test and they failed it and then they were sad and they were like ok maybe this is just a one time thing and then they did another test and maybe they failed it again and then they- they just ingrained it in their mind that like i'm not good at math and so i don't like math and like math is not nice to me and so i won't be nice to them {*laughter*} kind of thing um so: yeah i think it for sure stems from that uhm i think that people still naturally find math fascinating though i feel like every one is curious like you think of a child every child is curious i think there's some people that just kind of grow very sadly out of being curious and just accept things and just be like ok this bird flies cool whatever uh where as children is like why is this thing in the air and why is it not touching the ground! {*laughs*} kind of thing uhm so way i guess that people that don't like math they just kinda lost (.) that- that **fascination** for it because of the fact that they- they just told themselves that they couldn't understand it and that it was just like not worth it for them to- to- to just keep (.) kind of trying to understand it (.) yeah

Kim seems to attribute the divide between her understanding of mathematics and that of the average person as stemming from many people having lost their fascination with mathematics if they had struggled with it and felt they couldn't understand it and gave up. At best, she feels the average person may view mathematics as convenient as it can be used in their day to day lives, but that many see it as an obstacle or as stressful. This is in contrast to Kim who finds it fascinating and fun to engage with mathematics, and as absolutely essential to understanding the world. Within Kim's figured world, mathematics forms a critical foundation as she explains when revisiting how she would explain mathematics at the end of our interview

> K|1:37:38| i guess math is a way of understanding what's happening all around us and there's some things that to advance technology and to do some basic things and i guess it's kind of like a communication tool also just like universally if you know math then you know how to count things and you know how to calculate things and then- but

> further on if you want to develop something new and if you want to invent things then you kind of **have** to know some math to be able to do that because it's kind of like it's- it's the starting point of most things even if you don't think about it///i would yeah describe it as that first of all just like a- a kind of like starting point to- to things that people need to know because it is also a form of- of communications and of- of using it as a way to- to kind of live it's kind of like being illiterate i guess if you can't count or if you can't do basic calculations day to day life it could be very hard yeah

I believe that this comment helps to illustrate the degree to which mathematics is central to Kim's way of interpreting the world, and to her it is saddening that other people do not always acknowledge the value of mathematics. She seems to find the idea of being unable to do 'basic calculations' as something that would be almost crippling as she compares this to being illiterate. In Kim's figured world, there is a sense of separation at times between her and some of her friends as well as 'average' people with whom she is unable to discuss mathematics which for her is an essential part of everyday life that she sees all around her. Although she is able to discuss mathematics with other people who enjoy the subject, Kim says it is sad to her that so many others have lost their fascination with mathematics. While she says that the aversion to mathematics by her friends has not affected how she relates to them 'that much' and that she is saddened by others dislike of a subject she finds so important, I believe it is important to contemplate the impacts this may have on her figured world as she interacts with others.

Over the course of my interview with Amy, as with the other participants, she often remarked on the low number of people in mathematics. For Amy this perception may be amplified by her enrollment in the French mathematics classes which may have had fewer students than some of the English courses, and she commented that not only are there few people who go into mathematics but that few people remain in the program as well

> A|32:14| nice but it's really the fact that since like no one **is** and stays in co- uh in math they like- w- once you're there and if you're actually interested they will do their best to like keep you there so (.) uh when this semester started i was in three comp sci classes and three math classes including the real analysis where were like nine or- ^i don't remember^ um i was talking to my ahh to my prof about it like switching like into just math and he was like hey if you want to come to just math like we'll be happy we'll welcome you and um and just stuff like that it's just like you (.) feel kinda more like (.) they actually want you there given that no one is there no one ever goes through with it

While for Amy this had the benefit of providing smaller classes which she indicated felt more welcoming and encouraging, there is also a sense of isolation as she repeatedly speaks about how 'no one' is in mathematics. This separation may come from her view on the rarity of those who enjoy mathematics as she remarks later in the interview as I asked if she felt any of the professors or students shared any personality traits

> A|47:38| i wouldn't say a lot of the students cause we're not a lot i'm just kidding (.) honestly i don't know maybe it's just the fact that we all like **math** given that we are such a small portion of the population that likes math that much we're kind of just like all relating on that level that it interests us compared to people in like- oh i'm studying math oh eww i've always hated math ugh it's not=

In this comment, Amy's frustration with the common dislike of mathematics became evident and she described peoples' reactions to finding out she was in mathematics

> CF|48:02| =do you get people that say that?
>
> A|48:04| yes and then they get really- well yes and then i'm like okay that's really like cool for you {*laughter*} or people say like i used to be **really** good at math its like buddy being good at math in high school is not something that like (.) would make me feel like it's just like it doesn't change anything we were all good at math in high school {*laughter*} like so yeah so i- i get people like that like ugh math you know that was my worst subject its like ok that's: great?
>
> CF|48:31| so people have like weird reactions to it then sometimes?
>
> A|48:33| **yes** because no one has ever heard of someone studying math because everyone that is smart goes into engineering or biomed to become a doctor **like** i still feel like it's really stereotyped of like oh you do bio oh you want to become a doctor or a dentist or something like that oh you're smart and you're great at all the sciences go into engineering

These reactions, which seem to reflect the 'popular' dislike of mathematics certainly seemed to irritate Amy. She then connects this with the idea that very few people go into mathematics itself as a program and instead go into other fields like medicine or engineering. When I followed up on her comment about the stereotype and how it related to mathematics,

> A|49:04| well just no one goes to math because maybe it's not advertised enough or maybe (.) it's too hard? because it- it really is hard {*laughs*} um (.) yeah i don't know ah i'm really **not** sure but its just (.) cause no one **is** in math///

Her suggested reasons for the lack of people entering mathematics are intriguing, as the first, that mathematics is not advertised enough may connect with the struggle that many have in naming

careers one can do with a mathematics degree also noted in Piatek-Jimenez (2008). However, Amy's second suggestion that mathematics is possibly too difficult is interesting, as it seems to reflect some of her own struggles as despite her interest and pursuit of the subject Amy, as I have discussed in other themes, often disparaged her own mathematical ability. The idea that mathematics would be too difficult for may people also draws on precisely that stereotype in popular culture, which at times she instead rejects. When I prompted her directly on how she thought society in general sees mathematics, we had an exchange that truly underscored the sadness and frustration she felt with society's views

> A|1:08:07| i think it most of them just see it as something scary because they don't understand it and it make them feel like extremely stressed about not understanding it (4) so yeah i just like kind of really think that like a genius weird minded person would actually want to- would actually understand or **would** want to understand that it's kind of (.) its (.) it's kind of sad because it's i- i'm not going to say that its not **that** complicated but if (.) if you sit down with someone who really understands math and you actually listen to that person explain it to you you **will** understand it (.) so maybe it's kind of a will thing? to be like i've never been good at math and then your parents have told you oh i've never been good at math so you're going to be like okay i'll keep the trend i've never been good at math or i've never understood the point of it ahh this is what pisses me off is like when people are like oh i don't understand the point of math i'm just like okay well the point of math is to have everything around you (.) that is the point of math realistically
>
> CF|1:09:13| mhhm it's like describing everything
>
> A|1:09:16| exactly or like basing everything you (.) know around that okay maybe like (.) you could you would still be able to hunt and find food and eventually make clothes without math but it's just every single piece of technology wouldn't be there without math every (.) every kind of scientific (.) stuff we wouldn't have without math so it's like ok then that is a pretty big reason for math to like exist or for people to try to understand math
>
> CF|1:09:53| mhhm for there to be like more value [in it
>
> A| [exactly
>
> |1:09:55| there is **value** and (.) in (.) understanding math but it's just that since people don't understand math in general they don't see it as having a value because when you don't understand something and you kind of reject something that that thing doesn't have value (.) but that is just {*audible exhale*} (.) that's just being closeminded like personally i've **never** understood **anything** in french classes but i do see the merit in having literature because literature is art and art is a form of expressing yourself and that- there is

> merit to it and there is value to it i don't understand it like personally i don't understand art so for example if we go to a museum and look at a painting (.) that's just me personally but i will not feel different looking at a painting compared to looking at another painting (.) with more sadness or something i will not feel **sad** or much sad if i read a sad poem or like something like that i don't feel it as much but i **understand** the point the value and the merit behind it (.) so like maybe you better- if i'm really scared of looking at (.) like (.) classical- classic piece of literature and be like i have to analyse that i don't know how to analyse this but at least i do see the point and the merit behind it
>
> CF|1:11:19|mhhm not kind of just throwing it **all** out [because you don't like it
>
> A| [yeah like you know what
>
> |1:11:20| art is trash like let's just throw everything out because just like it's not because i don't understand it that means that it doesn't have value but it's just like since (.) a majority of the population doesn't understand math or hasn't been explained math in a (.) way that they understand they're just throw it out directly (.) but then you can't do anything without math so it's kind of sad

This portion of our conversation is perhaps one of the pieces that has remained with me since, as the transcription cannot do justice to the passion with which Amy spoke about mathematics and her frustration with those who do not value it. She too attributes much of the generalized dislike of mathematics with fear or a lack of understanding of the subject and references the stereotype that only odd geniuses can understand mathematics as an element within this. For her, mathematics is so critical to everyday life that it seems baffling to her that people are so willing to dismiss it entirely. In Amy's view, beyond the most basic ability to hunt and perhaps make clothing, we would not have anything particularly scientific or technological that we enjoy today without the use of mathematics. Further, to her this lack of understanding of mathematics is what has led many to place no value on mathematics since they have rejected it. Amy then elaborates on her frustration with what she sees as closemindedness from society on mathematics as she compares it to her own lack of interest in art, yet she does not dismiss all art as trash even if she does not quite understand it or find it interesting. Shortly after this exchange, at 1:37:34, I followed up and asked her directly about how this difference in views of mathematics may have impacted her relationships with others

> CF|1:17:34| yeah do you think that's changed how you like relate with some people?
>
> A|1:17:37| ye:- well (.) i don't know probably? like i- i honestly really wouldn't- wouldn't know its just when someone's like ugh i hate math its like (.) {*sigh*} ugh that is **so** like (.) it's such a **general-** (.) hating math is really like not specific **at all** and (.) it

> would really- it annoyed me- sometimes it annoys me to the point whe- where its like i wou- i get **as** annoyed with someone being like oh i hate math as like i hate women its like **you** just hate everything that **you** (.) that h- humanity has learned or discovered during the past (.) centuries cause it's really like h- you cannot say you hate math okay its like okay you hate how it was explained **to** you (.) you hate the relationship you have with it but like (.) **math** has **never** done anything to you other than (.) make- help make computers or phones or anything else but its just like how- yeah for me it doesn't make any sense that you can say like that///

Amy seemed a bit conflicted as to whether it had impacted how she relates to some people, starting out as if to say yes and then settling on saying she did not know. She explicitly references just how common the hatred of mathematics is, at least in her view as she labels it as very general. Perhaps one of the most striking comments is her comparison that 'i get **as** annoyed with someone being like oh i hate math as like i hate women' which I believe truly speaks to the depth of the connection between Amy and mathematics. In her figured world mathematics is so essential and so valued that someone dismissing mathematics is placed on the same level as someone expressing hatred for an entire gender. For Amy, it makes no sense that people can throw away a subject that not only explains the world around them but as she lists here, has also provided the basis for major technological breakthroughs. As she points out, it is likely that many people do not actually hate mathematics itself but rather the way in which it was (or was not) taught to them and their relationship with it. Amy in particular seems not only saddened and perhaps a bit confused by the general dislike of mathematics but is also frustrated by it and while she appeared uncertain as to whether this tension between her views of mathematics and those of others had impacted how she related to them, she certainly made how she feels about the general attitude of society towards mathematics abundantly clear.

In Participants versus the World, I set out to explore how each participant spoke about how their understanding of mathematics and its value may be at odds with the general dislike of mathematics and how they navigated the tension between these views. While the reactions of each participant are of course unique, all of them swiftly affirmed that they received 'odd' reactions when sharing that they were enrolled in a mathematics intensive program with others. Many of these stories involved people reacting negatively to the mention of mathematics, ranging from calling it difficult or boring, to expressing a hatred for mathematics and even telling a participant to stop talking when she tried to discuss mathematics. Although there are of

course stories of positive experiences, I believe it is telling that in most instances when discussing reactions, the first ones they describe tend to be either the person being shocked or of the other person responding in a stereotypical fashion such as calling mathematics difficult or boring. This theme was particularly challenging to write as it relies upon the narratives of participants about their interpretations of peoples' reactions and behaviors and questions about how their view of mathematics as it may contrast with others and how that tension may influence their relationships are not ones which lend themselves to an easy or simple answer. Each participant dealt with the varied reactions to their programs in their own way, and I have included as much of the relevant portions of the transcripts as possible so that readers may consider the myriad of possibilities behind each response for themselves. For all of the women in this study, mathematics is a crucial part of their figured worlds, yet for many mathematics is a subject to be avoided. Thus, I believe it is important to consider how this socially acceptable dislike or avoidance of mathematics may impact those who are highly invested mathematics especially in regard to how this may pose difficulties in performing identities as mathematical.

Chapter 5: Conclusion

In this research project I set out to answer the question, how do Canadian female mathematics students engaged in mathematics-intensive undergraduate programs identify themselves in relationship to mathematics and negotiate that identity, as it relates to holding identities as both female and mathematically-able? I believe it is important to begin by acknowledging that there is of course, no single answer, as each student inhabits a unique figured world that is always changing as they interact with and interpret the world around them. Particularly when speaking about gender identities, which as Butler describes,

> gender proves to be performative - that is, constituting the identity it is purported to be. In this sense, gender is always a doing, though not a doing by a subject who might be said to preexist the deed…There is no gender identity behind the expressions of gender; that identity is performatively constituted by the very "expressions" that are said to be its results (1990, p. 34)

As such, the identities of the participants are always in flux as they work to negotiate performances in order to 'do' gender. Throughout each of the seven themes within my thesis I have endeavored to share the wonderful, messy, complex and sometimes contradictory ways in which my participants performed identities as mathematically able and as women. To do so, I explored the discourses they used as they narrated stories about themselves, about mathematics and on the world around them. However,

> discourse is not the majestically unfolding manifestation of a thinking, knowing, speaking subject, but, on the contrary, a totality, in which the dispersion of the subject and his discontinuity with himself may be determined (Foucault, 2002, p. 60)

Further, as discussed by Wetherell and Potter,

> Ideology and discourse become implicated in the very instantiation and maintenance of social and economic relations...discourse is active, compelling, and a pervasive part of the fabric of social life (1992, pp. 60–61)

Seeing the discourse participants used and how they each deployed, adapted or rejected them is key to understanding their figured worlds and their performances of identity. While I was not surprised to see many of the stereotypical discourses around mathematics and mathematicians appear in the narratives, like Epstein et al. I was "surprised at just how ubiquitous, and yet simultaneously seemingly invisible, they were" (2010, p. 48) As I have discussed throughout my

thesis, the images of mathematics and mathematicians remain overwhelmingly masculine. The perception that my participants held of mathematics, as certain, rational, difficult and sometimes beautiful, draws heavily on long standing Western views of mathematics. As Dorothy Buerk noted "For many women, mathematics is a collection of right answers with correct methods and exact symbols. While this view may provide security for those who can correctly use the symbols, it is devastating for those who cannot." (1985, p. 59) In exploring the discourses of my participants on how they would define mathematics, although they approached it from different perspectives, all of them seemed to draw comfort or a feeling of security from the certainty they associated with mathematics. However, this rigid rationality holds gendered connotations and so may contribute to the struggles the participants faced when trying to relate to mathematics. What the definitions of each participant also made clear was the extent to which they valued mathematics, yet often they faced difficulties in explaining precisely what mathematics is and focused instead on what mathematics does. For each participant, mathematics had an important role to play in everyday life and could be used to explain 'everything' around them.

These views of mathematics as certain and rational carried over into how they spoke about themselves, as people involved in mathematics as opposed to 'others' who were not involved in mathematics. In 'STEM versus Arts' I examined the ways in which participants constructed their identity in relationship to those who were in non-STEM fields. I was already aware from my own background in history, the construction of STEM/Arts runs along the lines of a masculine/feminine binary, and these binary pairs are not equally valued. As Mendick discusses in the stories of her participants as she explores their narratives and

> the ways that the fragmented, contradictory and fluid identifications of learners with mathematics are constituted through patterns of sameness and difference: the samenesses/differences between mathematics and *other* subjects, and between mathematicians and *other* people (2005b, p. 212)

While each participant employed these binaries to different degrees, each certainly made use of them to perform identities as mathematically able, though these were not always stable and they often tried to balance their statements around STEM versus Arts in an apparent effort to avoid sounding derogatory. The women in my study were not always positioned on the masculine/higher value side of these binaries, for instance they often opted to express a preference to work collaboratively rather than competitively which would place them on the 'feminine' side of that particular binary. This is not to say they did not enjoy elements of

competition, perhaps most evidently in Megan's narratives, but this was a way in which each could negotiate a performance of identity that can be understood as feminine while trying to position themselves as mathematically able. When speaking about the climate in their programs, several of the participants noted a feeling of 'everyone for themselves' rather than being interested in working collaboratively. In some ways, it feels as though we have reduced explicit sexism that stand in the way of women entering STEM fields but have done little to improve the more implicit gender biases. Participants often spoke about people reacting in a very surprised fashion when finding out they were in mathematics-intensive programs, and while some of this may be due to the idea that 'few people enjoy/can do mathematics' I cannot help but wonder if the male classmates of the participants would report surprised reactions as often. I believe that this is one of the areas where further research should certainly be encouraged, as each participant emphatically replied yes when asked if people ever reacted 'oddly' when told their field of study.

The stories participants shared about reactions were often linked with the popular perception of mathematics as difficult, and something that only a few 'odd' or as is often portrayed, 'nerdy' people can understand and enjoy. Epstein et al. observed that students;

> whether they had continued with mathematics past the age of 16 or not, both directly referred to and used images of mathematicians drawn from popular culture and more indirectly drew on the tropes of mathematicians that circulate there (2010, p. 54)

My participants drew on these same images, whether they used the terms geek or nerd directly as I explored in the theme Freaks and Geeks. My participants each negotiated how much they wished to identify with and/or reject the stereotype of 'nerdy' mathematicians as it applied to themselves as others they spoke about as involved in mathematics such as friends or professors. All of the women in my study adapted these stereotypes in a unique way, performing some of the behaviours associated with mathematicians while rejecting others. While the image of the 'nerd' is a challenge for many to identify with, it appears to be more so for women as most of the depictions in popular culture are male. Further, there are negative connotations to 'nerds' which the participants themselves address and reject as they speak about 'who does mathematics' as some elements, such as being introverted tend to be embraced, others, such as being socially inept are not. In Freaks and Geeks, I aimed to share the ways in which my participants navigated these stereotypes and to showcase their unique responses to the associations that can accompany the image. In carefully adapting some behaviours or associations with the idea of 'nerds'

participants were able to position themselves closer to the popular culture image of 'who does mathematics' without necessarily identifying with the idea directly.

Another way in which participants were able to perform identities as both mathematically able and as feminine was by drawing connections between mathematics and helping others. In Sharing is Caring, I explored how participants used discourses about teaching mathematics, or using mathematics to help others, when speaking about their future as a way in which they could hybridize identities. Cheryan (2012) suggests that the gender gap in some mathematics-intensive fields such as medicine has been closing more swiftly than others, as careers in medicine were more easily connected to traditional 'caring' roles and as such seem more 'possible' or more appealing to women. This hybridization of mathematics with caring roles is not easy, as Solomon, Radovic and Black discuss in their reflection on their participant's own efforts to do so

> Thus, in coming to see and hybridise the contradictions between enactments of mathematics and of femininity, Roz does not simply imagine a new future for herself as a professor of mathematics; in becoming, she must live with the ongoing struggle that this entails—the contradictions persist in the wider social structure, perpetually throwing up new contradictions for her, and her enactment of a hybridised identity is difficult and real (2016, p. 69)

While my participants did work to negotiate images within their future which combined mathematics with more 'caring' and social roles, I feel it is important to understand that this hybridization is an ongoing and challenging process.

The struggles that participants faced in trying to negotiate identities as both feminine and mathematically able, were particularly clear in the theme Good at Math? While all my participants were able to say that they were 'good' at mathematics or had found mathematics easy, these positionings were difficult to maintain. Each of them navigated this challenge differently, although they generally tried to avoid speaking directly about skill, or if they did and were able to claim that they were 'good' at mathematics at various points in the interview they would also offer anecdotes to suggest they were not 'that good' or outright claimed that they were not very good at mathematics. Participants were more likely to frame their relationship with mathematics in terms of enjoyment, interest, or passion than ability and often attributed their continuing participation in mathematics to 'hard work.' As Walkerdine explains in *Counting Girls Out*

> it was far more common for even high-ranking girls to be called *hard-working*. This was used in opposition to terms such as *ability* and *flair*. In other words it had pejorative connotations… This phenomenon—of 'downgrading' the 'quality' of girls' good

> performance because it is thought not to be produced in the right way—is extremely common (1998, p. 87)

So, observing that the women in my study tended to say that they struggled to understand mathematics at times and they attribute much of their success to 'lots of studying' is to some degree concerning. The double standard of ability vs 'just' hard work is problematic, as it continues to privilege ideas of the 'mathematical genius' as the standard by which being good at mathematics is measured. Participants often downplayed the association of mathematics with intelligence and instead focused on persistence as playing a vital role in their choice to move forward in mathematics. They often cited family who had encouraged their success academically, even if not necessarily in mathematics, directly as part of the reason they have persisted.

While most of the themes in my research were aimed at looking in to and doing my best to interpret the figured worlds of my participants, my final theme, Participants versus the World was intended reflect on how each participant felt society saw mathematics. Given the centrality of mathematics to each participants' figured world, and the many negative stereotypes associated with mathematics/mathematicians I believe it would be helpful to understand the participants figured worlds by asking them about what they thought of other peoples' perceptions of mathematics. In many ways, the participants often attributed disliking mathematics with not understanding it and each of them expressed that due to the way in which mathematics is taught, if a student misses or needs more time to understand one section they are often left behind and the gap in knowledge is one which they do not recover from except by exceptional efforts. While I do not believe it would be prudent to make recommendations based on such a focused study, I feel that it is important to share what my participants believed to be problematic and why. They largely attributed the loss of other students in mathematics to students having become 'lost' along the way and that if people struggled too much they became discouraged and chose to reject mathematics.

I believe some important areas for further research would be to explore how societal perceptions of mathematics impact the interactions students in mathematics have with 'others' who, if the anecdotes of my participants are any indication may react poorly to mentions of mathematics. Given the challenges participants faced when attempting to perform identities as mathematically able, having many people you encounter react negatively to a subject they are so invested in may pose further challenges to those performances. How do Canadian female

mathematics students engaged in mathematics-intensive undergraduate programs, identify themselves in relationship to mathematics and negotiate that identity, as it relates to holding identities as both female and mathematically-able? For my participants, as I have shared throughout this dissertation, they struggle to maintain identities as mathematically able as they try to negotiate the complex relationships between representations of what it is to be mathematically able against performances of femininity. That they have persisted in mathematics is admirable and there is much that can still be learned by exploring the narratives of the women who are able to continue in mathematics, however I believe that it is concerning that this is still in 'defiance of stereotypes' as this remains a barrier to women's participation. As Epstein et al. note "Being unable to cope with mathematical ideas and thinking excludes people from such jobs in ways that produce and reinforce social inequalities" (2010, p. 46) and so the struggles women face in identifying as 'good at math' can have important implications, for if women continue to be lost along the 'leaky mathematics pipeline' then they are indirectly excluded from key fields. By continuing to problematize stereotypical images of mathematicians and explore the contradictions between 'femininity' and being 'mathematically able' I hope that my work contributes to ongoing efforts to "enlarge the group of people who can bring mathematics into their lives" (Buerk, 1985, p. 70).

Appendices

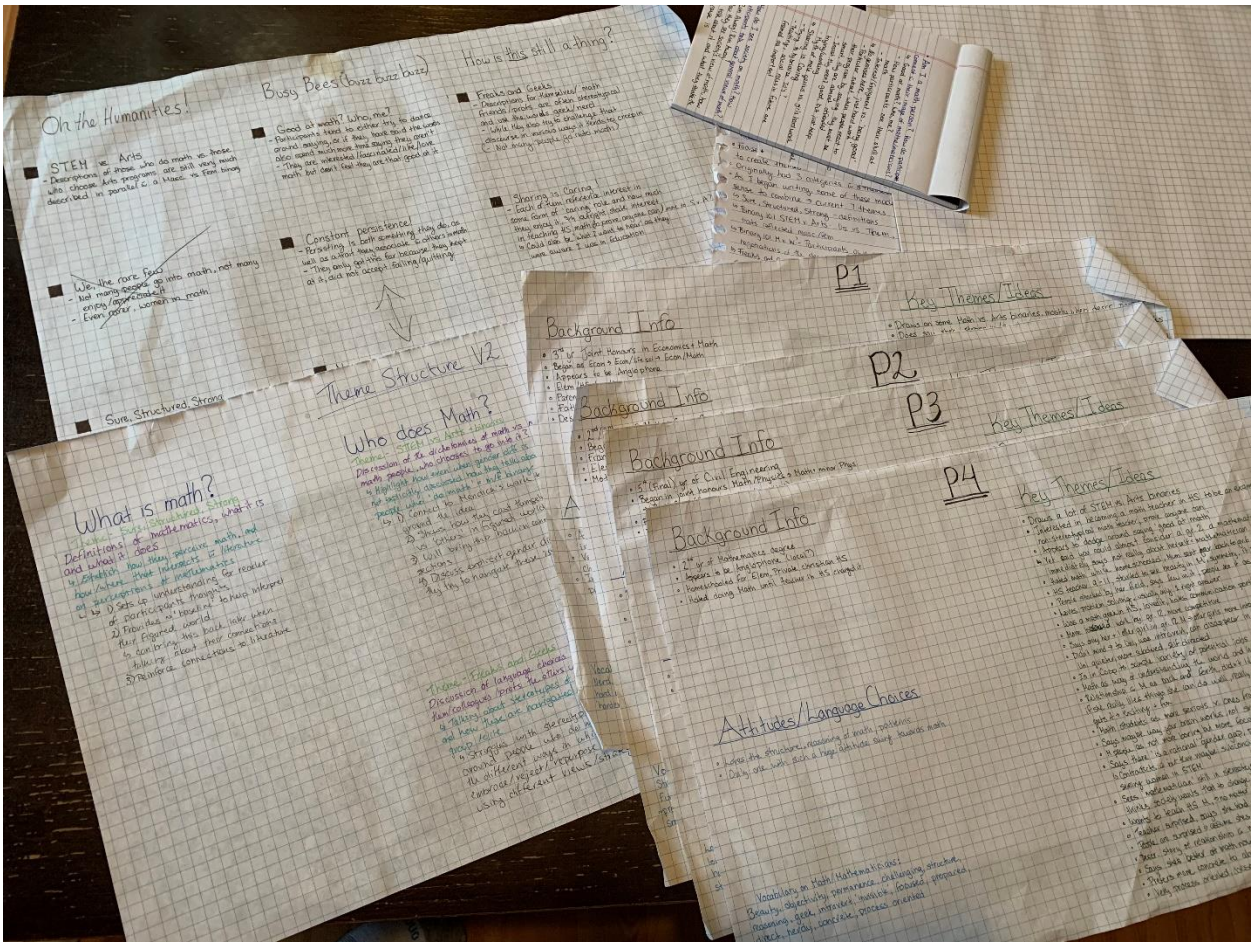
Appendix A

This appendix contains the topics that were used as a starting point for discussions during the interviews with participants. To keep the interview from becoming too structured and to encourage the participants to tell their stories, in keeping with narrative methodology, this list was intended to suggest topics for discussion and potential areas of interest rather than an exhaustive list of questions.

1. Can you tell me about your program?
    a. How long have you been participating in the program?
2. Could you tell me about some of your experiences since you've been studying mathematics at the university?
    a. What made those moments stand out?
3. Looking back, what was your elementary school experience like with mathematics?
    a. What do you remember most about it?
    b. Were there any people that influenced that experience?
4. What was your experience with high school mathematics like?
    a. How did you find the transition from elementary to high school math?
    b. Tell me about how you saw mathematics
    c. Was there anyone that had a particular impact on your high school experiences
        i. Tell me about them, how did they impact your experience?
5. Could you tell me about how your experiences with math changed over time?
6. Could you describe how you see or feel about mathematics now?
    a. Has that changed over time?
    b. What comes to mind when someone says 'mathematics'?
7. What was it about your experiences with math that lead you to choose this program?
8. How would you describe your mathematical ability?
9. Looking forward, sort of things would you be interested in doing once you finish your degree?
10. Overall, how would you characterize the story of how you got here, and where you hope to go with mathematics in the future?
    a. What roles have others played in your story?
    b. How has your relationship with math changed in the course of your story?
    c. What role do you think math will play in your story moving forward?

Appendix B

The image below represents a sample of the extensive note making and revisions that went into the creation of the thematic analysis.



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