Minimizing Gender Stereotype Threat for Female Students in the Math Classroom

By:

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Abstract

The purpose of this qualitative study was to investigate how a sample of Ontario teachers are addressing the effects of gender stereotype threat in math classrooms and to discover how this changes the overall atmosphere and outcomes of female students’ performance within a co-educational system. The primary research question that guided this study was: What strategies do a sample of teachers utilize to minimize the effects of stereotype threat in relation to gender and mathematics learning for female students within a co-educational system to create a gender equitable environment? The data for this study was collected through semi-structured interviews with three elementary school teachers currently working in TDSB and YRDSB schools. Findings suggest that female students may display potential academic and behavioural indicators of gender stereotypes. Further, findings also suggest that the teachers’ attitudes towards math positively impacted their commitment to helping female students. Moreover, findings suggest that whole-group teaching strategies can be used in the classroom to positively impact female students’ achievement. The implications of these findings suggest that awareness of gender stereotype threat needs to extend to the whole school community. Both teachers and administrators need to be positive role models, foster positive perspectives towards math, and incorporate cross-curricular integrations of math and language along with a variety of gendered pairings to create gender-equitable math environment for female students.

Key Words: gender, stereotype-threat, math, math strategies
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1.1 Introduction to Research Study

Despite all the movements towards equality in our societies, gender differences still exist. These differences are especially prevalent in mathematics, with an under representation of females in math intensive fields (Campbell, & Evans, 1997; Ceci & Williams, 2010; Davies, P. G., Spencer, S.J., Quinn, D. M., Gerhardstein, R., 2002). While many people will openly admit their frustration and dislike of mathematics, as evidenced by the multitude of existing memes on various social media sites in comparison to any other academic subject, it appears that this dislike manifests itself primarily in females. Approximately 90% of academic positions and more than 80% of non-academic positions in math intensive fields are held by males within the U.S. (Anglin, Pirson, & Langer, 2008), with approximately 9-16% of tenure positions in math intensive fields being occupied by women (Nelson & Brammer, 2010). These aversive feelings and decisions not to pursue math intensive careers generally stem from a very young age, with very few adolescent females choosing careers as engineers or physicists, instead opting for careers in medical fields, psychology and law (Ceci & Williams, 2010).

Although perceived gender differences are known to exist in other subjects such as language (literacy) being predominantly a female domain, the negative perceptions regarding female ability in mathematics takes the forefront. Both adults and children within the United States share the cultural stereotypic view that math is prominently a male domain (Nosek et al., 2009; Lummis & Stevenson, 1990 as cited in Cvencek, Meltzoff, & Greenwald, 2011). Negative attitudes towards mathematics may manifest before children reach kindergarten, with boys in elementary school as early as Grade two displaying stronger identifications towards math on
both implicit associations tests and explicit self-report measures than girls, further fortifying the cultural ideology that “math is for boys” (Cvencek et al., 2011). Denissen, Zarrett, and Eccles (2007) suggest that children will cultivate reduced interests in both academic courses and occupations that they believe to counter their sense of gender-related academic identity, which may partially explain the existing under representation of females in math intensive fields.

With these perceived stereotypes in place, it is important to question what effects it may pose for girls learning math in school. Studies suggest that females are more likely to show diminished performance on math tests when placed in gender minority situations (Inzlicht & Ben-Zeev, 2000; Davies et al., 2002). Conversely, these situations presented no threat to their verbal test abilities and when these female subjects were placed in gender homogenous conditions, their math performance increased significantly (Inzlicht & Ben-Zeev, 2000). Gender differences can further be seen in math performance when females and males are given problem-solving questions. In a study conducted by Che, Wiegert, and Threlkeld (2012) in comparison to the male students, 54% of girls’ responses in comparison to 27% of boys’ responses, did not show any evidence of reasoning beyond application of memorized procedure.

Despite the persisting evidence that supports the existing gender differences between females and males in mathematics, the Ontario Mathematics Curriculum has paid less attention to these issues in comparison to issues of males and literacy. The Ontario Language Curriculum has been equipped with accommodations, specified prompts, and suggestions for teachers to promote literacy among boys. Teaching pedagogies in math need to experience a shift from the traditional “explain-practice-memorize” methodology, centering learning on math textbooks, which can in turn foster mindless learning (Shields, 2005). Although this shift has begun,
teachers need to continue to develop differentiated pedagogies that foster in-depth conceptualization which allows students to perceive multiple solutions as opposed to the rote memorization methodology that focuses on absolute solutions (Anglin et al., 2008). Thus, students within the co-educational classroom may not only be subjected directly to stereotype threat, but further mathematical teaching pedagogies that may not cater to their specific needs.

1.2 Purpose of the Study

Given the stereotypical misconceptions of mathematics performance in females, through this study I hope to learn how a sample of Ontario teachers are addressing the effects of stereotype threat in relation to gender and mathematics in their classrooms and to discover how this changes the overall atmosphere and outcomes of female students’ performance within a co-educational system to create a gender equitable environment in mathematics. Moreover, I hope this research paper will provide teachers with a collection of approaches that will enable educators to teach math education in an effective manner. Additionally, with the knowledge of the existing underrepresentation of females in math-intensive fields, I hope this paper will provide insight to the educational community on methods of promoting positive attitudes towards mathematics.

1.3 Research Questions

The principle question that will be addressed through my research is: What strategies do a sample of teachers utilize to minimize the effects of stereotype threat in relation to gender and mathematics learning for female students within a co-educational system to create a gender equitable environment?
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The following questions will support the principle research question:

1. What indicators do these teachers see that their female students are internalizing gender stereotypes related to math education?
2. How, if at all, do these teachers’ own attitudes toward math impact their commitment to challenging gender stereotypes in math?
3. What specific strategies do these teachers enact to foster female engagement and achievement in math?

1.4 Researcher’s Background

Mathematics has always held a complicated position throughout my life. During my childhood I remember the significance that mathematics held within my family, as both of my parents had completed their educations in math related fields and my older brother was in an enriched math program throughout his school years. My parents, who had grown up and completed their education in Sri Lanka, had been taught mathematics in the traditional way of practicing numerous identical questions until solving the equations became second nature. Consequently, I was taught that being successful in mathematics depended solely on the “practice makes perfect” motto as well.

Although I managed to excel in mathematics during my elementary and middle school years, there was an intense amount of effort and preparation I underwent before the beginning of each school year. During summer vacations, I distinctly remember doing one math book after another in hopes of perfecting my math skills. The methods used by my teachers during my younger years, largely revolving around a text book, proved effective for me as they were simply
math drills of equation after equation. However, even then, when we would arrive to a unit on problem solving, or a section of a test contained problem solving questions, my math performance would suddenly diminish.

Eventually as I reached my high school years, the superficial understanding of math I had developed through the repetitive practicing of problems and math drills became insufficient as the concepts became more complex. Furthermore, the high school I attended was composed of a high Asian population, and both the teachers and students internalized the stereotype of ‘Asian people are proficient in math’. The math teachers would make remarks in class such as “You are Chinese, you should know how to do this question.” It was at this point that mathematics became a daunting subject, and one that I dreaded taking until I took calculus and vectors in Grade 12. My calculus teacher, who was also female, took genuine concern in helping me understand the concepts behind the math and I soon found myself enjoying math and eagerly attempting to solve the questions. My focus changed shift from getting the correct answers to understanding the process towards finding the answer. Her effort had played a significant role in my decision to confidently pursue my undergraduate degree in science.

As a future teacher, I am concerned that I may not be able to identify and incorporate methods for challenging stereotypes about females and mathematics within my own classroom. During my elementary years we would seldom do activities that related mathematics to real life applications, thus making mathematics an abstract and theoretical concept, instead of something we use in everyday life. However my own experiences have lead me to recognize that this method can create an intimidating and negative learning experience for many children, especially those who are developing an awareness of the existing stigma around mathematics. By creating a
more inclusive environment during math lessons by utilizing various methods I hope female students will feel more relaxed and open to learning mathematics. Further, I would like to learn how other Ontario teachers handle stereotype threat in relation to mathematics within their own classrooms so that I may be able to implement these methodologies within my own teachings and create a positive attitude towards math as my Grade 12 teacher had done for me.

1.5 Overview

This research paper contains five chapters: Introduction, Literature Review, Methodology, Findings, and Discussion. I will be conducting a qualitative research study to examine my research questions by using purposeful sampling to interview 3 teachers about their strategies and pedagogies towards minimizing stereotype threat in relation to gender and mathematics within their co-ed classrooms. Chapter 2 will examine a multitude of research to provide compiled information on the existing perspectives of females and mathematics, stereotype threat, causes and effects of stereotype threat, and strategies for creating gender-equity classrooms. The next chapter will focus on the methodologies used to conduct the study and will provide an outline of procedure, participants, ethical review procedures and limitations of the study. Chapter 4 will report the findings from the interviews with their significance in light of existing research being examined in Chapter 5. The last chapter will look at further implications of this research in my own practices as a teacher and for the educational community and will further outline any areas for potential future research.
Chapter 2: Literature Review

2.0 Introduction

This chapter will focus on the existing literature related to the stereotype threat and mathematics learning for female students. For the purpose of this study, the topics that will be examined in this literature review are the existing perceptions about female math ability, definition of stereotype threat, and what causes stereotype threat for female students. Next I consider what effect stereotype threat can have specifically focusing on female student’s math performance and in what conditions these effects occur. Following these sections, strategies for creating gender-equitable mathematics classrooms will be explored based on current research.

2.1 Perceptions of Female Math Ability

Perceptions of women’s inability to perform mathematics have been prevalent in society for many years. As teachers, it is crucial to comprehend and accept where these negative perceptions may stem from. The cultural stereotype that math is a male domain is held by children, both boys and girls, as young as Grade 2 (Cvencek et al., 2011; Tomasetto, Alparone & Cadinu, 2011; Gunderson et al., 2012). These negative perceptions can be fortified by young children when they are exposed to members of society such as parents and teachers who also hold these opinions.

2.1.1 Parental perceptions.

A child’s abilities and personality are significantly influenced by their parents and their home environment (Jacobs & Bleeker, 2004; Tomasetto, et al., 2011). Although genetics, nature, contributes partially to an individual’s intellectual ability, the environmental stimuli through
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 parental perceptions, nurture, an individual receives throughout development can have detrimental influences on their overall ability (Jacobs & Bleeker, 2004). Subtle cues as implicit as purchasing more games and math related manipulatives for sons could reinforce parental beliefs of gender differences in math ability (Jacobs & Bleeker, 2004).

In their research, Yee and Eccles (1988) found that parents’ perceptions of children’s math ability varied depending on both performance and gender. Parents attributed their daughters’ math performance to her effort, in contrast to sons’ math performance to natural ability or talent (Yee & Eccles, 1988). As a result, children, especially females, who are brought up in environments where the parents may have these negative perceptions in place may be at a predisposition to develop lower math abilities than their male counter-parts as they may receive differing opportunities. In congruence to the parental perceptions that Yee and Eccles examined, in a study conducted by Tapasak (1990) female participants were shown to attribute their math failure to their own inability, whereas males would associate any math failure with external causes. These children mirrored the beliefs of parents about gendered math abilities, with females attributing their failure to their own inability, whereas males attributing failure as being caused by outside factors and not their own ability. This similarity in perspectives held by both parents and children, speaks to the immediate effects parental perceptions have on their children’s intellectual growth.

Of particular interest however, is the influence that a mother’s perspective has on shaping her child. When mothers do not endorse gender stereotypes regarding female math ability, performance in females is unaffected (Tomasetto, et al., 2011). Although, it may be argued that females in lower elementary grades are not shown to have an explicit understanding of existing
gender biases, (Heyman & Lagare, 2004) they are still implicitly affected by stereotypic beliefs held by their mothers. Moreover, mothers’ belief of their children’s future success in math related fields has been shown to have a significant influence as late as 12 years later on the child’s career choices (Jacobs & Bleeker, 2004). As mothers are generally a child’s first female role model, having a mother who endorses negative perceptions can have damaging effects on their daughter’s own perception of females and math.

2.1.2 Teacher perceptions.

Teacher’s perceptions of their student’s abilities are equally as important as parental perceptions in influencing their student’s performance outcomes. A study by Upadyaya and Eccles (2014) found that students’ math preference and performance were influenced and paralleled their teacher’s perceptions of mathematics. The underlying general perception of gender differences in math ability can be attributed to whether or not the ability is a natural talent and not a learned ability. Teachers have been found to believe that girls are less competent than boys in mathematical achievement, with girls being required to exert more effort to achieve equivalent academic math performance as their male peers (Tiedemann, 2002; Gunderson, Ramirez, Levine, & Beilock, 2012). Teachers have also been guilty of attributing their female students’ success to external factors, versus failure to more internal ability and vice versa for male students’ math performance. Further, some teachers in the U.S. view their male students as being more competitive, independent and having a greater liking for math than they perceived of their female students (Fennema, Peterson, Carpenter & Lubinski 1990). These gender stereotypes held by teachers can influence their student’s perceptions of gender differences in math ability as well, eventually affecting the student’s own performance.
In addition to perceptions teachers may hold regarding female math ability, studies have found that the teacher’s own math anxiety, particularly female teachers’, can have negative impacts on their female students’ own beliefs (Beilock, Gunderson, Ramirez, & Levine, 2010; Gunderson et al., 2012; Upadyaya & Eccles, 2014). As demonstrated in the study by Upadyaya and Eccles (2014), students’ perceptions of mathematics can mirror their teacher’s attitudes by the end of the school year. Furthermore, math anxiety has been generally found to be more common among women in comparison to men (Hembree, 1990). This can be problematic for female students as children are more likely to imitate behaviour and perceptions of same-gender adults. Since many teachers are female, if they exhibit math anxiety it is more likely to impact their female students’ attitudes towards math (Beilock et al., 2010). In their study, Beilock et al. (2010), found that girls’ were more likely to endorse the gender stereotype “boys are good at math, girls are good at reading,” if their teacher displayed math anxiety. In conjunction math perception, the teacher’s math confidence can have further impacts on the female student’s math ability.

2.2 Definition of Stereotype Threat

Stereotypes can be described as a method through which the human mind can categorize information based on a generalization which is then used to identify a certain subgroup (Inzlicht, & Schmader, 2012). However, generally when people think of the word stereotype they think of the negative associations of the group, regardless of how much merit the association might hold. As a result, we hold negative perceptions of people solely because they belong to a certain group, and not based on their true potentials and abilities.
How do these stereotypes affect an individual? To comprehend that, it is important that we first define what is meant specifically by stereotype threat. Stereotype threat can be defined as the discomfort an individual might feel when they are at risk of confirming a pre-existing negative perception or stereotype about their group (Inzlicht & Schmader, 2012). This threat can induce the psychological phenomenon known as the choking effect which is paradoxical effect of not wanting to perform badly (Inzlicht & Schmader, 2012). Thus an individual, who in normal conditions may not possess the negative stereotype, will be more likely to fulfill the misconception when placed in a situation that may reinforce the stereotype.

Having said this, it is important to comprehend that stereotype threat should not be categorized as a subtype of other social evaluative threats such as test anxiety. While the two share certain commonalities, according to Schmader, Johns, and Forbes (2008) stereotype threat can only be triggered if an association is made between the self and their membership to a negatively stereotyped group. As such, an individual who may generally perceive their abilities positively may perform poorly if placed in a situation where the stereotype becomes salient and internalized (Schmader et al., 2008). Test anxiety is the result of more personalized, individualistic issues. Further, an individual under stereotype threat has the potential to be motivated to do well if they are capable of disconfirming the stereotype, unlike other social evaluative anxiety threats (Judd, Jamieson & Harkins, 2007). With the current concerning under representation of females in math-intensive fields and the negative perceptions held by society regarding females and math, it is imperative to examine what may cause stereotype threat.
2.3 Causes of Stereotype Threat

Teachers need to understand what causes stereotype threat so that they may be able to address and minimize its effects within the classroom. Explicit understanding of gender stereotyping in mathematics begins to appear in children around the age of 8-9 (Muzzatti & Agnoli, 2007). Stereotype threat can be triggered by very subtle cues in a testing environment. Stereotype threat is most likely to be triggered in situations where an individual is the minority in the group and knows that outgroup has specific negative perceptions (stereotypes) of the individual’s group (Eccles, et al., 2011). It should be noted that the term minority is being used here to refer to an ingroup, or group that an individual can identify with, versus an outgroup or dominant group that the individual is not a member of. Moreover, the minority group will only be affected by a stereotype when acting under the specific stereotyped domain (Eccles, et al., 2011). As existing literature widely this suggests that there will be no change in performance when the perceived stereotype is not present (Schmader et al., 2008). Within the co-education system that the majority of schools follow, this could translate into gender differences in math performance between male and female students. The literature draws on various causes of stereotype which have been grouped into three categories: an effect of ingroups vs. outgroups female roles, and gender identification.

2.3.1 Effects of in-groups vs. outgroups.

A study conducted by Inzlicht and Ben-Zeev (2000) examined math performance of females while doing math tests under two settings. Female participants who had been placed in male dominated rooms displayed significant diminished test scores in comparison to participants
who had been placed in a female dominated room. Conversely, females in same-sex have been shown to have less anxiety when measured using the Math Anxiety Rating Scale for Adolescents than females in co-educational classrooms (Campbell & Evans, 1997). The differing levels of anxiety were believed to be associated with an increased feeling of intimidation and competition females in co-educational classrooms felt due to the presence of males. (Campbell & Evans, 1997) These studies’ results are important insights into the effects of male to female ratios in co-education classrooms and their implications on female math performance.

Stereotype threat can only be triggered if an individual belonging to the stereotyped group is placed immediately within the stereotypical domain regardless of whether they are the ingroup or outgroup (Inzlicht & Ben-Zeev, 2000; Eccles, et al., 2011). Female students will only underperform in math if the following two criteria are met: they belong to the ingroup and are undertaking a mathematical task (Eccles, et al., 2011; Schmader et al., 2008). When female participants were placed in male dominant rooms and left to do a verbal linguistic test their performance was unhindered in comparison to their math rest results (Inzlicht & Ben-Zeev, 2000). Therefore, context is a component that is fundamental for stereotype threat to be internalized by a stigmatized individual.

2.3.2 Female roles.

Susceptibility to internalizing stereotype threat has also been linked to exposure to sexist roles (Dasgupta & Asgari, 2004). Females who are exposed to stereotypical sexist female roles are more likely to make an association to their gender identity (Dasgupta & Asgari, 2004). Female participants who were shown sexist commercials not only displayed lower performance
on the subsequent math test, but in addition avoided math items in favor of verbal linguistic items on an aptitude test and showed less interest in math-intensive educational and occupational domains (Davies et al., 2002). In comparison, counter-stereotypical commercials did not have any significant effects on the female’s math performance or preferences (Davies et al., 2002).

The underperformance in math after being exposed to sexist female stereotypes may be explained by the psychological concept known as Social Identity Threat, or the idea that one of an individual’s identities are at risk of being devalued (Judd, Logel, Walton, Spencer, Iserman, von Hippel & Bell, 2009). When women come in contact with sexist portrayals or interact with sexist men, they may feel threatened and undermine their performance. Moreover, cues as subtle as viewing males in dominant interactions with females in a math related context were shown to cause an internalization of the sexist stereotype and decrease female math performance (Van Loo & Rydell, 2014).

Contrarily research by Dasgupta and Asgari, (2004) found that females who took many math courses post-secondary education differed in levels of stereotype internalization depending on whether they attended a co-educational college versus a same-sex college. In same-sex educational settings, female students do not face any competition or intimidation the presence of male students. As a result, the female students are not exposed to situations of possible stereotype threat and learn not to internalize the stereotype. These students are instead only exposed to positive female role models in their educational community. The presence of a female who is known to be competent in math is sufficient in buffering female math performance (Marx & Roman, 2002).
2.3.3 Gender identity.

As mentioned previously, cues as subtle as watching females performing stereotypical roles can cause depletion in math performance. However, even the simple association of one’s self to one’s gender has been shown to lead to stereotype threat in math. This was noted in Nosek, Banaji, and Greenwald’s study in 2002 in which females that made stronger associations on the Implicit Association Test between the ‘self’ to ‘female’ and ‘math’ to ‘male’, also made weaker relations between ‘self’ and ‘math’. Moreover, a task as simple as indicating one’s gender before taking a math test was found to have profound effects on their test performance. Students who were asked to identify their gender before writing the test performed poorly in comparison to females who were asked to indicate both gender and their school status (Judd, Rydell, McConnell, & Beilock, 2009). The researchers explain that when the participants only indicated their gender it made their female identity more salient and accessible, thus causing a stronger identification to their gender (Judd et al., 2009). Teachers in co-educational systems need to be aware of these subtle cues when, addressing students as “boys and girls”, as it could cause the stigmatized individuals to form a subconscious association thus making their gender identification stronger and reinforce the stereotype threat.

2.4 Effects of Stereotype Threat on Performance

When internalized, stereotype threat can cause impairment in performance, most notably in the strand of mathematics for females which may eventually lead to avoidance and reduced interest in related academic courses and occupations. Teachers, especially those who teach within the co-educational system, should be aware of the repercussions that female students may
face so that they may help these students. The impairment of performance due to stereotype threat has been accredited to a variety of explanations in the literature such as anxiety, expectancy, working memory interference, arousal, and cognitive load (Steele & Aronson, 1995; Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Schmader & Johns, 2003; Ben-Zeev et al., 2005; Croizet et al., 2004, as cited in Judd et al., 2007). However, although many potential explanations exist, researchers have not come to a consensus on the mechanisms involved (Judd et al. 2007). Due to the complex nature of social interactions involved in stereotype threat, Judd et al. (2007) suggests that a number of pathways must be simultaneously at play. Thus stereotype threat’s effects on performance cannot be accredited to one independent factor. The following two predominant categories in the literature are the effects of stereotype threat on math performance through anxiety and working memory interference.

2.4.1 Anxiety.

When people are placed in testing situations a natural physiological response is an increase in stress and anxiety. This anxiety can be further heightened when individuals are exposed to stereotype threat (Steele, 1997 as cited in Osborne, 2007). Anxiety can be physiologically measured by an increase in heart rate and as a result blood pressure, changes in skin conductance, and decrease skin temperature. Osborne’s (2007) study recorded these physiological disturbances in girls who had been subjected to stereotype threat however; these disturbances were not present in boys. The physiological changes were recorded as the participants completed a subsequent math achievement test, suggesting that these girls faced elevated levels of anxiety while performing math because of the stereotype threat (Osborne, 2007).
Why does anxiety affect female math performance when subjected to stereotype threat conditions? It is important to remember that stereotype threat may be perceived through subtle cues as simple as gender identification. This causes an association between math inability being ‘natural’, innate, or fixed to occur with the following anxiety. In other words, the female perceives that her anxiety is the result of her own math inability. Reappraisals of the anxiety have been observed to buffer math performance in females (Johns, Schmader, Marten, 2005). By teaching females to alter their initial association to the stereotype threat causing feelings of anxiety, females show unaffected math performance (Johns et al., 2005).

2.4.2 Working memory interference.

In order to understand how stereotype threat may cause deficiencies in performance, it is important to look at the cognitive mechanism that is essential for performance, working memory. Wilhelm, Hildebrandt and Oberauer (2013) have defined working memory as a hypothetical cognitive process that allows us to retrieve information necessary for an ongoing task. This process is what allows us to temporarily focus our attention on a task at hand by inhibiting irrelevant information while providing access to applicable information. Individuals can have varying levels of working memory capacity, the higher working memory an individual has allows them to better protect themselves from stereotype threat (Régner, Smeding, Gimmig, Thinus-Blanc, Monteil & Huguet, 2010). This may be explained by the individual’s ability to better suppress unwanted negative stimuli in comparison to individuals with lower working memory capacities.
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Reoccurring levels of stress and anxiety are determinants of lower levels of working memory capacity (Eysenck & Calvo, 1992). Not only does general stress cause a lowering of available cognitive resources, but further stress from math anxiety can produce similar depletion. The lower levels cognitive resources we have available while doing a specific task, translates into reduced attention and thus a heightened chance of reduced performance. Women who were exposed to stereotype threat conditions remembered fewer words and vowels on the absolute span and vowel counting tests which determine working memory capacity as well these participants decreased performance on math tests (Schmader & Johns, 2003). Thus, internalizing the stereotype threat caused depletion of the women’s cognitive resources that were available for the math test and instead focus on the presence of the negative stereotype as was displayed by the increased activations of brain regions related to socioemotional information processing but not in regions necessary for math problem solving (Krendl, Richeson, Kelley, & Heatherton, 2008).

2.5 Strategies for Gender Equitable Instruction

As educators it is important to acknowledge and take the steps necessary for establishing a learning environment in math in which all students can succeed. This means, teachers need to recognize the importance of equity not equality. Children learn in many different ways, and as the causes and effects of stereotype threat on female’s math performance have shown us, this entails providing students with differentiated learning opportunities specific to their individual needs. Mathematics is often taught using the traditional teaching methodology in which the objective information is presented as absolute, lacking insight into the context and perspective
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(Anglin et al., 2008). This method of teaching can help foster rote knowledge of mathematics nonetheless proving inadequate for solving problems (Fuson, Kalchman & Bransford, 2005).

The significance of positive female role models and same-sex environments on the improvement of math performance of stigmatized individuals has already been explored (Eccles et al., 2011; Dasgupta and Asgari, 2004). Another method which has been proven to increase academic performance is variation of instruction. Teachers can often become set in pedagogies they believe are efficient for student learning however, it is vital that teachers utilize variation within their instructions based on the malleability of intelligence and student’s individual needs. (Johns et al., 2005) This section will focus on the impact of mindful learning, mindfulness, collaborative learning, and cognitively guided instructions and their positive impact on female students’ academic performance in mathematics.

2.5.1 Mindful learning.

Although negative perceptions of mathematics that develop during the early years of schooling can significantly influence the educational and occupational path one chooses, it appears that negative emotions begin to explicitly emerge in females during later years as the math curriculum changes from abstract theoretical concepts to application of those concepts. Research has shown that gender differences exist in math performance depending on whether the problem is “conventional”, problems that may be solved using familiar algorithms, or “unconventional”, requiring application of existing knowledge (Gallagher & De Lisi 1994). Males tend to outperform females in the later (Gallagher & De Lisi 1994) suggesting that females lack the ability to apply the knowledge. Similarly, a study conducted by Davies, Conner,
Sedikides, and Hutter (2016) found that female participants’ performance under stereotype threat varied depending on the type of math question given as well. Females participants appeared to have debilitated performance on comparison type questions in comparison to solve questions (Davies et al., 2016). Moreover, educators continue to foster this limited mind-set by using absolute language such as stating that a certain problem is solved using a certain way. In comparison teachers should use conditional language, or mindful learning, such as “a problem can be solved using this method” to indicate to students that there are multiple solutions for a single problem (Anglin et al., 2008). Mindful learning encompasses the use of conditional instructions and perspective taking that help females develop mind-sets that improve math performance in novel math tasks (Anglin et al., 2008).

2.5.2 Practicing mindfulness.

To reduce the effects of stereotype threat on stigmatized individuals, research suggests that teachers should encourage the practice of mindfulness within the classroom as it can help develop working memory capacity (Weger, Hooper, Meier & Hopthrow, 2012). As previously mentioned, when internalized, stereotype threat drains the cognitive resources, working memory, necessary for focusing on a specific task. Nonetheless, practicing mindfulness for merely 5 minutes is sufficient for reversing the effects stereotype threat has on working memory capacity (Weger et al., 2012). The use of mindfulness has been effective in developing more efficient usage of the available working memory resources (Chambers, Lo, & Allen, 2008). Through mindfulness individuals are capable of redirecting their attention to the target task while constraining the stereotype threat, or distraction, from taxing their working memory (Weger et al., 2012). Incorporation of mindfulness practices into the classroom’s daily routine can provide
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female students with an outlet for redirecting negative emotions during math lessons allowing them to be fully present and engaged in the learning.

2.5.3 Collaborative learning.

Collaborative learning, when done effectively, can be beneficial for student growth and learning cross-curriculum (Tobias, 1993). Similarly, collaborative learning can be utilized within the math curriculum to help alleviate feelings of anxiety that may arise when stereotype threat is triggered. Campbell and Evans (1997) mentioned that anxiety in females was associated with increased feelings of intimidation and competition females due to the presence of males. The nature of collaborative learning forces students to work together in order to succeed thereby reducing the presence of competitiveness. This allows opportunities for female students who may feel intimidated by their fellow male classmates to build confidence and lessen anxiety levels. Through fostering confidence and reducing anxiety, teachers can utilize collaborative learning in mathematics to help female students develop a positive attitude towards math.

2.5.4 Cognitively guided instructions.

Cognitively guided instruction or CGI is a student centered pedagogy that is based on the child’s working knowledge of mathematics from which teachers can develop their instruction around (Carpenter, Fennema, Franke, Levi, & Empson, 1999). In CGI, teachers provide students with word problems and observe the student’s solution strategies. Teacher’s observe and interpret the student’s strategies to help better inform their teaching practices (Moscardini, 2014). As a result the teaching is based on what the child already knows and can help them develop a stronger understanding of the mathematical concepts. Although, most research involving CGI has been conducted in America, there is strong evidence of its positive effects on student
learning and on teachers’ comprehension of children’s mathematical thinking processes (Moscardini, 2014). Furthermore, as this model of teaching centers on the student’s thinking, it provides an equal opportunity for stigmatized individuals to thrive and reach their full potential.

2.6 Conclusion

This chapter has looked at the current perspectives held by parents and teachers regarding female math ability, stereotype threat, the causes and effects of stereotype threat, and possible strategies for creating gender-equitable math classrooms. This literature review elucidates on the possible implications of stereotype threat on female math performance within co-educational environments and how our current educational system may reinforce these negative perceptions. The existing under-representation of females in math domains brings upon the question of whether there is sufficient awareness of stereotype threat on female math performance and teaching strategies to provide more inclusive environments for these stigmatized individuals within the educational community. Taking the existing research into consideration, I hope to provide a better understanding of how the educational community may minimize the effects of stereotype threat in relation to gender and mathematics learning and help foster positive attitudes through gender-equitable environments.
Chapter 3: Research Methodology

3.0 Introduction

In this chapter I describe the research methodology I have used along with the rationale for the methodological choices I have made. I begin by explaining the research approach and procedures followed by a discussion of the instruments used for data collection. I then explain the participants of the study, listing the sampling criteria, discussing the sampling procedures and providing background information of the participants. Subsequently, I elucidate how I have analyzed the data and elaborate on the relevant ethical considerations to my research. Further, I address some of the methodological limitations of the study, while also identifying the strengths. Finally, I conclude this chapter with a brief summary of my methodological decisions and rationales in light of the research purpose.

3.1 Research Approach and Procedures

The approach used to conduct this research study will be qualitative in nature involving a review of the existing, applicable literature semi-structured interviews with two to three teachers. While quantitative research can be described as a method through which the research question can be statistically assessed, qualitative research relies on the participant’s experiences and their in-depth responses to the research questions (Jackson II, Drummond & Camara, 2007). A Qualitative study requires both an explanation and the interpretation of the phenomenon being examined. This research approach focuses more on the thoughts and feelings of the participants based on their own lived-in experiences (Thorne, 2000). Through qualitative research, the researcher can uncover the understanding that already exists from the participant’s experiences (Smythe and Giddings, 2007).
Given the parameters of my research purpose and the questions I use to frame this study, a qualitative approach will allow me to gain an in depth understanding of methodologies used within the classroom by teachers who practice gender equitable pedagogies in mathematics. As Maxwell (2012) argues qualitative research is crucial particularly in educational research as it provides valid and transferable insights into what works within the classroom. This advantage of qualitative research suitably applies to my research purpose as I attempt to understand different methodologies and how they impact female student’s performances and experiences in mathematics.

3.2 Instruments of Data Collection

Focus groups, structured, semi-structured, and unstructured interviews (grounded theory), case study approach, and ethnography, are a few methods through which data may be collected for qualitative studies (Jackson II et.al., 2007; Sutton, & Austin, 2015). Each method has its strengths and should be chosen depending on the requirements of the research study. For the purpose of the study, the method of data collection that will be utilized is primarily the semi-structured interviews with individual participants.

The semi-structured interview approach is the most commonly utilized methodology of data collection for qualitative studies and can be conducted individually or in small group settings (DiCicco-Bloom & Crabtree, 2006). Due to the flexibility and responsiveness for both the participant and researcher, semi-structured interviews are the preferred method of choice for data collection (Jackson II et.al., 2007). This approach allows room for digressions depending on the Moreover, using interviews as a method of data collection requires the researchers to develop as much expertise in relevant topic area so they can ask informed questions to elicit appropriate
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responses. Individual interviews conducted using the semi-structured protocol allow both the researcher and participant to co-create meaning by reconstructing perceptions (DiCicco-Bloom & Crabtree, 2006). As a result, given my research purpose the semi-structured interview protocol will enable be to develop a better understanding of personal experiences of teachers who are working towards building a gender equitable math environment for their students.

3.3 Participants

The interview design process has many different aspects that must be considered to ensure a high quality of data, such as who to interview, how large the sample will be, what type of interview to conduct and how the data collected will be analyzed (Qu & Dumay, 2011). In this section I review sampling criteria I established for participant recruitment, and further the possible methodologies I will use for teacher recruitment. I have also included a section wherein I will introduce each of the participants once I know who they are. For the time being, I have left this as a place-hold.

3.3.1 Sampling criteria.

The following criteria will be applied to teacher participants:

1. Teachers will have taught mathematics for a minimum of at least 5 years.
2. Teachers will be female and have taught in Grades 3, 6, or 9 in mathematics.
3. Teachers will have demonstrated a commitment to challenging gender stereotypes in mathematics learning and to fostering female engagement and achievement in math.

As Qu and Dumay (2011) argued, when using the interview approach to data collection in qualitative studies, it is vital that the small sample of participants is selectively chosen to ensure
minimum retention of relevant results. For this study, the teacher will be required to have at least 5 years of teaching experience. This criterion has been chosen as within those 5 years teachers will have had ample time to have utilized a variety of mathematical pedagogies and adopted one they believe works best for their students. The participants should also have taught mathematics in Grades 3, 6 or 9 due to the existence of EQAO testing within these years. Since one of the components of the EQAO is mathematics, these grades will place greater emphasis on math. Further the presence of stereotype threat may be heightened in these grades as female students may display higher levels of anxiety due to EQAO testing. Participants will include only female teachers who actively challenge gender stereotypes within their classrooms. Additionally, research suggests the existence of performance differences depending on the presence of a male or female role model.

3.3.2 Sampling procedures.

Various strategies may be employed to recruit samples depending on the research approach, purpose of the study and the questions it seeks to examine. Marshall (1996) elucidates that there are three major methods to selecting a sample for a qualitative study. They are: convenience sampling, judgment or purposeful sampling and finally theoretical sampling. Of these three strategies, purposeful sampling is the technique that is widely used by qualitative researchers (Gentles, Charles, Ploeg, & McKibbon, 2015). This strategy of recruitment involves identifying and selecting individuals who have experience or knowledge pertaining to the research of interest (Palinkas, Horwitz, Green, Wisdom, Duan, & Hoagwood, 2015). This form of sampling can provide insightful data collection as participants will meet the criteria outlined to provide maximum results. Moreover, these participants may further suggest other potential
candidates for the study. This process of referral is known as snowball sampling (Marshall, 1996).

Theoretical sampling focuses on recruiting participants to examine who will help elaborate on interpretations of existing theories (Marshall, 1996). Of the three methodologies, convenience sampling is the least strenuous as it involves selecting participants who are the most available (Marshall, 1996). Although, this method requires the least amount of effort it is potentially disadvantageous as it could result in poor quality of data. For the purposes of my research study, I will be using a combination of both the purposeful and convenience sampling methods for participant recruitment. Although participants will be required to meet the criteria for this study, as a pre-service teacher, I hope to contact participants using existing connections with both pre-service teachers and working teachers.

3.3.3 Participant bios.

My first participant is Anna who has been working with the York Region District School Board (YRDSB) for 5 years. She first completed her Early Childhood Education diploma and went on to graduate from both a Bachelors of Education followed by a Masters of Education. Anna has worked as an ECE with the YRDSB for 2 years and has been working in various LTO positions including Grade 3. She described her attitude towards math as having been positive.

My second participant is Mary who has been working with the Toronto District School Board for 16 years. Mary has taught Grades 1-4. Mary has been co-teaching Grade 3 with Judy in an open concept school for the past 5 years. Mary described her experience in mathematics as having been negative and further identified having math anxiety in her early years of teaching.
My third participant is Judy who has completed her 24th year working with the Toronto District School Board and has taught Grades K-5. Judy has been co-teaching Grade 3 with Mary in an open concept school for the past 5 years. Judy described having negative experiences in mathematics and also faces some math anxiety.

**3.4 Data Analysis**

In the qualitative approach, Thorne (2000) argues that the process of data collection and analysis can occur simultaneously. Throughout the process of developing a sampling criterion, recruiting participants, the method chosen for collecting the data and distinguishing between what is significant data in answering the research question are all analytic processes that influence the data (Thorne, 2000). However, analysis further occurs as an independent step of data interpretation using strategies appropriate for the research questions. There exists a variety of analytic strategies each serving its own purpose and strengths depending on the research study such as the editing approach, the template approach, and the immersion/crystallisation approach (DiCicco-Bloom & Crabtree, 2006).

Data collected from interviews for the purpose of this study underwent the template approach. This approach relies on using codes from a coding book to tag portions interview transcripts before sorting sections of similar content in distinct categories determined by prior research (DiCicco-Bloom & Crabtree, 2006). All data collected during the semi-structured interviews with participants was transcribed into transcripts that underwent a process of coding using the research questions as an interpretive tool. I coded each transcript independently to identify categories of data and emerging themes within each category. The categories and themes were compared against one another and new themes were synthesized where appropriate. These
themes were then interpreted in relation to existing research examined during the literature review.

3.5 Ethical Review Procedures

As Bresler (1995) argues, the code of ethics in research should address concerns regarding the individual’s dignity, privacy, and confidentiality, and avoidance of harm. Although all paradigms of research must follow and address ethical issues, due the reflective nature and the meaningful immersion of participants in qualitative studies, the considerations of ethics is made more essential (Bresler, 1995). Four ethical considerations related to conducting interview protocols for qualitative studies include minimal risk associated with participating in the study, confidentiality of the participants, thoroughly informing participants about the nature of the study, and lastly ensuring minimal risk of exploitation.

Since the interview questions require honest personal responses, it may result in a response that jeopardizes the interviewee’s position (DiCicco-Bloom & Crabtree, 2006). To ensure that participant’s confidentiality is maintained, all participants were assigned a pseudonym and any identifying markers related to their schools or students were excluded from the study. There are no known risks involved with participation. In addition, participants were notified in the consent letter that they have the right to refrain from answering any questions they were uncomfortable with and ultimately withdrawing from the study if they wish. Participants were provided with the opportunity to review the transcripts and to clarify or retract any statements before I conducted the data analysis. Furthermore, to reduce the risk of exploitation all data stored as audio recordings will be destroyed after 5 years and kept on a password-protected computer. Participants will be provided with a letter of consent thoroughly informing
them about the nature of the study, ethical implications and the expectations of participation (one 45-60 minute semi-structured interview).

### 3.6 Methodological Limitations and Strengths

As this study, follows the qualitative research approach, it faces some limitations associated with the methodology. Due to the given ethical parameters and time constraints of this research paper the maximum number of participants that may be recruited is limited to a small sample size. Although the interview process of the qualitative design will provide in depth insights and reflections about the phenomenon, the limited sample size will be a major drawback as the results will not be generalizable to a broader population (Jackson II et al., 2007). The responses provided by the participants were restricted to their own personal experiences as an educator and do not provide sufficient external validity. Moreover, the sample size only included interviews with teachers, thus reducing the opportunity to gain multiple perspectives. However, despite the small sample size, due to the nature of the interview process, responses provided by the interviewees had a deeper meaning and significance to the research purpose and questions. As the role of an educator is reflective in nature, the interview process allowed participants to pull on their lived experiences and how they practically address the research topic within a classroom setting. This type of rich data cannot be collected through other forms of data collection such as surveys that may provide a larger sample pool.

Another significant limitation of this study is the potential for biases to emerge during interpretation of the data. As Qu and Dumay (2011) argue, even when there is a barrier between the interviewer and interviewee, there can be issues of in communication when words have different cultural meanings. Data interpretation could face issues of subjectivity as it may be
difficult to construe meaning from the interviewee’s perspective as distinct from the researcher’s own perspectives and experiences. Moreover, due to the limitation of finding participants from existing networks of teachers, this may further influence the process of data analysis.

3.7 Conclusion

In this chapter I discussed the research methodology beginning with the research approach I used while examining the significance of qualitative research. This was followed by identifying my method of data collection would be through semi-structured interviews. I then identified the criteria required for participants such as only sampling female teachers to identify female teachers’ math perspectives may influence female students. After the interviews were conducted, the data was analyzed to identify underlying common themes that emerged which were further analyzed in conjunction with existing literature discussed in Chapter 2. Considerations for potential ethical issues of the study were also outlined such as consent, confidentiality, the right to withdraw, and data storage. I ended the chapter discussing the possible limitations of the study, which provided insight into possible next steps, while considering its strengths. In the next chapter, I report the research findings.
Chapter 4: Research Findings

4.0 Introduction

In this chapter I will be reviewing the contents of the semi-structured interviews conducted with three Ontario elementary educators who have shown commitment to challenging gender stereotypes in their math classrooms. These interviews were conducted to explore the strategies teachers utilize to minimize the effects of stereotype threat in relation to gender and mathematics learning for female students to create a gender equitable environment. In this chapter, connections will be drawn between the participants’ experiences and perceptions and research from the Chapter 2 literature review. Findings from the interviews have been organized into three themes:

1. Teacher-participants recognize potential academic and behavioural indicators of gender stereotypes and its impact on female math education.
2. Teacher-participants’ attitudes towards math positively impact their commitment towards female student’s math education.
3. Participants recognize whole-group teaching strategies can positively impact female student’s math performance.

These themes have further been divided into sub-themes that will elaborate the findings from the participants’ interviews. Each theme will not only report the participants’ data but also discuss the significance related to existing literature. Moreover, I will conclude by summarizing key findings and make recommendations for next steps.
4.1 Teacher-participants Recognize Potential Academic and Behavioural Indicators of Gender Stereotypes and Its Impact on Female Math Education

All teacher participants spoke about the presence of implicit behavioural and academic indicators of gender stereotypes displayed by female students in the math classroom. It is important that educators are aware of behavioural and academic signs because it can help them make decisions/strategies to minimize the stereotype threat. Specifically, participants highlighted the decreased participation of female students during whole class math lessons and collaboration with the opposite sex, which may stem from a lack of self-confidence in their math abilities. Teacher participants also noticed that female students prefer focusing on the language aspect of math problems. They agreed that female students will spend more time explaining a word problem and focusing on language to communicate their answers, in comparison to male students’ whose focus is on solving the problem. Furthermore, participants spoke of female students’ use of extra time and resources as a method of improving their understanding of math concepts in contrast to male students.

4.1.1 Participants recognize a decrease in female participation and avoidance during math lessons as an indicator of stereotype internalization.

One of the primary indicators of stereotype internalization participants mentioned was the difficulty some female students displayed while participating in whole class discussions. This participation was dependent on the gender ratio dynamics of the classroom environment. When looking back at her own experiences, Anna shared that while working in different grades, she had always noticed that the majority of the girls would not be as engaged in verbally answering questions during a whole class lesson in comparison to the male students. Further, she added that
when asked to share their answers with the class, female students would typically be hesitant. Similarly, Mary also spoke about the lack of participation during lessons, especially when the classroom environment had a higher boy to girl ratio. She indicated,

They maybe don’t answer as much on the carpet, but we also had a class where it was majority boys last year so that was also a factor too because if you have more boys more boys are going to answer. It also might be more intimidating for the girls to answer, and the boys are probably more willing to take a risk than the girls.

Mary and Judy expressed that the decreased participation behaviour was also true when female students were paired with the opposite gender or placed in collaborative small group settings with male students. Both participants found that in these scenarios the male student would often take control of the task at hand while the female student. Mary revealed, “The initial reaction is eye rolling, when I’ve paired them up boy-girl, but eventually they will work. I do find that sometimes the boys will take more control of the work and the girls may be a little reluctant.” Similarly, Judy explained that even when she would take aside a smaller group, some of the female student’s participation would be decreased depending on the gender composition of the group. She has found that these students would feel more self-conscious and try not to stand out.

As indicated by participants’ acknowledgement of behavioural indicators, students as young as Grade 3 demonstrate internalization. While most studies focus on the effects of gender stereotype threat on math performance for older students (Inzlicht and Ben-Zeev, 2000;
Campbell & Evans, 1997; Dasgupta & Asgari, 2004), participants’ experiences validated other studies that suggest that young children are aware of gender stereotypes in math (Muzzatti & Agnoli, 2007; Cvencek et al., 2011; Gunderson et al., 2012). Furthermore, as illustrated in Mary and Anna’s experiences, the negative impact of male dominance on female performance in a math setting has been a prominent finding throughout the literature on stereotype threat in female math performance (Inzlicht and Ben-Zeev, 2000). Participants explained that the lack of confidence and hesitation in participation displayed by their students in participants’ classrooms may be due to anxiety or the fear of making a mistake and confirming existing stereotypes. An interesting parallel was Mary’s identification of the feeling of intimidation, to the reported increased feeling of intimidation and competition that females in co-educational classrooms felt due to the presence of males in a study conducted by Campbell & Evans (1997). Further, the avoidance behaviour Mary and Judy spoke of parallels the avoidance behaviour displayed by female participants who, after being exposed to sexist commercials and scoring low on the subsequent math test, avoided math related terms and occupations (Davies et al., 2002). Therefore, to ensure the female students can learn in a nonthreatening environment, it is suggested that avoidance behaviours or decreased participation may be signs of stereotype threat internalization.

4.1.2 Teacher-participants acknowledge female students’ preference for a language-based learning approach to learning math.

Although teacher participants acknowledged avoidance behaviours and decreased participation, some also recognized female students’ increased attention to explaining their thinking and the wording of a question in mathematics as an indication of language preference
and stereotype internalization. Anna believed that when given a math word problem, female students’ approach differed in comparison to the more direct approach taken by male students. She indicated,

Girls to me, with my experience, if they have a chance they will explain why this is A and B. They kind of dissect what the problem is. Questions like these really allow them to show me what they are thinking, especially if they are struggling using just numbers.

Anna even suggested that because female students tend to be higher in language abilities than boys, they attempt to apply different concepts learned to the word problem and interpret the problem differently than male students.

Correspondingly, Judy also echoed similar experiences as she identified a more prevalent focus on language in her female students’ math solutions when compared to solutions given by male students. She stated,

When I taught Grade 5, the girls’ answers would always have more explanation than the boys’ did. The boys just kind of showed their work. I also found the girls would struggle with the wording of a math problem a lot more than the boys in the class.

Although the literature does refer to female participants’ preference to linguistics in the presence of the math stereotype (Davies et al., 2002), these findings show the pertinent role language plays in female students’ math perception and how it influences their performance. While the
study conducted by Davies et al. (2002), demonstrated that female participants under stereotype threat avoided math items in favor of verbal linguistic items on an aptitude test, Judy and Anna’s experiences demonstrate how female students utilize their strength by focusing on language when attempting math problems. Their insights point to a potential relationship between math word problems and female students’ self-perception of their abilities in math versus language that educators should be mindful of when providing math problems.

4.1.3 Participants indicate that female students sought increased additional support in math as a specific strategy for improvement.

While participants recognized the importance of language, they also identified increased female effort through seeking additional support as a behavioural indicator of stereotype internalization. Anna referred to the discrepancy in support seeking by male students to be attributed to their sense of confidence in their math abilities. She reported,

I find that the boys’ attitude in my class wasn’t as nervous…they were like

“Whatever happens, happens.” They weren’t the ones to come up to me and ask me questions and staying after school, or using their recess time when I gave them recess time to come in you know what I mean? It was more of the girls that I felt showed more interest. Not to say the boys weren’t interested in anything, but the girls showed a lot more interest of using the time that I gave them in the classroom for sure.

Similarly, Mary believed that male students may be more hesitant to receive support due to the existing stereotypes surrounding their math ability which may have been formed outside the
school environment. She explained that a strategy frequently used in the class was to purposefully take aside a small group of students who had been identified as struggling in math. However, she had come to notice that the male students were more hesitant than the females to be seen in that group. She speculated that this reluctance might have been influenced by parental views regarding their child’s math abilities, since the students do not want to receive or ask for help. In this case, she suggested that the boys might feel like they should know how to do the math and seeking support from the teacher is an indication of inability.

Anna indicated that female students also received external support from tutors as a resource to support their math learning. She discussed that in her own experience as a student, her parents offered to take her to extra math tutoring to support her learning. Similarly, when Anna outlined the details of one of her struggling female students in math, she mentioned that the parents proactively sought math tutors to aid their child’s learning. They felt that this would be beneficial alongside with working actively with the teacher to support their child’s math education. A common finding throughout the literature has been the perception of female math performance as an internal ability being associated with the amount of effort placed in the learning. Parents attributed their daughters’ math performance to her effort, in contrast to sons’ math performance to natural ability or talent (Yee & Eccles, 1988). Correspondingly, female participants have also been shown to attribute their math failure to their own inability (Tapasak, 1990). Therefore, female students may believe that in order to be successful in mathematics, they must demonstrate an increased commitment and effort in their learning as demonstrated through the female students’ active seeking of teacher assistance.
4.2 Teacher-participants’ Attitudes towards Math Positively Impact Their Commitment towards Female Students’ Math Education

Participants spoke about how their different experiences in math education, in conjunction to noticing stereotype internalization in students, had positively affected their own perspectives and efforts towards creating an equitable math environment. The impacts of teachers’ attitudes are crucial to consider, as they can influence their students’ mindsets and perspectives towards learning. In particular, the teacher participants discussed how the quality of their own math education has encouraged them to provide students with additional support and varying instructional techniques to engage student learning. Furthermore, the participants spoke of the extracurricular activities they are involved in to expand their knowledge in teaching mathematics. They discussed their proactive approach to seeking opportunities for growth and learning as a teacher which they could transfer into the classroom. Participants also emphasized the importance of maintaining belief in all their student’s abilities. This growth mindset mentality, participants explain, could influence female students’ openness to exploring future opportunities in math related education and careers without limiting their success.

4.2.1 Participants indicate the how the quality of their math educational experiences has affected their approach and effort towards to teaching female students.

Teacher participants mentioned the effects of their own childhood experiences and how it positively impacted their outlook on math as a teacher. Anna believed that positive teacher and parental support were crucial for student success in math, based on her own personal experiences. She discussed how the role of her teacher and parents allowed her to succeed and
gain confidence in her math abilities because they created a supportive learning environment for her in mathematics. She recounted how, although she was struggling in math, her teacher had recognized and understood that learning style differed from the traditional paper pencil style. Furthermore, her parents were supportive by providing her with tutoring and the confidence she needed to do well. Her own positive results have informed her approach to helping students struggling in math by providing the child with more teacher support as well as involving the parent in the student’s learning.

Mary and Judy, however, spoke of their negative experiences related to their math education and the lack of support they received from teachers as students. They also recognized that providing students with teacher support, in conjunction with teaching the math concepts and possibilities of multiple solutions as an alternative to teaching students rote, could build student’s confidence in math. Mary stated,

I know I always felt like I could not do math and I ended up dropping it after whenever we were able to. I think it was Grade 10, so after Grade 10 I dropped math and I didn’t take it anymore. I know even when I had to teach Grade 4 feeling like some of the math was even challenging for me and I had to have somebody help me. Now I see things differently and I realize if I had learned the way we’re teaching it now I would not have been so afraid of it and now I can teach it confidently because I understand it in a different way than I did as a kid

Judy further discussed how their negative childhood experiences have allowed Mary and herself to be empathetic towards their students’ struggles in math. Judy indicated,
I also think because both of us were not really strong in math and didn’t have that support, we can understand where the kids are coming from if they’re struggling. We kind of understand their feelings and what they’re going through. We don’t really say, “Why aren’t you getting this!” We understand they’re frustrated, struggling and we help them look at math from different points of view because math is also not my strong point.

She believed that, as a teacher, it was important to show students that you understand their struggles and be supportive when they are facing difficulties in math.

The participants’ experiences have influenced both their own and their students’ confidence and perspectives in math as well. All participants had experiences that eventually enabled them to become confident in mathematics and thus positive female role models to their students. In congruence to the findings the study by Marx & Roman (2002) demonstrated, exposure to positive female role models can have significant positive influence on female students’ math performance. This buffering effect is due to the nonexistence of a potential stereotype threat and thus limited internalization of the stereotype. Thus the confidence these educators demonstrate could have positive impacts on their students’ beliefs as well.

4.2.2 Teacher-participants have indicated open-mindedness towards continued learning/professional development.

In conjunction to being positive role models to their female students, the participants also indicated their active participation in various professional development and extracurricular activities. Participants all acknowledged actively seeking math related workshops and Additional
Qualification (AQ) courses as pertinent steps in their commitment towards student learning. They agreed that these workshops and courses can provide teachers with a deeper understanding of math concepts and practical instructions and techniques they could transfer to their classroom to benefit all learners as well as increased confidence for their students. Judy revealed why she engaged in professional development when she indicated, “I attend math workshops because they are less threatening to me and provide hands on ideas that you can take straight to your classroom and use with the kids. I think that’s most beneficial for their learning and ours.”

Aside from attending workshops, Mary and Judy spoke of being able to share their knowledge with other new educators so that they may also foster math environments supportive of all student needs. Mary mentioned, “We do a math program, on how to get them started and talking about differentiated instruction and how that might look like in the class. We talk a lot about being mindful of different learning styles in math.”

Moreover, Anna identified that her students’ learning was a reflection of her own learning. She recognized that if she wanted to enhance their thinking she needed to challenge herself as well by taking math AQ courses. She mentioned, “I’m constantly thinking ‘How can I become a better mathematician for my students to feel that they are mathematicians? When I tell students that I am still learning math, they are amazed and it makes them feel better.’”

Participant’s findings of teacher influence parallels and validate the study by Marx and Roman (2002) which found that the presence of a female who is known to be competent in math is sufficient in buffering female math performance. In addition to Marx and Roman’s (2002) findings, by demonstrating confidence and open-mindedness to enhancing their own math
learning, teacher-participants’ experiences indicated that they are able to provide students with more learning opportunities and instill confidence in them as well.

4.2.3 Participants suggest that maintaining a positive perspective about student abilities contributes to opening female students’ perspectives in mathematics.

Aside from participating in professional development opportunities, participants further acknowledged the need to maintain positive perspectives and genuine belief in female students’ math abilities to be able to provide them with the assistance and opportunities they need to succeed. Further, participants noticed that positive teacher encouragement motivated female students to take more initiative and effort into improvement. Mary referred to a specific incident where one of her female students had been struggling in math. She recounted how providing the child with positive encouragement and opportunities that suited her learning style increased the student’s willingness to improve. She explained how by the end of the year the child had been able to perform an entire grade higher than what she demonstrated at the beginning of the school year. She compared this to her own experience as a student, where, although her teacher provided her with extra support, it was apparent that her teacher did not believe she could perform well, which eventually caused her to give up. Similar to Mary’s experience, Judy spoke of her own negative experience in math and the implications of having an unsupportive teacher. She indicated,

One of my teachers wasn’t very supportive. Even though she knew I was struggling in math and trying my best. She never provided me with
encouragement or offered support unless I asked for it. It was very frustrating for me as a student and I just ended up thinking I wasn’t good at math.

Judy and Mary explained how these negative experiences left them with limited career opportunities because they avoided math, eventually dropping it when it stopped being a required course. Both participants described how their teacher’s negative perspectives of their ability impacted potential future opportunities.

Anna described the stereotype as limiting the growth opportunities for female students which creates a deficit mindset in the student. She responded, “I think that the gender stereotype limits girls’ growth. I was terrible at math, but my teacher believed in me and gave me the right strategies and materials and now I can confidently say I’m good at math.” The participant’s associations between belief in students’ abilities and performance, parallels the findings from the study by Upadyaya and Eccles (2014), where positive teacher belief of student’s potential performance and effort was found to positively influence student’s interest in mathematics. By demonstrating belief in female students’ math potentials, educators may be able to help foster interest in mathematics and alleviate math anxiety. Thus, participants suggest it is important to realize that providing students with positive belief can help students challenge gender stereotypes by realizing their potential and thereby enabling student success and opportunities.

4.3 Participants Recognize Whole-group Teaching Strategies Can Positively Impact Female Students’ Math Performance

Participants spoke of varying whole-group approaches utilized within their classrooms when teaching mathematics to alleviate stereotype-threat. Specifically, participants highlighted
the importance of creating a gender neutral environment by using teaching strategies that reduce the effects of stereotype threat for female students. Participants Mary and Judy spoke of the significance of being mindful when placing female students in collaborative group settings as an increased male to female ratio can negatively impact female performance. Moreover, participants indicated the benefits of creating opportunities to discuss gender stereotypes to bring awareness and challenge these perspectives. Further, participants agreed that teachers need to practice mindful questioning in math lessons to engage all learners.

4.3.1 Teacher-participants suggest that varying students’ working dynamics can increase confidence and comfort.

Participants acknowledged the importance of collaborative student learning in co-educational settings, however also recognized the impact it could have on female students’ math performance. They challenged this problem within their classrooms by providing students with alternative grouping strategies such as creating opportunities for same-gender partners whenever possible. Judy recounted,

I try to pair up the girls, and especially ones who I know are struggling, with other girls in the class when doing partner work, thinking that it would make that student more comfortable. For example, even when I work one-on-one with a girl who is struggling, I sometimes invite one of her friends over as well so she can feel more confident. I think it’s helpful for them because they don’t seem as intimidated.
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These participants also spoke of the noticed relaxed behaviour and increased participation female students displayed when male-to-female ratio decreased while doing whole class discussions at the carpet. Mary stated,

When the boys had basketball tournaments, there would be more girls than boys in the classroom. Those days, we both noticed how relaxed the girls seemed, they were louder, taking more risks, and even some of our quieter girls we found were answering more questions.

Conversely, Anna did not believe that separating students by gender could be beneficial to female student’s math learning. Instead, she believed using mixed gender pairing could provide students with different learning perspectives. She mentioned, “When I do partners, it’s usually a boy and girl, because they can learn from each other. They all have different learning styles, strengths and weaknesses, so I think it’s important for them to be exposed to that.” While Mary and Judy’s perceptions agree with reoccurring findings throughout the literature, Anna’s perceptions offered new insight. A common finding in the literature suggests that female math performance is diminished when participants are placed in male dominated rooms in comparison to participants who had been placed in a female dominated room due to gender salience and intimidation (Inzlicht and Ben-Zeev, 2000; Campbell and Evans, 1997). While the literature on gender stereotype speaks to the negative impact of gender dominance in mixed-gender groupings which can be harmful to females’ math performance, studies on collaboration suggest that working in groups can be beneficial for student growth in reducing math anxiety (Tobias, 1993). Anna’s experiences expand on this by offering insights into how mixed-gender pairing can allow
students to be exposed to different learning styles and perspectives which may benefit student learning.

4.3.2 Participants recognize beneficial effects of discussing gender stereotypes in the classroom on female students’ perspectives of math.

In addition to being mindful of classroom dynamics, participants believed that exposure to counter-stereotypical representations in relation to gender could change student perceptions on math ability. A particular strategy utilized by all participants to challenge the subject of gender stereotypes was reading purposefully selected books. Anna recounted,

I read several books throughout the year that challenge gender stereotypes, sometimes in general and sometimes when we are doing math it will be STEM related. Off the top of my head, I remember reading *Me...Jane* and *Who Said Women Can’t Be Doctors?* And I make sure we’re not just reading the book, but also having a discussion before and after about what boys and girls can do. It’s always reassuring to see how they change their minds after reading the book about gender roles.

In conjunction to using books, Mary and Judy further described their use of videos and real life examples to engage students in classroom discussions regarding general and math-related gender stereotypes. Mary recounted talking to students about astronauts and who children thought could be astronauts. When students kept coming up with examples of male astronauts, she decided to show examples of women astronauts as well. Her students were surprised at how many women astronauts there were and how they had not heard about these women before. Moreover, Judy
mentioned the significance of discussing gender stereotypes in general. She used the Dove commercial, “Always #LikeAGirl” to approach the subject in her classroom. She asked the students questions from the video prior to playing it. She found this to be a powerful method as it allowed the students to draw conclusions and come to the realizations on their own.

As participants suggested, current literature demonstrates that exposure to counter-stereotypical representations can positively impact math learning. Studies have found that exposure to sexist commercials, whether in a mathematical context or not, could affect female math performance (Van Loo & Rydell, 2014; Davies et al., 2002). The effects of the participants’ strategies, of providing students with positive female roles in math and counter-stereotypic roles, mirrors the perceptions of math held by female students in same-sex schools (Dasgupta and Asgari, 2004). Participants’ experiences validates current research on the benefits of exposure positive female role models in the classroom, and how repetitive exposure to challenging math gender stereotypes, through reading books, videos, and real-life examples, may open students’ perspectives and perceived math abilities in female students.

4.3.3 Teacher-participants have indicated the importance of mindful questioning during math.

While providing students with counter-stereotypical examples can challenge their existing schemas, teacher participants acknowledged the need to be mindful of the wording and types of math questions utilized in the classroom, due to gender differences in math perception. As mentioned earlier, participants indicated the presence of language preference in math by female students, thus they believed that this also impacted their teaching approach. Anna spoke about her usage of diagnostics to guide her math lessons. She stated,
When I start my math unit, I start with a diagnostic assessment so that I know what they know prior to planning. I then take it from there using the information they provide me to inform my teaching and planning, so it’s a student-led math program.

Another approach taken by Anna was the use of inquiry-based, open-ended questions. She described how this approach allowed students to explore the question using pre-existing knowledge. The nature of these questions left room for multiple solutions and the opportunity for students to explain their thinking which she finds utilizes female students’ strength in language.

Similarly, Mary and Judy spoke of how they utilized parallel tasks, created by Mariam Small. Parallel tasks are a form of differentiated instruction that varies the wording of a question and complexity while focusing on the same concept allowing students to choose the question they want to answer based on their comfort. Here are two examples of a parallel task question:

- **Option 1:** Twice as many people came in ahead of David’s dad in a race. There were 112 runners. What was David’s dad’s position?
- **Option 2:** Twice as many people came in ahead of David’s dad in a race. How many people might have been in the race? By allowing their students to choose which question to work on, they believe it creates an environment in which all students can feel successful. They found this to be particularly supportive for female students who would often have difficulty interpreting word problems. Besides female specific strategies, it is important to note that teacher participants also indicated approaches that were supportive for all students’ learning. All participants mentioned the frequent use of scaffolding, technology, and manipulatives as essential components of their math programs.
The student lead teaching approach used by Anna parallels the cognitively guided instructional pedagogy. Research pertaining to the usage of CGI has proven that it can have positive effects on student learning and on teachers’ comprehension of children’s mathematical thinking processes (Moscardini, 2014). While current literature suggests that female students’ performance is stronger in conventional word problems as opposed to unconventional or comparison word problems, (Gallagher & De Lisi 1994; Davies, Conner, Sedikides, & Hutter. 2016), it does not elaborate on the effects of specific questioning strategies teacher-participants elaborated on such as parallel tasks or inquiry based open-ended questions. Participants’ findings suggest that the use of parallel tasks and open-ended math questions can help female students’ comprehension of math problems as it provides them with alternatives and an understanding that there is not one absolute solution.

4.4 Conclusion

In conclusion, upon reviewing the participants’ interviews, this study found that teachers utilize a variety of strategies to reduce the effects of stereotype-threat and promote female students’ performance in mathematics. Most of the findings address how teachers can support female students’ math learning in the classroom. These approaches begin by acknowledging the significant role language plays in math interpretation and explanation. Participants’ findings suggest that female students may be more hesitant and focus on their language strength during mathematics as a sign of potential stereotype internalization. To help these students succeed, participants’ noted how their own educational experiences and perspectives of mathematics influenced their approach to teaching math. Teachers agreed that their positivity towards math could foster interest in math for female students who may be internalizing gendered stereotypes.
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Moreover, inquiry-based and open-ended questions, parallel tasks, and student-led learning were strategies participants believed could utilize female students’ strength in language to provide opportunities for growth and success. Their findings further elaborate how challenging gender stereotypes should go beyond the teacher being the positive role model to include counter-stereotypical representations of females through videos, books, and real-life examples. While current research discusses the negative repercussions of male dominance on female performance, findings from this study suggest it could be beneficial to pair female students with male students during math lessons. This may be beneficial as it exposes female students to different learning styles and perspectives that can broaden their understanding of math concepts. Next, in Chapter Five, I will be exploring the significance of these stereotype reducing math strategies while considering further implications and recommendations for future studies.
Chapter 5: Conclusion

5.0 Introduction

In this chapter I discuss the significance and implications of my research study. I begin this chapter by reviewing the key findings that emerged on how educators may minimize the effects of gender stereotype threats for female students in the math classroom. Following this I explore the implications of my findings for the educational community and myself as a teacher and researcher. Using these implications I make recommendations which may be used by various stakeholders such as parents, school boards, and the media. Finally, I identify and suggest areas where further research and discussion can be explored.

5.1 Overview of Key Findings and Their Significance

As discussed in the previous chapter, teacher participants acknowledged the presence of certain indicators of gender stereotype internalization in female students. Indicators such as avoidance behaviours during class discussions in mathematics were a common finding in teachers’ experiences. Given existing research, this behaviour may be a coping mechanism to avoid vulnerable situations where students are at risk of confirming the stereotype. Additionally, in congruence to research, participants recognized the difference in female students’ effort in math as perceptions of ability that have been influenced by parental perspectives. A key indicator noted by participants was female students’ preference to language in math learning and word problems. While current literature suggests a preference towards language in comparison to mathematics under stereotype threat (Davies et al., 2002), this insight points to a potential relationship between math word problems and female students’ self-perception of their abilities in math versus language.
The participants’ understanding of their role in creating a positive perspective towards mathematics for their students was reflected in their active participation in professional development opportunities. While teacher participants had varied educational experiences in mathematics, they echoed existing literature about the importance of having a positive role model who displayed genuine belief in relation to fostering both an interest and confidence in female students’ math abilities (Upadyaya and Eccles, 2014). Further, participants recognized the importance of modelling positive behaviours such as attending math workshops to further their own math learning. They believe that all students have the potential to perform well given the right tools and techniques that benefit their learning needs.

Participants’ understanding of differences in math learning was evident in the specific approaches they utilized in their math program. Teacher participants were conscious of creating opportunities for female students to use their strength in language to support their math learning through open-ended inquiry questions and parallel tasks. This finding is significant as these approaches allow students the opportunity to explore multiple solutions and explain their thinking using more than algorithms. Moreover, they incorporated strategies such as discussing and providing exposure to counter-stereotypical role models as a method of challenging negative perspectives of females in mathematics. Given the existing research on the negative impacts of mixed-gender groupings on female math performance (Inzlicht and Ben-Zeev, 2000; Campbell and Evans, 1997), this study’s findings suggest that there may be potential benefits of such groupings towards female students’ math comprehension. This finding is significant as much of existing literature focuses on the negative effects of male presence on female math performance while there may be some benefits to mixed-gender collaborative group settings. In addition,
participants recognized that these strategies can be helpful in enabling all students to experience success.

5.2 Implications

In this section I outline the implications of my research findings. I begin by discussing broad implications for the educational community followed by what these findings mean for me as a teacher and researcher.

5.2.1 The educational research community.

While most of the existing literature focuses on the effects of gender stereotype threat in math for older students, it was evident from participants’ experiences that some female students at the elementary school level also internalize gendered stereotypes in math. As participants highlighted, teacher perspectives can greatly influence female students’ interest in mathematics, especially if the teacher is also female; thus, teachers should be aware of potential factors that may indicate stereotype internalization. This awareness of gender stereotype threat needs to extend to the whole school community so that both teachers and administrators may take active approaches to enable female student success and equitable learning opportunities in math classrooms.

All participants recognized the importance of being a positive role model in math which includes demonstrating a positive perspective towards math. While all teachers may not feel confident in their math abilities, they can also look forward to engaging in professional development opportunities such as math workshops. These workshops, held by school boards, often provide practical strategies that may be transferred to the classroom and equip teachers
with the strategies they need to create an equitable math classroom. Moreover, school boards should understand the importance of providing teachers with frequent math related workshops as they can provide educators with the tools they need to feel confident in their own abilities.

The relationship between female students’ self-perceptions of their language ability versus math ability and the strategies which focus on this strength have value and can be utilized in a variety of classroom settings, from Kindergarten to Grade 12 classrooms. This relationship suggests that cross-curricular integrations of math and language may be beneficial for student success. Further, specific strategies utilized to minimize the effects of stereotype threat for female students in math can be beneficial to all students’ learning as acknowledged by participants. Participants highlighted strategies such as parallel tasks that provide all students with an element of choice giving them the opportunity to experience success without feeling inferior or having their abilities exposed to other students. Faculties of Education should understand the importance of these strategies on all students’ success in mathematics so that preservice teacher math courses can better equip teacher candidates.

5.2.2 My professional identity and practice.

I believe that after conducting research on minimizing gendered stereotype threat in mathematics I am confident that I have furthered my own understanding as an educator on how to create an equitable classroom. From conducting interviews with a sample of teachers who actively challenge gender stereotypes, it was evident that the first step to ensuring student success was dependent on teacher mindset. I understand that it is important to acknowledge that stereotype internalization can occur at a young age. As an educator this means that I must be conscious of female students’ behaviour in the math classroom and understand that avoidance
behaviours may not be because of lack of interest or effort, but instead could indicate stereotype internalization.

After hearing the participants’ experiences, it allowed me to comprehend the role of the teacher in creating a positive perspective towards math for the student. In my own teaching this means having regular meaningful discussions and exposure to counter-stereotypical portrayals of females, including examples of females in math-intensive fields. These discussions can help open students’ perspectives towards math and allow them to recognize that they are all capable succeeding in mathematics regardless of their gender. Further, these discussions do not need to be limited to the math period and should be reflected in the classroom environment and other curriculum areas. In conjunction to providing such exposure, I must also be mindful of demonstrating positive belief in my students’ math abilities. Not only will this growth mindset allow students to develop confidence in their math abilities, but will also positively impact the amount of time and effort I will place to aid students’ learning.

Through my research, I have come to understand the importance of language in mathematics for female students. In my own math program it is critical that I incorporate open-ended questions which may allow female students the opportunity to utilize their strength in language to explain their solutions. Additionally, I will provide students with choice by regularly utilizing parallel task questions that offer students some choice that will allow them to discover solutions at the level they feel comfortable at. Moreover, when making groups I will be mindful of the gender ratios within the group so that students who may be experience stereotype internalization can feel safe to participate in the learning. However, as one participant indicated it is also important to expose students to different perspectives and learning styles that they might
otherwise not receive if students are consistently placed in same-gender pairings or groupings. I believe that by creating a safe environment where students are have been exposed to regular counter-stereotypical models, I can use a variety of gender groupings in the math classroom so that all students may benefit from their peers in a way that is nonthreatening to their math performance and sense of math ability.

5.3 Recommendations

In order for educators to successfully challenge and minimize female students’ perceptions of math ability, it is important that changes occur in the educational community, parental perspectives and the media. As participants indicated, their level of self-confidence in math influenced their perspective of the subject which in turn impacted how their students viewed it as well. While pre-service teacher education courses in mathematics focus on theory and math pedagogy, they often overlook providing teacher candidates with content knowledge. While some preservice teachers may enter teacher education programs with a background in STEM fields, others are left feeling unequipped and needing to relearn the material before they can teach it to students. I believe that the findings from this study suggest that teachers should be required to engage in regular professional development opportunities such as math workshops that develop transferable strategies and build confidence in math concepts.

In addition to providing teachers with more learning opportunities, school boards in Ontario need to continue to develop additional programs in STEM for students at the elementary level. While school boards such as the Toronto District School Board have summer programs varying in grade specifically in STEM, other Ontario school boards do not provide such resources. These opportunities allow students to extend their learning in mathematics outside of
the classroom in more meaningful engagement. These programs should not be gender specific to allow children to be exposed to varying learning styles and perspectives that may be limited if the program was gender specific. Moreover, programs such as these allow students to apply their learning and begin to see themselves in these fields in real life situations.

While educators and schools are key contributors in minimizing gendered stereotypes in math, messages students receive outside of the classroom also influence their perspectives. Parents should be aware that their perspective of female math ability can impact their child’s math performance. Parents should not attribute their female child’s math ability to the amount of effort their child puts in mathematics. Parents should provide female children with equal opportunities in math learning and work with teachers to understand their child’s learning style. As evidenced by participants’ findings, parents often provide female students with math tutors as an aid for their learning. Although this can be a great resource, it is important that parents genuinely believe in their female child’s math ability by providing encouragement and support and not endorsing stereotypical beliefs.

During the interviews, participants noted the importance of providing their students with counter-stereotypical models to prompt discussions around gendered stereotypes in mathematics. With this in mind, I suggest that members of the media, including book authors, are mindful of how they portray female characters in their products, particularly female representation in STEM. Stereotypical representations of females in media create negative perspectives of societal expectations of female’s abilities. These views can limit young girls’ belief of their own abilities. Thus, it is recommended that members of the media provide more accurate portrayals of female characters so that young girls may develop open-perspectives towards mathematics.
5.4 Areas for Further Research

While research regarding stereotype threat on female math performance is extensive, strategies for minimizing these effects are limited at the elementary school level. I am confident that, through my research, I have been able to build upon existing research and delve further into strategies pertaining to minimizing gendered stereotype threat. I feel that further research could be conducted to explore the challenges of implementing these strategies within a co-educational math classroom. While this study looks at the benefits of particular strategies it does not examine potential disadvantages and limitations of the strategies.

To this effect, one strategy highlighted by participants was the potential relationship between language and math learning for female students. Although participants’ findings suggest that female students benefit from strategies that incorporate language, due to students’ perceived differences in ability in math vs. language, would this strategy be effective for female students who are also English language learners (ELL)? Moreover, further research should be done to examine how this strategy impacts female students who do not identify language as their strength.

Another strategy mentioned by Anna during our interview was ensuring that students were placed in mixed-gender pairings. While current research prominently explores the negative effects of being placed in male dominant settings her insights suggest potential for student growth and learning through exposure to different learning styles and perspectives. Differences in math performance as a result of both mixed and same gender pairings should be explored at the at the elementary school level to examine its impacts on students’ math learning.
5.5 Conclusion

In this chapter I provided a summary of my key findings from Chapter 4 along with potential implications and recommendations for the educational community. For teachers to be able to successfully implement strategies, parents and the media must also endorse counter-stereotypical views, especially with regards to mathematics. This research study has better helped me understand how to minimize the effects of gendered stereotype threat for female student in a co-educational math classroom. As an educator I have learned that strategies such as parallel-tasks and mixed gendered pairing can be beneficial not only for female students, but further for all students’ success. Through my interviews I have come to realize the critical role that teachers play in shaping students’ perspectives towards both math and gendered stereotypes. As a future teacher-researcher I hope to utilize the strategies shared by participants to challenge these societal constructs that may limit students’ achievements and perception of their potentials in math and all other areas of the curriculum.


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Appendix A: Letter of Consent for Interview

Date:

Dear _______________________________,

My name is Remija Vijayakumaran and I am a student in the Master of Teaching program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on the strategies and pedagogies that a sample of teachers utilize to minimize the effects of stereotype threat in relation to gender and mathematics learning for female students within a co-educational system to create a gender equitable environment. I am interested in interviewing female teachers who have taught math for a minimum of 5 years, have taught math in Grade 3, 6, or 9, and have demonstrated a commitment to challenging gender stereotypes in mathematics learning and to fostering female engagement and achievement in math. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one 45-60 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications. This information will remain confidential. Any information that identifies your school or students will also be excluded. The interview data will be stored on my password-protected computer and the only person who will have access to the research data will be my course instructor Angela MacDonald. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to
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participation, and I will share a copy of the transcript with you shortly after the interview to ensure accuracy.

Please sign this consent form, if you agree to be interviewed. The second copy is for your records. I am very grateful for your participation.

Sincerely,

Remiija Vijayakumaran

Tel: 647 __________________________

Email: Remija.vijayakumaran@mail.utoronto.ca

Course Instructor’s Name: Angela MacDonald

Contact Info: angela.macdonald@utoronto.ca

Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty.

I have read the letter provided to me by Remiija Vijayakumaran and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ________________________________

Name: (printed) ________________________________

Date: ________________________________
Appendix B: Interview Protocol

Thank you for agreeing to participate in this research study, and for making time to be interviewed today. This research study aims to learn what strategies and pedagogies that a sample of teachers utilize to minimize the effects of stereotype threat in relation to gender and mathematics learning for female students within a co-educational system to create a gender equitable environment. This interview will last approximately 45-60 minutes, and I will ask you a series of questions about your background information, beliefs and perspectives, strategies and practices, any challenges and supports that you experienced and received, and finally next steps. I want to remind you that you may refrain from answering any question, and you have the right to withdraw your participation from the study at any time. As I explained in the consent letter, this interview will be audio recorded. Do you have any questions before we begin?

Background Information

1. How many years have you been working as a teacher?
2. What is your current position?
   a. What grades and subjects do you currently teach?
   b. Which grades and subjects have you previously taught?
   c. Do you fulfill any other roles in the school? (e.g. advice club focused on girls in STEM, coach, councilor)
3. Can you tell me more about the school you work in? (e.g. size, demographics, program priorities)
4. What experiences have contributed to developing your interest in challenging gender stereotypes and math?
   a. Personal experiences? (e.g. own experience learning math)
   b. Educational experiences? (e.g. university coursework, teachers college, additional qualifications, professional development)
   c. Professional experiences? (e.g. teaching experience)
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Teacher Perspectives/Beliefs

5. In your view, what is the relationship between gender and mathematics learning? What have you observed in your experience as a student and teacher?

6. In your view, what are some of the common stereotypes perpetuated about gender and math? In your experience, how do female students typically perceive math? Why do you believe they perceive math the way they do?

7. And male students?

8. How do teachers’ commonly perceive the mathematics abilities of female versus male students?
   a. What evidence have you seen of this?
   b. In what ways, if any, do you think this impacts female students’ engagement and/or achievement in math?

9. Why do you believe it is important to challenge gender stereotypes related to math?

Teacher Practices

10. How would you describe your approach to teaching math? What are some key instructional strategies that you use and why?

11. How do your students generally respond to your approach to teaching math? What outcomes have you observed from them?

12. More specifically, how do you create opportunities to challenge gender stereotypes related to math through your teaching?
   a. How, if at all, do you introduce this topic?
   b. What curriculum, if any, do you connect this work to?
   c. How do your students respond? What outcomes do you observe from them? (male and female)

13. When you see a female student become struggling in math or disengaged in math learning, what do you do?
   a. What are some ways that you work to foster female engagement and achievement in math?
   b. How do your female students typically respond?
14. Can you provide me with an example or two of how you worked with individual female students to enhance their engagement and achievement in math?

15. How, if at all, do you work to reduce the presence of stereotype threat related to gender and math during assessments?

Supports and Challenges

16. What are some of the resources that support you in fostering engagement and achievement of females in math? (e.g. books, websites, videos, songs, curriculum materials, manipulatives)

17. What are some of the challenges you encounter in your efforts to challenge gender stereotypes related to math? How do you respond to these challenges?

Next Steps

18. How would you like to further develop the work that you do in this area? How could the education system further support you in challenging gender stereotypes in math, and fostering engagement and achievement from female students in math?

19. What advice, if any, do you have for me as a beginning teacher who is committed to fostering gender equity in math?

Thank you for your participation.