“The Girls and Math Problem” An Exploration of Middle School Girls’ Confidence in the Mathematics Classroom: A Teacher Perspective

By

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Abstract

Women in mathematics has been a topic of discussion for several decades. In North America, it was observed that middle school aged girls display low interest and confidence in their ability to perform in the mathematics classroom regardless of their academic ability. This study seeks to determine the social factors as observed by teachers relating to the declining confidence and limited interest in math amongst girls, and to draw comparisons to the existing body of research for girls in middle school. This study explores teacher observations in their single gender and co-educational classrooms through qualitative research; semi-structured interviews. Findings indicate that, while ability is not an issue, confidence remains an observed problem. The influence of parents on girls’ confidence is strong, which can be more influential than those of peers in certain situations. Single gender mathematics classrooms can also be used to meet the different learning needs of boys and girls. Role models and on-going school-wide initiatives which promote mathematics as enjoyable and accessible can encourage girls and boys. Implications broadly focus on the systematic spread of this issue, given the history of gender equity research and the bias in which a teacher could bring to the classroom.

Key words: girls; middle school; confidence; mathematics; gender
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Chapter 1: Introduction

1.0 Research Context and Problem

Statistically, over the years, it has been observed that fewer girls are enrolled in mathematics and mathematics related programs in secondary and post-secondary intuitions as compared to boys (Dubetz & Wilson, 2013; Hall, 2012; Hyde, Lindberg, Linn, Ellis, & Williams 2014; Lloyd, Walsh, & Manizheh, 2008). Furthermore, if they are not studying mathematics in higher education, they are unlikely to pursue it in careers. This study explores the lower confidence and interest of girls in mathematics. Hall (2012) has noted that in the past, most research focused on the biological factors contributed to this difference of fewer women in mathematics careers. However, current research has largely shifted because this claim has been disproven; as studies, have shown comparable ability—based on academic performance (Hyde et al., 2008; Lloyd et al., 2005). Yet, despite enjoying mathematics work and performing well in junior grades, it has been observed that the majority of girls lose interest or confidence in mathematics class by middle school and early elementary years (Blue & Gann, 2008, Gunderson, Ramirez, Levine, & Beilock, 2011; Shapiro & Williams, 2011).

Scholarship exists to claim that there is an apparent ‘gap in confidence’ between boys and girls, in favour of the boys (Crombie, Sinclair, Silverthorn, Byrne, DuBois, & Trinneer 2005; Lloyd et al., 2005) This decreasing confidence can be a contributing factor to low mathematics course enrolment in university as noted by Dubetz and Wilson (2014). The negative mathematics perception by girls has been explained by Gunderson et al. (2011) because of the “social transmission of gender related mathematics attitudes”
including parent and teacher anxieties (p. 153).

Current studies have indicated that the following factors can contribute to this decline in interest and confidence; societal pressures and stereotyping of traditional gender roles, lowered self-confidence when entering adolescence, and parental influence (Crosnoe, Riegle-Crumb, Field, Frank, & Muller, 2008; Jacobs & Bleeker, 2004; Gunderson et al., 2012; Lloyd et al., 2012; Ross, Scott & Bruce, 2012). Stereotyping of gender roles includes the mentality that certain traits and activities are appropriate only for girls or only for boys (Gunderson et al., 2011). The negative influence of peers based on social stereotypes often deters girls from pursuing mathematics in higher grades (Shapiro & Williams, 2012). Outside of the school community, Jacobs and Bleeker (2004) have found parents can have a strong influence on whether a girl will continue in a career in mathematics. One paper suggests parents subconsciously push their daughters towards other professions, for example, by providing more traditionally feminine toys to their girls (Jacobs & Bleeker, 2004). Parents can also unknowingly push their sons toward Science, Technology, Engineering, and Mathematics (STEM) jobs (Jacobs & Bleeker, 2004). Teachers also have an impact on student interest and can intentionally or unintentionally influence girl’s interest in mathematics during adolescence as they are the most visible adult in a child’s life other than their parents or guardians (Gunderson et al., 2011; Shapiro & Williams, 2011). Unfortunately, if teachers also subconsciously believe in the stereotype of traditional roles, they could also push girls in a direction.

However, research has helped to develop strategies to support girls in breaking these influences. Good mentoring, meaning a strong interest in a mathematical profession and maturity and leadership opportunities are strategies found to help a girl foster her
natural mathematical ability (Kerr & Robinson, 2004).

It appears overall, the problem is the lack of confidence by girls in the middle school mathematics classroom. If girls have equivalent or higher ability in mathematics (Crombie et al., 2005; Lloyd et al., 2005), then it is important to consider the factors influencing their behaviour as well as can, and how these girls be helped.

1.1 Purpose of Study

The current research on girls and mathematics has pointed to social factors as the one of the causes for the declining interest and limited confidence. Therefore, the key purpose of this study is to determine the social factors as observed by teachers relating to the declining interest and confidence of middle school girls and mathematics, and draw comparisons to the existing research for middle school. This paper attempts to consider the topic from a teacher perspective making it relevant for pre-service and current teachers looking to better support their students. I chose to consider this topic from a teacher’s perspective as I am a pre-service teacher, and this is something I observed in the classroom. I feel I could—as well as other teachers—benefit from an exploration into this observed problem. Based on literature and teacher observations, I would like to provide some strategies a teacher could implement in their own classroom.

By interviewing current teachers, I can understand what teachers are doing presently with their students regarding the topic of middle school girls and mathematics. With this understanding, I hope to make connections between their strategies and those strategies and findings I have read in the literature to best support these students.
1.2 Research Questions

This paper explores research regarding the factors that contribute to middle school girls’ declining interest and confidence in mathematics. Furthermore, this paper asks: what types of social factors can influence a girl’s view of their mathematics ability and what strategies can teachers implement into their classrooms to support them? Additional questions explored are how do single-gender mathematics classrooms affect this issue? What do current teachers find effective? Through the lens of an educator, the issue is explored from the social influences that form a girl’s perspective of mathematics. I explore the research regarding middle school-aged girls, the grades where interest declines according to Blue and Gann (2008).

1.3 Background of the Researcher

As someone who grew up in a household where experimentation and curiosity were valued, from an early age my love of mathematics and sciences was cultivated. Both my parents were trained in physical chemistry, and encouraged my sister and me to explore all scientific disciplines in high school as well as in our post-secondary training. I had always had an inclination for science and experimentation, and a strong family support is likely the main reason I pursued it as a career. Consequently, I studied environmental science in my undergraduate career.

Considering that most of my girl peers did not enjoy mathematics and lacked confidence in their ability within my elementary environment, I could have been largely swayed in another way. I also know I did not have strong teachers within the mathematics classrooms, I felt they did not show a passion for these subjects and my aptitude for
mathematics was likely the cause of my success. My parents were the influencers that maintained my confidence in my scientific ability.

As I enter into the classroom and school environment, I expect to have girls in my middle school classes who have been “turned off” mathematics. While family strongly influenced me, I realize this may not be the norm for younger girls as often parents can discourage girls unconsciously. However, the presence of a strong mentor such as a teacher could help to support these girls to find their strengths and develop their confidence. I am doing this research to learn what I can do as a future teacher to help them rediscover their interest and confidence in mathematics. While teachers may not only be the root causes of these issues, they can help to undo some of the damage due to their tremendous influence.

1.5 Overview

A qualitative research study was conducted to assess the confidence and interest of girls in mathematics classrooms. Three teachers were interviewed about their experiences with girls and their confidence and decreasing interest in the mathematics classroom. These teachers are experienced with teaching middle school mathematics to girls in a co-educational or all-girl classroom. The teachers discussed the efforts they make on an individual daily basis to support the girls in their classroom. The teachers also discussed their observations of the behavior of middle school girls’ in their mathematics classes, furthermore exploring whether their observations met current research. Teacher input is used to add a current relevant component to my overall conclusions as these are the individuals working with the girls every day. When selecting
candidates to interview, the intention was to interview someone from a public school and someone who has taught mathematics in an all-girls classroom.

In chapter two, I review literature about the confidence and interest level in girls in the mathematics classroom. This included the social factors influencing their declining interest and confidence in mathematics. I reviewed strategies and other factors that current research has shown to help the confidence and interest of girls. I also included and compare research on single gender classrooms to co-education classrooms, in terms of the confidence and interest of girls in the mathematics classroom.

Chapter 3 elaborates on the research design: how the interviews and the literature review was conducted. I developed my interview questions so that theory is included as well as practical advice. My questions included the information from the literature review to extract the perspectives of practicing teachers on the literature findings. I also discussed the strategies they used to support their girl students in their own classrooms.

Chapter 4 discusses my findings from the qualitative research conducted. I reviewed what the teachers saw as contributing factors to the issue of middle school girls’ interest and confidence in the mathematics classroom and their practical strategies that they found effective in supporting the girls. I compare the ideas of all three interviewees, searching for repetition in ideas. I then compare their feedback with the literature considering agreements and contradictions.

In chapter 5, I used my findings as well as the key points from my literature search to identify the implications of this study. I discussed narrow implications; the findings that influence teaching practice in the classroom and broad implications; what the findings mean for educational pedagogy. I considered my past experiences, literature
and interview feedback to make suggestions for any teacher including myself to use, to support girls in mathematics. I also articulated what my implications mean for future research and the direction in which the research can continue.
Chapter 2: The Literature Review

2.0 Introduction

In this chapter, I review the literature with regards to the attitudes of North American, adolescent girls towards mathematics. In this paper, the term ‘adolescent girls’ describes girls in grades six to nine. I review factors that contribute to girls decreased interest and confidence in mathematics classrooms by considering literature in the field pertaining to girls and mathematics. I further explore research on single gender classrooms, specifically girls-only mathematics classes to compare how their interest and confidence varies as compared to a co-education mathematics class. From there, I discuss researched strategies for supporting interest and confidence in mathematics within girls.

2.1 Girls and Math: A Historical Context

Girls and their engagement in mathematics class has been a topic of discussion for several decades (e.g. Fennema and Sherman, 1977; Jacobs & Bleeker, 2005; Perl, 1982). Most research in the last decade considers social factors that contribute to this problem (Gherasim, Butnaru & Mairean, 2013; Pico & Stephens, 2012; Sonnert, 2009). Some research considers what tactics or strategies would most effectively support girls’ confidence, as well as their interest in the mathematics classroom (Kerr et al., 2004; Ross et al. 2012).

Historically, it was believed that girls were less capable than boys in certain areas of school due to biological factors (Fruchter, 1954). By the 2000s, this belief has been
dismissed by scholarship (Hall, 2012; Hyde et al., 2008, Lloyd et al., 2005). Research by Lloyd et al. (2005) supports that the academic performance of girls in both grade four (before middle school) and grade seven (during middle school) mathematics classrooms met or surpassed those of boys. Furthermore, Hyde et al.’s (2008) research for grades two to eleven found the same results. Conversely, Jacobs and Bleeker (2004) suggested that gender differences in achievement decreases with age but this gap is not fully closed. Findings in other papers detailed that there were no differences in achievement in mathematics class between boys and girls (Hyde et al., 2008; Lloyd et al., 2005; Else-Quest, Hyde, Linn, 2010).

Lloyd et al. (2005) found that girls typically demonstrate lower confidence in their achievement in mathematics than boys, despite close to or equal academic performance. In a similar vein, Hall (2012) noted that within “developed countries” such as Canada, there is evidence to suggest that any gap in achievement academically between boys and girls on assessments has been closed (p. 59). Hyde’s (2008) research in the United States also contributed to the scholarship findings of a closed achievement gap in mathematics between boys and girls, but also found a gap of confidence in mathematics exists between boys and girls. Hall (2012) found studies across developed countries, including Canada, indicate that girls show less confidence and positivity towards mathematics as well. Hyde et al. (2008) while not opposing Hall’s findings, found that while previously a problem, girls in senior grades are taking the same mathematics courses as boys and “almost 50% are graduating from mathematics related programs” at university (p. 494). It is not clear between these two opinions which is a
more accurate representation. However, Hyde’s research considered girls in the senior
grades before university while Hall considered the confidence of girls in grades three, six
and nine.

Research has seen a general drop in interest with increasing age; Blue and Gann
(2013) found that middle school—grades six to eight—is when girls begin to lose
interest in mathematics. Similarly, Cooper (2013) found in the literature that this “low
confidence” starts when the girls are young and “increases with age” (p. 3) although the
age was not specified. However, the cause as to why girls lack confidence in
mathematics is still not easy to understand despite the existing research. Ross et al.
(2012) noted that we “cannot assume that the confidence gap will decline as a natural
consequence of the closing of the gender gap in achievement” (p. 265). Meaning even
though achievement is comparable, confidence can be affected in other ways.

This low confidence in ability has been viewed in the past by Steele and Aronson
(1995) because of “the stereotype threat”. The “stereotype threat” was first established in
1995 by Claude Steele and Joshua Aronson in their research on African American
academic performance compared to that of European Americans. The stereotype threat
suggests that negative stereotypes can impact intellectual performance. Steele and
Aronson (1995) found that while this perceived ‘threat’ can impact academic
performance, “careful instruction by the teacher” can remedy these “negative
perceptions” (p. 48). In the case of girls in math, the stereotype that women’s abilities in
mathematics are weaker than men’s can be transmitted to developing girls by people in
authority including teachers and parents (Shapiro & Williams, 2011). Steele and Ambady (2005) noted in their study that undergraduate university students who were women, when subtly reminded of their gender—using words like aunt, doll, and dress—“expressed a greater preference for arts over mathematics” (p. 431). Reminding students of their gender brings awareness and appears to be important to girls. This study however surveyed women and it is not clear how this could vary with girls in younger grades. Parents can also unconsciously or consciously support or contradict this stereotype and influence what their children believe about themselves (Sonnert, 2009). Sonnert’s findings are promising when considering their suggestion of parent influence, but considered behaviour in sciences instead of mathematics. Women who did end up in a science career were more likely to cite parental influence, though it was not specific to their mother or father (Sonnert, 2009). There is a natural inclination to consider parents as influencers. Sonnert (2009) also observed the influence to be stronger if their parents had higher educational training. However, this study considered women who had completed doctorate degrees in science so the results should be considered carefully when applying them to the problem of middle school girls and mathematics.

2.2 Contributing Factors

The major factors that literature discussed as contributing to girls’ low interest and confidence in mathematics were family and parent influence, the stereotype threat, and peer influence. Experts make arguments about the significance of each based on their findings, but it is important to note that the influence of one factor can vary from one
2.2.1 Family values

Family values or parents’ behaviour and attitude arose as a contributing factor to girls’ confidence and consequently their interest in the mathematics classroom. Jacob and Bleeker (2004) asserted that it is parents who place a value on mathematics and encourage their children to continue to learn it. They argued that if parents believe their child is or will be successful in a mathematics related career, the child may continue in that area because of this family pressure and support (Jacob & Bleeker, 2004). Sonnert (2009) also suggested that career choice for girls can be influenced by numerous factors including job security, earning potential and peer pressure but also “inspiration by teachers, and …confidence in one’s abilities” (p. 928). Gunderson et al. (2012) also agreed that students’ mathematics attitudes are shaped by their environments, and are typically influenced by their parents. Parents can influence their developing children by acting as interpreters of reality by provision of opportunities in certain subject areas. Jacobs and Bleeker (2004) saw parental influence through their involvement in math-type activities and by their role modelling of the mathematics activities as positive. Provision of opportunities, for example, can mean parents choose to purchase toys that require or support mathematics skills (Jacobs & Bleeker, 2004). Jacob and Bleeker (2004), wrote that parents who provided toys that fit existing expectations for boys and girls, in turn influenced their child’s “knowledge, expectations, preferences and abilities” (p. 8).

Participation or involvement in a child’s activities has previously been linked to a child’s
preferred leisure activities and achievement, if the child views the parent’s participation as helpful (Jacobs & Bleeker, 2004). However, should the child not view their parents as a viable role model, Jacobs and Bleeker’s theory is not applicable. Bleeker and Jacob do not consider this situation in their findings, leaving room for exploration. In most cases, Jacobs and Bleeker (2004) surmised children may prefer activities, should it involve parental attention, and the attention can positively affect their academic performance and confidence. Jacobs and Bleeker (2004) also found that the way parents spend their own time sends a clear message to the children on what is acceptable. If a child views their parents participating in scientific or logical mathematical hobbies for their own benefit and not their child’s, it sends strong positive message about mathematics (Jacob & Bleeker 2004). Gunderson et al. (2012) agreed, and suggested that anxiety about the subject of mathematics that adults face can impact children’s mathematics attitudes. If parents hold these own beliefs for themselves, their children can pick up this unconscious behaviour. Not only will a child not see their parent participating in mathematical hobbies, but also they will see their distaste for them.

2.2.2 Traditional role stereotypes

Stereotypes regarding girls not doing well in mathematics are relatively common knowledge. Picho and Stephens (2012) found different treatment of boys compared to girls can reinforce the negative stereotypes about girls and mathematics. This treatment can be by general society, school or at home, for example: making a girl aware of “low parental expectations of their daughters on mathematics related tests and assignments” (p.
Shapiro and Williams (2011) research findings showed that these stereotypes, even if not explicitly spoken, could negatively impact the confidence and academic performance of girls in mathematics. Cherney and Campbell, (2011) clarified in their paper that a common stereotype is that women have poorer mathematics skills than men. In a study conducted by Shapiro and Williams (2011), girls to whom the stereotype was relayed before a test performed worse than a girl who did not hear the stereotype before writing the test. Charles, Harr, Cech, & Hendley (2014) found this effect of stereotypes, is more strongly seen in “affluent societies” where "individualism and “self-expression” are emphasized with a reduced interest to mathematics (p. 101). If people do not see the integrative nature of creativity and mathematics, and in societies which emphasize self-expression and creativity, mathematics may not always be valued. Charles et al. (2014) also emphasized that “interpersonal and caring skills” are seen to be “almost universally thought to be core female traits” which cannot be embraced in technical and mathematical careers (p. 102). Female, which was used to describe girls and traits associated with them by Charles et al. (2014). The thinking is that one cannot be both compassionate and in a successful mathematics career, which can further discourage girls. In “affluent” societies, people value aligning educational and occupational roles” with “cultural gender beliefs” (Charles et al., 2014, p. 102). Charles et al. (2014) noted that “self-understandings are strongly influenced by gender stereotypes” in these societies (p. 102), putting these girls at a disadvantage. Regardless of where these stereotypes arise from or what interaction a girl has with them, girls do seem to integrate them into their thinking and feelings of inadequacy can further damage their confidence in the mathematics classroom (Shapiro and Williams, 2011). Gunderson et al. (2011), saw
modeling of a dislike for mathematics may be interpreted by girls as appropriate for all girls. Kerr et al. (2004), suggested positive women role models in mathematics could be a good way to counteract this traditional role stereotype.

Interestingly, Shapiro’s and Williams’ (2011) research suggested that racial stereotypes seemed to overpower gender stereotypes. They discussed a paper about Asian girls who talked about the racial stereotype that ‘Asian people are good at math’ before they completed a mathematics test. Those girls performed better than Asian girls who talked about a gender stereotype ‘boys are better at mathematics than girls’ (Shapiro & Williams, 2011). For other racial stereotypes, in another series of studies, the effect appeared to be like that of the gender stereotypes; “white males underperformed in mathematics when compared to Asian males” when reminded of the stereotype than “white men are weaker in situations” compared to Asians (Shapiro & Williams, 2011, p. 177). “African American students ...under performed relative to their ability”, academically when the stereotype that “African Americans lack intellectual ability” was reiterated (Shapiro & Williams, 2001, p. 176). The paper uses girls, women and female interchangeably, which can prove confusing. Also, it is not possible to directly compare the negative stereotypes of gender with the positive ones of race easily, but these stereotype studies indicate the profound influence of any stereotypes on a student’s academic performance. It is interesting however, that race overpowered gender stereotypes for girls but not for boys. Further exploration is necessary to see what this means for the issue of girls and mathematics. It is likely that these stereotypes have cultural support; as the “gap in positive attitudes towards mathematics between boys and
girls is highest in affluent industrial advanced country”, in favour of boys (Charles et al., 2014, p. 101). It is notable that, even “boys’ affinity” and interest in mathematics “decreases” in these countries as opposed to “developing nations” (Charles et al., 2014, p. 101). It is not clear as to why less industrially advanced countries would have a larger gap. More research would improve understanding, especially considering the findings indicate the problem for both girls and boys.

2.2.3 Peer and teacher influence

During adolescence, the desire for autonomy from parents increases the “socializing power of peers” (Crosnoe et al., 2008, p. 140). As children age, their connection with their parent’s changes. While parents still have an overarching influence, peers can sway behaviour in the classroom (Crosnoe et al., 2008). Gherasim et al. (2013) agreed; in adolescence, peers have an impact on children’s development and educational goals. Gherasim et al., (2013) noted the positive impact of peers when they saw that girls with low academic performance goals still did well with strong peer support. The findings of Crosnoe et al. (2008) support this, as they found that “students value their friendships and use them as a “context for learning about the world and learning about the self” (p. 151). From these findings, in the context of the mathematics classroom, feelings towards mathematics will likely be affected by these peers.

“Gender socialization” as explained by Spade (2002) considers how society socializes the behavior of boys and girls. In the context of this paper, behaviours focus on attitudes and actions in the mathematics classroom. Charles et al. (2014) found that at
least in more developed—economically and socially—societies, girls will often “feel affinity towards fields reputed to require stereotypically feminine personality traits” (p.102). If gender socialization does propagate stereotypes of gender roles, girls will likely find the environment difficult to navigate. Gender socialization however, may not be the case in all school environments and other factors may be more influential.

Crosnoe et al. (2008) suggested that peers can influence an adolescent’s academic behaviour through direct and indirect mechanisms. These mechanisms include social approval of behaviour—the ‘girly girl’ type personality can be honoured among peers through ‘social popularity’ (Crosnoe et al., 2008). Thus, this popularity can be perceived as “social competence” and can positively reinforce and enhance this behaviour (Crosnoe et al., 2008, p. 140). Additionally, modelling and social learning can arise just from acting as the majority does (Crosnoe et al., 2008). If there is a case where most of their peers are disinterested in math, these girls may act this way regardless of their feelings. Crosnoe considers girls and their peers in high school and while the information is valuable, it is possible the results could vary in younger girls.

For teachers, their own gender stereotype beliefs whether conscious or unconscious can influence their expectations for their students and can unfortunately affect these girls’ mathematics attitude (Gunderson, 2011). Teachers typically offer the same amount of feedback to boys and girls, but in a study girls “received more positive feedback about their nonintellectual performance”—neatness, speaking clearly—than boys and thus, this “devalues the positive feedback” (Gunderson, 2011, p. 159). Ideally,
the idea of feedback should be explored further.

2.2.4 Self-confidence

The confidence of girls in mathematics tends to decrease over puberty (Cherney & Campbell, 2011). Cavanaugh (2005) suggested middle school as the start of the downward trend. Therefore, it is natural to consider middle school as a time when girls need the most support for their confidence.

Research has found girls lack confidence in the mathematics classroom (Crombie et al. 2005; Lloyd et al., 2005; Ross, Bruce & Scott, 2012). Lloyd et al. (2005) conducted a study regarding girls’ and boys’ attributions of success. Lloyd et al. (2005) found that “ability attribution” was relatively the same for both genders (p. 401). In fact, effort was the most common attribution of failure for both genders (Lloyd, 2005). However, despite these findings, and the fact that achievement was comparable to the boys, girls still have lower confidence (Lloyd, 2005). Ross et al. (2012) agreed, and found that there was a significant difference in confidence within girls compared to boys. Their findings support the belief that girls have a self-defeating, lack of confidence behaviour towards their ability in mathematics.

In Ontario, boys show greater confidence in mathematics across all grade levels as compared to girls (Hall, 2012). Between grades three, six, and nine, the greatest difference in confidence in mathematics occurred in grade six, in favour of boys (Hall, 2012). Within these grades, still in Ontario, during classroom group work girls’
participation is unbalanced in favour of boys (Ross et al., 2012). Hall noted no achievement gaps in mathematics academic performance however (Hall, 2012). Which is in support of the overall findings of other researchers as previously mentioned for North America. In contrast, Crombie et al. (2005) found that girls in grade nine believed competence in mathematics affected their grades as well as future mathematics enrolment unlike boys where competence and grade outcome had a weak connection. This makes it unclear how much confidence and interest can affect academic achievement in girls specifically; especially if they are always compared to boys’ achievement. Academic achievement changes within girls as a whole in varying situations could be considered.

2.3 All-Girls Classrooms

The behaviour in the mathematics classroom has been reviewed in both the co-educational setting and the all-girls classroom setting. Socially, in an all-girls environment, girls reported feeling more comfortable in terms of how they dress and how they carry themselves (Yalcinkaya & Ulu, 2012). Yalcinkaya and Ulu (2012) also found most teachers needed to modify their lessons to meet the varying needs of boys and girls. Yalcinkaya and Ulu’s work was with schools in Istanbul, and while the information is valuable, it may reflect cultural differences. Charles et al.’s work also noted the drop in confidence as well as interest in both girls and boys outside of North America.

Cherney and Campbell (2011) found girls had higher self-esteem and greater intrinsic motivation in their all girls’ mathematics class than a co-educational setting. Girls in older grades will not be exposed to harassment, or negative attention by boys, in
a girls-only classroom (Cherney & Campbell, 2011). Picho and Stephens (2012) also found girls in single gender classrooms were not being exposed to gender stereotypes as often, and that the environment was less intellectually threatening. As an aside, academic performance in mathematics does not show significant improvement according to Yalcinkaya and Ulu (2014), who found girls scored “0.30 GPA points” higher in a “single sex classroom” overall (p. 14). Other research has also found higher academic performance by girls in an all-girls mathematics classrooms as compared to co-education, but no metrics were given (Cherney & Campbell, 2011). Demers and Bennett (2007) noted however, girls only classrooms are typically only reserved for affluent families, meaning these results may not consider a broad range of girls’ backgrounds.

While this paper considers only girls’ confidence, Yalcinkaya and Ulu (2012) found that both boys and girls “lacked confidence in their interaction with their opposite gender [after] having developed socially in a single gender class environment” (p.15). Boys overall in terms of academic performance and socialization seem to benefit less than girls in these single gender classrooms (Demer & Bennett, 2007). If a teacher is looking to better support the girls, this should be considered. However, despite the girls showing positive attitudes towards being in a girls-only class, Cherney and Campbell’s (2011) study in a single gender class did not “show a significant increase in interests in STEM careers, despite the higher motivational factors of girls in single-sex schools” (p. 721). Note that the use of term single sex schools by Yalcinkaya and Ulu and Cherney and Campbell indicates a classroom of only girls in their study, and uses sex in combination with terms of gender: girls and boys.
Contrary to research within a coeducational classroom previously discussed, and the stereotype threat affecting girls negatively, “girls performed better under the stereotype threat” than without it (Cherney & Campbell, 2011, p. 721). It can only be speculated—as there is no obvious concrete evidence—that the threat acts as a motivator, and without the social pressure of boys, it strengthens girls’ focus by encouraging them to break the stereotype. In an all-girls mathematics classroom, it is possible girls may motivate one another through competition or otherwise but this should be explored in greater detail.

2.4 Teaching Strategies for Girls

This section discusses teaching strategies targeting positive outcomes for girls in mathematics. The factors that positively affect girls mentioned across research papers were considered in this section and include role-modeling, mentorship, leadership opportunities, positive feedback, and problem based learning. Wait time and competition as tools for support were introduced, but have limited literature on each of the topics. The practical strategies can be employed by a teacher in their classroom based on the research that was reviewed and highlighted as possible solutions.

2.4.1 Factors that positively influence girls

A study conducted by Kerr et al. (2004) revealed a strong identification with a particular profession or area of study can support and encourage girls’ interest in the mathematics classroom. Kerr et al. (2004) suggested the use of role models in
mathematics related careers. If a young girl can see herself in a job using mathematics, she is more likely to show interest in learning the subject (Kerr et al., 2004). Making mathematics more applicable to students is another issue, but can assist in supporting all students. Mentoring and guidance of girls within the field of mathematics can also encourage career development and help with confidence (Kerr et al., 2004).

Teachers can be excellent mentors for all students, and with the right focus can help girls to see their potential and raise their confidence in the mathematics classroom. Ghersasim et al. (2013) noted the positive and negative impact of teachers on students’ performance academically. Proper teaching can support good marks; but a caring teaching can support good morale in the classroom. Demers and Bennett (2007) note that a “teacher’s” positive “attitude for inclusion” can impact a student’s behaviour (p. 2). Carrington, Tymms and Merrel (2008) have found however, that gender had little to do with the influence; teachers that were women were not more likely to enhance girl performance (2008). It is less obvious if these results if teacher gender would translate into confidence within girls in the classroom.

Kerr et al. (2004) also noted the importance of leadership opportunities. Any opportunities to lead, especially within the mathematics field, can help girls mature and build their leadership skills. The building of leadership skills is tied to overall confidence in girls, which can translate in the mathematics classroom (Kerr et al., 2004). Leadership skills can also encourage girls to stretch the boundaries of society, specifically of gender roles (Kerr et al., 2004).
2.4.2 Teaching Strategies

In terms of actions to be taken by teachers, experts have suggested multiple strategies. Role modeling has been a strategy that has appeared in literature (Halpern, Aronson, Reimer, Simpkins, Star and Wentzel, 2007; Kerr et al., 2004; Ross et al., 2012). Kerr et al. (2004) suggested the use of role models to support the “strong identification with a particular profession or area of study” in girls (p. 87). If a girl can see herself in a role in math, she is more likely to “pursue it” (Kerr et al., 2005, p. 87). Halpern et al. (2007), also suggested “exposing girls to girl role models who have succeeded in math…” (p.19). Halpern et al. (2007), saw this as a method of counteracting the stereotypes that women are not good at mathematics.

In the same vein as role models, Kerr et al. (2004) suggested mentorship, “mentors encourage, guide, and support; they also continually remind the gifted young woman of her own dreams and goals” (p. 88). Mentors seem to be a step up from a role model role, the girls may have direct contact with the mentors. Kerr et al. (2004), suggested women mentors could double as role models for supporting girls.

Halpern et al. (2007) also suggested creating a classroom where mathematics excitement can be sparked and maintained. This involves appealing to students’ interests because interest typically leads to academic performance (Halpern et al., 2007). In previous sections, academic ability between boys and girls has been proven comparable, but interest can also help the girls stay with mathematics (Halper et al., 2007). In addition to this, Ross et al. (2012) suggested more thoughtful grouping of students for
any group mathematics projects, to allow proper collaboration (2012). He is suggesting that unequal participation between boys and girls in groups could be minimized through grouping by the teacher (Ross et al. 2012). However, there was not a lot of research about this; it is unclear how useful group selection would be. Ross et al. (2012), also suggested giving all students equal time for explaining solutions and making sure to call upon everyone equally.

Girls tend to perform better on problem-solving exercises while boys perform better on computational (Cavanagh, 2005). Therefore, diverse questions on assignment and tests can benefit both genders’ confidence. Cavanagh suggested using real world mathematics problems to reach girls (2005). Hall agreed, suggesting a movement away from memorization of formulas in favour of concepts (2012). Cooper and Heaverlo (2013) also agreed, suggesting cooperative learning; with hands-on activities that can best support girls and boys learning. These strategies should meet the needs of diverse learners (Demers & Bennett, 2007), and help them build confidence in all subjects despite challenging concepts. Girls interested in problem solving are likely to be interested in any STEM fields (Cooper & Heaverlo, 2013). Cooper argued that teachers should be aware of the students who show an aptitude for problem solving, and provide them with complex interdisciplinary assignments when they can, to encourage the students’ use of logical systems for problem solving (2013). This technique is known as “problem-based learning (PBL)”, and is used to combine “logic and creativity”, both traits of STEM (Cooper & Heaverlo, 2013, p. 28).
Because leadership opportunities help girls build confidence within themselves (Kerr et al., 2004), Kerr notes that teachers should try to provide opportunities for both middle school girls and boys to take on leadership roles in clubs or school-wide projects. While Kerr et al. (2004) does not provide specific suggestions, any opportunity to be creative within the STEM should be encouraged within schools. Kerr et al. (2004) has seen great value in girls stretching the boundaries of what they think that can do. Ross et al. (2012), also stressed the importance of encouraging a sense of agency and empowerment in girls regarding mathematics.

In terms of empowerment, teachers should attempt to “praise effort over ability”, as children always feel they can control effort (Heilbronner, 2009, p. 47, 50). It is commonly agreed that teachers are most often the biggest academic mentors to their entire class and consequently have tremendous power when it comes to guiding their students. Halpern et al. (2007), agreed noting that “prescriptive, informational feedback enhances students’ beliefs about their abilities” which can support a girl’s confidence (p.15).

Finally, some areas not as explored as teaching strategies include wait time and competition in assessment. Wait time was explored by Maroni (2011), to encourage classroom participation in any elementary classroom, including but not limited to mathematics. The findings indicated waiting and pausing is effective, if the pauses are adjusted based on the need (Maroni, 2011). This was not considered specific to a mathematics classroom, so it is difficult to consider its effect in the mathematics...
classroom making this an interesting avenue to pursue in research. As well, Burguillo (2010) used competition-based learning to motivate student overall participation in the classroom. Some of the benefits of this type of learning that Burguillo (2010) found included motivation of the students to explore their own topics in mathematics to solve challenges and the active participation of students in the lessons. However, the students in the study were men and women and were enrolled in university-level courses. Problem-based learning was suggested by Cooper and Haverlo (2013) to engage girls in mathematics and build their mathematics skills and these findings are promising but considerable research is still needed.

2.5 Conclusion

In this literature review, I looked at research on factors that influence the confidence and interest of girls in mathematics class. This review clarifies the extent to which self-confidence as well as family influence has on girl’s interest and participation in mathematics. Considering this, the purpose of my research is to learn what teachers, find the most effective in supporting girls. Based on the scholarship, the next step is to compare this to experiences of current professional teachers. I interview teachers in the current school system, both in coeducation and all-girls classrooms.
Chapter 3: Methodology

3.0 Introduction

In this chapter I discuss my research methodology as it relates to middle school aged girl students and their confidence and interest in the mathematics classroom. I begin by reviewing the general approach taken, and the procedure used to complete my primary research. I identify instruments of data collection and the selection of participants for the semi-structured interviews. I then outline the sampling criteria and the procedure used for sampling. The sampling is intended to be diverse, and include multiple perspectives related to the area of middle school girls’ confidence in the mathematics classroom. Following the sampling details, I provide a brief description of each participant’s experience, and relate this to this study. I then outline my ethical review and procedures along with the procedure for the qualitative data analysis. Finally, I outline limitations to my methods and look to the future for next steps.

3.1 Application Approach and Procedures

Qualitative research “seeks answers to a given research problem” from the viewpoint of the “population it concerns (Mack, Woodsong, MacQueen, Guest, & Namey, 2005, p. 1). What sets it apart from other types of research are “the values, opinions, behaviours, and social contexts” it can obtain (Mack et al., 2005, p. 1). These subtle elements can provide deeper insight into a problem than purely statistical data. In the situation of girls and mathematics, while there are statistics to support this problem,
the deeper question is the cause and how can it be positively changed. Most scholarship about middle school and adolescence mathematics and girls’ confidence believe it is a problem. As a new teacher, I wanted relevant and implementable solutions that I might be able to incorporate into my classroom. Qualitative research can be conducted for an issue that needs to be explored (Creswell, 2012). Teachers can speak to their observations in the classroom where girls interact with factors that can sway their confidence either way. From there, this problem can be explored by comparing the teacher’s stories with literature, allowing an explorative comparison between the literature and teachers in classrooms. The purpose of “qualitative research interviews” is to learn about an area of knowledge that is based on meaningful “life experiences” of the interviewees (Bloom and Crabtree, 2006, p. 314).

Quantitative data “examines the effect of specified circumstances” on an “outcome of interest” (Lakshman, Sinha, Biswas, Charles, & Arora, 2000, p. 369). Lakshman et al. also found that they are most effective when the “content is so constrained and controlled” that it can eliminate bias. Like qualitative research, it can “address causation and involves observation”; there is observation involved in both cases (Lakshman et al., 2000, p. 371). But qualitative research seeks to “answer what not how often” (Lakshman et al., 2000, p. 371). Teachers are more concerned with what is the problem and how can it be solved. Both forms have room for bias. Qualitative studies are most informative when “contextual forces are ill-defined, uncontrolled or situational” (Lakshman et al., 2000, p. 371). In the case of girls’ confidence in the mathematics classroom, this problem considered from the perspective of internal and external factors
which cannot be easily controlled. The problem of girls’ confidence and interest can depend on human behaviour making it challenging to quantify and predict based on numbers alone. One girl could enjoy mathematics and have confidence in herself while another similarly positioned girl may hate mathematics. For studying the confidence and consequently participation of middle school girls in the mathematics classroom and how they can be supported by their teachers, a qualitative research approach was chosen in favour of the quantitative. The research for this topic was collected using semi-structured interviews, a common qualitative method.

3.2 Instruments of Data Collection

The instrument of data collection used is a semi-structured interview. For any form of interview in qualitative data collection, the variation comes from the amount of “control the interviewer has” (Stuckey, 2013, p. 56). In a semi-structured interview, the “researcher will set an outline of topics to be covered” and questions to ask, but the “interviewee’s responses” will determine the direction of the conversation (Stuckey, 2013, p. 57). The structure allowed me to guide the data collection, by providing specific questions for the interviewees to answer, I could deviate when necessary. The use of “open ended questions” can support “identifying new ways of seeing and understanding the topic” (Stuckey, 2013, p. 57). However, the clear outline and instructions can “provide reliable, comparable qualitative data” that can be used for analysis (Stuckey, 2013, p. 57). As a less experienced researcher, I found the preparedness that comes with the semi-structured interview to be beneficial. I benefited from this method because of
the structure. It provided my interviews with a baseline and a common foundation for when analysis is conducted.

3.3 Participants

Selecting qualified participants for qualitative research is important. The more qualified and interesting an interview the richer the data analysis will be. As such, in this section I review the criteria used when choosing those to interview and the procedure for which these three people were selected. I detailed a brief biography outlining the experience and qualifications of each participant of the study.

3.3.1 Sampling criteria

The criteria used to select candidates for interview were chosen to find teachers with focused relevant experience with middle school mathematics and girls’ lacking confidence and interest. “Criteria serves as shorthand about the core values of a certain craft” (Tracey, 2010, p. 838). When trying to answer a problem, by selecting some criteria, we can better clarify what we want to know. The following criteria were used for the selection of participants in the semi-structured interviews.

(1) Demonstrated experience teaching middle school mathematics

It was important for the teachers interviewed to have demonstrated experience teaching middle school mathematics. This is because the research is about middle school girls’ confidence and interest in the mathematics class, and therefore those interviewed need to be able to speak to their experiences with these girls in this range. To keep the greatest
consistency between interviewees, only current grade seven teachers were chosen—which falls in the middle of middle school years, though ideally they have taught other middle school grades. This was chosen to ensure greater consistency in the sampling, while still having a good picture of middle school teaching.

(2) Teaching experience of five years or greater

Interviewees needed to be able to discuss what they have observed over the years. The literature discusses long terms trends in detail. Consequently, observed trends throughout teaching would be extremely helpful for research analysis and comparison between literature and primary research, as such, five years of experience or greater is ideal. Should a teacher be new to middle school, they may not be able to confidently speak to their observations of the issue, having not had much opportunity to observe. Additionally, girls’ learning experiences before or after middle school can provide deeper insight into the research problem, but because of the scale of the survey, it is not possible.

(3) Teacher needed to be working in one of the following schools: public or private all-girls

Because the literature research has indicated mixed benefits and limitations for girls in a single gender classroom in terms of confidence, both types of teachers were interviewed. To get a good perspective of the landscape, teachers in both the private system and public system were asked to speak to the issue. This was also done because peer influence has been cited as a contributing factor to a girls’ participation in the mathematics class (Shapiro & Williams, 2012). Interviewing teachers in classrooms with different student
gender demographics allows for a better understanding of how influential the peer climate can be for a girl’s confidence. It would have been ideal to have an even split of interviewees in the public and private school systems to give as broad a perspective as possible.

3.3.2 Sampling procedure

The sampling process was mostly based on “criterion sampling”, where participants were chosen based on the criteria previously mentioned. Maximum variation sampling which involved choosing participants that widely vary in the criteria (Miles and Huberman, 1994) was used to a limited degree. This was ideal because in the beginning it maximizes differences and therefore the final research is more likely to have a variety of perspectives in the findings; which is ideal in qualitative studies (Creswell, 2013). However, given the limitation of three interviewees, limited variation was used: gender, and school board.

To find teachers to interview, I accessed my network of teachers from previous teaching employment and volunteer work to first determine if they are eligible to participate in this study. Because of the small scale of the study—due to the Master’s Degree program restrictions—and how immersed I am in the teaching environment and culture; I have a big network of possible candidates. The university environment provided rich networking opportunities. I wanted to get a wide range of opinions and limit bias sampling, so I needed to step outside the school of university and access my greater community.
When contacting people, I provided my contact information to them; to keep people from feeling obligated to participate in the study. I contacted people via email, a less aggressive approach than the phone.

3.3.3 Participant biographies

Michelle is a middle school mathematics teacher in Southern Ontario. She had been teaching grades six to eight for her whole career which is greater than 10 years. She has taught in both English and French immersion. Her formal training was in primary junior education and a Bachelor’s of Science; however, she has completed qualifications for intermediate mathematics since.

Sam is a middle school mathematics teacher in Southern Ontario. He has taught in Ontario for 3 years in middle school and had taught more than 10 years in middle school out of province. His formal training was not originally in math, rather physical education however he completed additional intermediate qualifications in mathematics since. His formal training was out of province.

Sandy is a middle school teacher at an all-girls Catholic private school in Southern Ontario. She has taught mathematics in middle school for over a decade, half of which was in a co-education environment. Her formal training was in engineering. She shifted to education in part because of her desire to support middle school aged girls in the mathematics classroom.
3.4 Data Analysis

The processes of “data collection, data analysis, and report writing” are not individual steps but occur simultaneously in the research process (Creswell, 2013, p. 136). While collection of data will occur before the analysis, as analysis and writing occurs, it may become apparent where more information is needed. This process is suggested to continue until “no new categories or themes emerge” (Bloom and Crabtree, 2006, 317-18). Following the completion of my interviews, I transcribed them in their entirety. Next, I reviewed the interview transcriptions thoroughly to get a proper sense of the ideas and themes conveyed by each interviewee. Any nuances were determined and interpreted. As an initial step to the analysis process, annotating the transcripts when reading helped me start the process of exploring (Creswell, 2013). It is after these initial thoughts, the mental processing began. From there I began coding each transcript individually and identifying categories of data and themes within each of them. Coding is described as grouping data into small categories and then “seeking evidence for the code” from other sources (Creswell, 2013, p. 138). Categories could include instructional strategies for supporting girls, while themes could be a specific behaviour that has been proven effective. Some problems suggested by Creswell (2013) are the limitations which existing codes in the literature can pose a bias of views. The coding was completed over several months to minimize this problem. At a deeper level, once each interview transcripts were coded, I compared them and generated themes where possible. I looked for overlap in the opinions of teachers. I made interpretations of this data, analyzing codes and themes deeper meanings (Creswell, 2013). The null data which is what is not
spoken about is valuable. It is an important to note when a teacher did not discuss something or not have experience in an area, it also speaks to the subject. For girls in math, this could say where the system had holes in terms of supporting teachers and students. Finally, to wrap up the analysis I speak to the importance of the findings from the interview given how it relates to existing research in the field. The comparison of primary research to the previously reviewed secondary research can provide an interesting wrap up to the analysis in chapter four.

3.5 Ethical Review Procedures

Bloom and Crabtree (2006) believe there are four main ethical issues to consider in an interview process; (1) “unanticipated harm”, (2) “protecting [the] interviewee’s information”, (3) “effectively informing interviewee about the study, (4) “risk of exploitation” (p. 319). As such, I ensured that the following procedures are completed with the utmost care.

(1) There were no known risks in participating in this research study, but to comfort the participants I reassured them in interview that they have the right to refrain from answering any question that they do not feel comfortable with. I also re-stated their right to withdraw from participation in the interview.

(2) All participants were assigned a pseudonym to keep identities confidential and any identifying markers related to their schools or students was excluded (Creswell, 2013, p. 174). These procedures protected the personal information of the interviewee, should their interview jeopardize their job. As suggested by
Creswell, the storing of data is also important for participant identity protection (2013). Therefore, all data – audio recordings — were stored on my password-protected computer and destroyed after 5 years.

(3) To ensure I was properly informing the interviewee about the research, I sent the interview questions in advance. Participants were asked sign a consent letter—found in Appendix A—giving their consent to be interviewed as well as audio-recorded. This consent letter provided an overview of the study, and addresses ethical implications, and specific expectations of participation; one 45-60 minute semi-structured interview. I also asked for consent “verbally” and “several times” in the process as suggested by Bloom and Crabtree (2013, p. 319). Allowing for several opportunities for “interviewees to reconsider their participation” (Bloom and Crabtree 2013, p.319)

(4) Participants had the opportunity to review the transcripts and to clarify or retract any statements before I conducted the data analysis. This is so I avoid any accidental exploitation of material collected from the interview. Contributions of each teacher were acknowledged within the paper; a plan suggested by Bloom and Crabtree (2013) to credit their knowledge.

Another problem is the researcher sharing personal information. Creswell (2013) stated that this sharing can limit the information the interviewee shares. To avoid this, I did not share personal information and I was aware of my body language to prevent any influence on their words. I tried to create a secure situation and warm interview environment where participants feel comfortable to share their opinions and experiences. These procedures if completed should support this goal.
3.6 Methodological Limitations and Strengths

Creswell (2013) suggested not to simplify information but instead make the specifics clear. Certain forms of narrative research can find good information from one or two individuals but in a semi-structured interview it is challenging to find good candidates (Creswell, 2013). This is the largest limitation of this study, and consequently additional problems stem from this limitation. Because the sample is limited to three individuals, a detailed Ontario, perspective is not possible. I have chosen to focus in Southern Ontario and pull people from varying school boards, and from there I considered the implications of the literature on the three teachers’ observations and experiences. But a micro-study can provide important information and can provide direction for further research.

Another problematic limitation to this qualitative research is the bias of the candidates selected. Roulston and Shelton (2015) found that “any demonstrations of bias on the part of the researcher” can be viewed as “indicators of a poor-quality study” (p. 332). “Observer bias” is when the researchers “perspectives impact observations of a particular setting” (Gall, Gall, and Borg, 2003, p. 264-265). “Experimenter bias” is when the researcher “contaminates” (Best and Kahn, 2003, p. 168-169) the data by affecting the interviewees “responses or reactions” (Roulston and Shelton, 2015, 334). The candidates were chosen based on criteria and based on network connections and are therefore not a randomly selected sample. Also, because I only had one hour for interviewing, the questions asked were tailored to extract certain information. There is
unfortunately a human bias that comes with qualitative research interviews. It is “imperative is for researchers to be aware of their…predispositions and to acknowledge them as inseparable from the research process” (Ogden, 2008, p.61). So, I remained as objective as I can and keep awareness of my bias. I was aware of my experimenter bias and how my body language can influence an interviewee, and my observer bias when writing my discussion of findings to minimize this weakness.

Another limitation to this study was the traditional gender framework in which this paper and the study was based on. While gender is seen as non-binary, this paper considered the problem from a boy and girl perspective. This was done because conversations regarding this problem are still happening in this binary way, and this language is still being used by teachers, including my interviewees. My interviewees, also use both terms of sex (male and female) as well as gender (boys and girls) to describe their students, despite their intention to specify only the gender of their students.

Conversely, a strength of this research method is its ability to handle the complexity of the topic. Because of the complexity of the issues with girls and math, it is difficult to encapsulate this in quantitative data. Quantitative data “examines the effect [of] specified circumstances” in the study (Lakshman, 2000, p.369). In a diverse environment, such as the classroom “an explanation of events” cannot fully be made without inquiry into “perceptions, attitudes and behaviours of those involved” (Lakshman, 2000, p. 369). Because this paper wishes to look at the factors contributing to this issue as well as teacher solutions the qualitative study allows for multiple dimension.
3.7 Conclusion and Next Steps

To conclude, this section outlines key aspects to my methodology in this qualitative research study. I outlined my research approach and data collection procedures including why semi-structured interviews are ideal. Next, I discussed my selection of participants for the semi-structured interviews and the criteria used to choose them. I then discussed my data analysis procedures, the coding of themes and the ethical review completed in the study. Finally, I review the limitations and strengths of this study. Looking forward, in chapter four, I discuss my research findings and perform my proposed data analysis.
4.0 Introduction

Student engagement within any classroom will vary depending on the teacher and the subject. When it comes to girls’ confidence and interest in the mathematics class, each teacher has their own experiences, which will influence their strategies and their beliefs about mathematics. This research asked what sorts of social factors can influence a girl’s view of their mathematics ability and considered how single-gender mathematics classrooms affect this issue. In this section, the research findings are summarized from the three interviews with experienced middle school mathematics teachers. The findings correspond to the following main themes: early and ongoing influences beyond the classroom, school and classroom environment, peer dynamics, self-confidence and academic ability in the mathematics classroom as well as strategies for supporting student needs. Within each of these themes, sub-themes arose allowing for deeper exploration, and overlapping ideas occurred because these factors do not act in isolation.

4.1 Early and Ongoing Influences Beyond the Classroom

Research findings from this study indicate that students’ views of themselves and their academics while influenced in the classroom are also influenced by factors beyond the classroom. This can include home environment and cultural background. Given the time spent outside of school and at home, these aspects should be considered when discussing girls and their confidence.
4.1.1 Cultural and ethnic influences

The cultural and ethnic background of a student can be expected to influence the beliefs of a student. Research findings have indicated that culturally influenced beliefs can translate into mathematics classroom performance. Sam strongly believed that, “culture would play a greater part in mathematics confidence than gender…” meaning that culture means more than being a girl in the mathematics classroom. However, these cultural beliefs do not always work in the girls’ favour according to Sam. More specifically, he found that “when looking at traditional cultures—Asian and East Indian cultures—the girls are not as encouraged to be academic in [math]…girls who don’t do well in mathematics tend to be from East Indian and Muslim cultures.” Conversely, Michelle found that “certain cultures place a higher emphasis on the math… both the boys and girls will tend to do better…[but] more in the girls.” Her higher academically performing confident girls were more often the girls from the “traditional” cultures, which she clarified generally as Asian. Shapiro’s and Williams’ (2012) paper discussing many studies supports Michelle’s observations, suggesting that racial stereotypes seemed to overpower gender stereotypes in a positive way for girls with Asian heritage, but contradicts Sam’s observations. Sam noticed that the parents of these lower achieving girls did not have “a concern of academics, but rather how they were doing socially” meaning, were they doing their work and following rules? In these cultures, he found the parents emphasized “taking care of other siblings” rather than the importance of working hard at school. While this may not be the norm, based on what Michelle had seen, it was in the forefront of Sam’s classrooms. Sandy, however, did not cite culture as an influence.
into how her students view themselves in the mathematics classroom at all.

4.1.2 Parental attitudes

All three interviewees spoke heavily about the impact of the parental attitudes towards mathematics that influences student behaviour and interest. When considering her more confident students, Sandy found that “they come from families that value mathematics and support them”. Michelle agreed, observing that “parents who are stronger in mathematics have careers in this area...they see the value in it more.” In Michelle’s words, it comes down to “family values” in mathematics. In cases of the higher academically performing girls, from Michelle’s perspective, these girls have parents who are “all very intense, [who] pushed their kids.” The pressure to do well academically did not end in the classroom, but carried into extracurricular activities. Sam, who did not mention the values of families of highly confident girls towards math, cited home pressure as an influence of a student's’ views of mathematics. He noted that “most of the pressure parents put on kids leads them to worry more about their marks rather than comprehension.” Sandy echoed this sentiment of pressure, when talking about assessment: “tests seem to be what matters the most to them...maybe because of parents.”

Literature by Jacobs and Bleeker (2004) supports the observations of all, with their research finding that parents’ behaviour towards their children influence the children’s later interest. Jacobs and Bleeker (2004) also found that parents tend to provide more opportunity for boys, though the interviewed teachers did not say anything about this specifically.
Emotional baggage of mathematics attitudes of parents can also prove to be damaging for girls already struggling with confidence in mathematics. Sandy states:

In the younger grades, most people still remember how to multiply and divide and add and subtract so they can generally help their kids at home. In middle school, you start doing integers and parents don’t always remember the integer rules... parents are like ‘this is scary, this is bringing back my high school memories, I don’t know this stuff’... I think it’s partly that they’re starting to feel more helpless.

This helplessness Sandy believed resulted in mathematics being “spoken about in a dismissive tone, as if mathematics would be your worst nightmare.” In parent-teacher interviews, Michelle found similar examples, where parents would voice their dislike of mathematics in interviews. Sam could not speak to this area, and felt he was unable to remark on how parents feel about mathematics compared to their children’s beliefs. Sonnert’s (2009) research and Jacobs and Bleeker’s (2005) shows parents can unconsciously or consciously support the stereotypes and influence what their children believe about themselves. These findings support what Sandy and Michelle observed: the influence of parents exists and can be both positive and negative. Picho and Stephens (2012) found negative stereotypes about girls’ mathematics abilities are reinforced through differential treatment of girls by general society, at school, and in the home; such as “low parental expectations of their daughters on mathematics related tests and assignments” (p. 53). The lower expectations were not explicitly stated as being observed
by Sandy and Michelle though Sam touched on it. Michelle and Sandy generally stressed the parent’s own self beliefs influencing their child.

For mothers, Sandy found that many of them promote the “‘I wasn’t good at mathematics either’ thinking”. Her finding was “if girls see their mother as not being strong that gives them permission [to believe they] don’t have to be strong either.” Sandy felt this behaviour of the mother makes it “acceptable” to also perform poorly in mathematics in the student’s mind. Michelle touched on this briefly, and mentioned how both parents have tried to justify a student’s performance by saying “I was always bad at math” instead of considering solutions. While Sam did not speak directly to this, it links back to the findings regarding parental influence, which both Sam and Michelle mentioned as being an influencing factor to student behavior towards mathematics. Sam found that with traditional Asian cultures—which he spoke of previously regarding cultural influence of confidence—he does not even see the mother and deals “primarily with the father” in parent-teacher interviews. He made a connection between the influence of traditional cultures and those of parents, and said that the mother is not a strong mathematics figure and is also less competent in other areas outside of mathematics. This behaviour from culture and parental roles, according to Sandy, can then be passed down through generations leading to continued low confidence in mathematics class. Sonnert’s (2009) research supports this finding, Sonnert (2009) cited parents’ characteristics—including parental education—were more important to girls than for boys when it came to career choice. The parents who are confident in mathematics will likely be the ones in the mathematics careers. Jacobs and Bleeker (2004) also, found
parents’ mathematics promoting behaviours did influence children, though it was not specific to gender.

4.2 The School and Classroom Environment

In the school and classroom environment—the physical and nonphysical set up of a classroom is important to consider. The setup includes desk orientation but also how a teacher sets up an emotional space. Consideration of teacher gender is addressed on how it related to girls’ behaviour in the classroom. Participants discussed their views on how to create a safe, learning environment through actions, indicating the importance of a safe environment cultivated on the part of the teacher.

4.2.1 Physical and emotional classroom setup

When it comes to the physical classroom setup, both Michelle and Sam arrange desks where most girls sit in the middle to back rows. In Michelle’s classroom, she has had “very busy, distracting boys” so she “put[s] them up front to keep them focused”. These boys also happen to be academically high mathematics students and ‘loud’; they participate intensely and sometimes shout out answers. From Michelle’s perspective, “the classroom set up is almost a physical barrier.” Therefore “classroom control is important” meaning, she needs to ensure students are respectful to each other, so her louder boys will not always “blurt the answer out” and take chances away from the girls. In Sam’s classroom, he draws names and “goes around the room” instead of having people put their hands up to support equal participation. This is his effort to draw out participation of
the girls who are less willing. This is supported by Gunderson (2012), who found that teachers can unconsciously exclude girls by providing the attention to louder boys who call for more attention, which can support the findings from Michelle. Ross et al. (2012), also suggests practices where students are called on equally.

In terms of emotional classroom setup, it was agreed by all three that it is important to wait before choosing a volunteer for an answer. Michelle remarked that “girls benefit from wait time. Whereas, the boys put their hands up immediately.” Michelle said “if you can remember to wait early on in the year, the girls will get more comfortable.” From Michelle’s perspective, “girls need some time to warm up to you.” Once the girls feel comfortable, “at the end of the year” Michelle observed that “the girls will ask more [than the boys]”. Wait time and questioning aside, Sam found it important to not put boys or girls “in situations that are embarrassing for them” when developing the emotional classroom space:

Get an idea of how students will react in certain situations, a student who doesn’t volunteer on a regular basis doesn’t necessarily mean they are not knowledgeable; it just may mean they are not necessarily wanting to volunteer or they’re not confident in their answer. If you can draw those answers out of them in a way that’s supportive and can help build their confidence, then hopefully that will lead to them volunteering more on a regular basis.

In his experience, it is an “even split between boys and girls who might have problems” they do not want to bring forward, whether it is due to “embarrassment or lack
of confidence.” He believed that knowing the students is the most effective way to build confidence and interest. Sandy, unable to comment on the physical space of her classroom set up, found it helpful to “make it acceptable” to enjoy mathematics. Sandy felt that because it is “not cool” to like math, students may feel uncomfortable in the mathematics class. As a teacher, she thought it was important to “create a safe space and encourage them”, and to remind them of the things they are good at and that “not all mathematics is bad.” The ‘supportive space’ all three talked about can support girls who are sometimes passed over because of louder boys. Gunderson et al. (2012), along similar lines suggests “using praise that emphasizes the child’s effort, work, and actions” (p. 159) to support girls’ positive belief in their ability. Heilbronner (2009) also mentioned the value of positive praise to encourage confidence in the girls. Gherasim et al. (2013) along similar lines suggested using cooperative strategies to encourage girls to offer and seek help from each other instead of just relying on the teacher. Halpern et al. (2007) in a similar vein suggests creating an environment that sparks math interest but also looks to maintain it through appealing to student interest.

4.2.2 Teacher gender

The teacher is an important part of the classroom environment as they orchestrate lessons and assessment for the students. The gender of the teacher was not commonly considered in the literature, and all three teachers did not consider it to have a direct influence on a student’s confidence. From Sam’s perspective, the relationship with students varies with men and women teachers. Sam felt it was more “risky” to take on a
“[support] role” being a man. As man, he said he had: “to be careful with what I get myself involved in.” The girls in his grade prefer to speak with his “female colleague” (a woman), which he said was because “females have more leeway in developing relationships. They can be more open.” From his perspective, being a man comes with limitations to his relationship with his students that are not an issue for women who are teachers, though he did not speak in specifics. However, he also held a strong belief that the willingness of girls to come forward in mathematics is affected by the quality of relationships formed more than gender. He states, “where the students feel comfortable asking questions, that teacher will get asked a lot of questions.” His girl students’ preference for his “female colleague” could partially be due to their comfort, but also he said it is “more her personality” to support students with personal needs.

Sandy strongly believed in the influence of a girl teacher with a love of mathematics. She said:

I hope that before every girl graduates, they have at least one girl mathematics teacher. It is important that they see a woman being successful in mathematics. If they never see a woman doing mathematics confidently, then it’s hard to imagine that they could.

From Sandy’s perspective, while a “male teacher” could be “just as knowledgeable,” the purpose served by a “female mathematics teacher” is as a “role model” to shape a girl’s view of herself and her abilities. She felt “women teach mathematics because of the girls. I think guys will find their confidence anyway it
seems… [to come] more easily”. She argues that gender, in a subtle way, is important to these girls. Kerr et al. (2004) agrees, stating role modeling is effective in supporting girls and “female mentors” can show “bright young women the possibility of fulfillment of potential” (p. 88). Michelle’s school is fortunate enough to have “strong mathematics teachers on staff [who] happen to be all [women].” In her experiences, as an aside, some of the “male mathematics teachers” have been “less academic” and therefore not as effective a teacher. Sandy’s belief regarding women mathematics teachers as role model to support girls’ ability was contrasted by Carrington et al. (2008). Carrington et al. (2008) noted that in their research there was no obvious indication that “male teachers” were particularly effective with boys or female teachers with girls” in higher ability children (p. 321). However, when it came to attitudes towards school Carrington et al. (2008), found they were more positive in children whose teachers were women, for both boys and girls.

4.3 Peer Dynamics

All three participants consider peer dynamics to be influential to student behaviour in class. Peer dynamics can pertain to how students interact with each other during breaks, group work and full class discussions. Sometimes the interactions are single gender, between girls, but also include interactions between girls and boys. The findings indicate that peers play a role in classroom behaviour.
4.3.1 Peer group interactions

For group work in mathematics class, Sam will “let students choose their groups” which often leads to “segregated groups of all girls or all boys.” He suspected this is because “boys do not want “to show what they don’t know” and girls do not want “to be in a situation where they have to take the lead.” Between all girl groups, Sam found they “tend not to compare themselves with the boys...girls are more focused on ‘how are we doing as a group?’...The boys are thinking ‘is mine better than yours?’” Sam has found boys show a greater competitive side amongst each other than the girls, and therefore needed a different teaching approach from their teacher. Comparatively, Michelle recalled in her classroom that she had a group of high level girls in mathematics who liked to compete with each other and would group together in class. Likewise, she found that when she had “a group that is weaker [in math], they tend to co-mingle together”. In her mind, it has to do with the students grouping where they are comfortable. Notably, the high-level ability girls show a competitiveness, Sam saw in most the boys in his class.

When it comes to boy and girl mixed group work, both Sandy and Sam have found balanced group work to be challenging. Sandy noted that “when boys are involved, girls often lean back. They don’t lean in... guys are frustrated, wondering ‘why won’t the girls just step in?’” Sam confirmed this with his observations, saying “in a mixed gender group, the boy who is most knowledgeable will tend to take over... less knowledgeable boys will then sit back and ‘let’ the girls do the work.” As for why this occurs Sam could not definitively give cause. In Sam’s class, the boys did not appear tired of the leader role
as observed by Sandy. Conversely, Michelle sees that there may be “a little more leadership by the boys on that end but not a lot.” In fact, from her perspective, it is more about ability than gender: “higher end boys and higher end girls will all just listen to who knows best.” Regarding girl and boy grouping behaviours, literature by Ross et al. (2012) supports the observations of Sam and Sandy, where during classroom group work girls’ participation is unbalanced in favour of boys.

4.3.2 Peer influence

For all students, Sandy found it “challenging getting the students to come for extra help.” She noticed that their “peers are very important to them so they don’t want to miss out on any social opportunities.” This is supported by Crosnoe et al. (2008) findings that students value their friendships and use them as “contexts to learn about the world” and themselves (p. 151). When it comes to class participation, Sandy said it would not “matter if they thought they were smart or not smart. It just matters what [their peers] think of them.” This can extend past their friends to the peers of their entire class, similar to Crosnoe et al.’s (2008) research which said that, how their peers judge them could affect how they will see themselves. Classroom behaviour aside, Gherasim et al. (2013), found peers did not affect the achievement in the mathematics classroom. Sam agreed, in testing situations he said it was individual and therefore there was not much peer influence. Sam discussed this dynamic in great length. He agreed with Sandy and found self-esteem to be a big influencer of how both boys and girls act in class:

[Boys] probably feel a little pressure to be more knowledgeable or assertive based
on what they are taught [boys] should be. Girls who are less confident in mathematics tend to sit back. Sometimes you see girls who have the ability but will sit back because they don’t want to embarrass the boys. They don’t want to make the boys look less intelligent, and then maybe get some attention in that matter. They play games. Sometimes they may ‘act dumb’…

The games he is speaking of ties in with a “fear of judgement” which Sandy felt “in younger grades [is] a non-issue”. Crosnoe et al. (2008) refers to “social approval of behaviour” as a method of peer influence on an “adolescent’s academic behaviour” (p.140). This research links to the observations of both Sandy and Sam; that girls' behaviours in the mathematics class can be a result of the social approval of the boys.

4.4 Confidence and Academic Ability

Confidence and academic ability considers how students view themselves in terms of their own ability and how that manifests as behavior and academic performance in the classroom. When viewing self-attitudes, girls were considered primarily, though Sam brought up his observations of boys into the conversation, which allowed for comparison. It is clear through the findings that a student’s self-attitude can affect their behaviour.

4.4.1 Academic Ability

In line with the literature found by Hall (2012), Hyde et al. (2008) and Lloyd et al. (2005) amongst others, Michelle confirmed that “girls are just as competent as boys” in
mathematics. She felt that gender did not matter as much to a student’s academic performance in a classroom. It is “your personality which can influence more.” By “influence more” she meant how the girls conduct themselves in the classroom. On the contrary, in Sam’s experience the “weaker students have been primarily [boys] on the bottom end, though there have been weaker girls.” However, overall, Sam agreed with research reporting “that achievement is comparable between boys and girls in math” but found that “there is not a big difference in confidence either.” Michelle, who did not comment on confidence, did say she found “…boys like mathematics more [than girls] … I don’t know if that is because it is less creative, or they like that there is usually a right and wrong answer or the reasoning but they tend to prefer the mathematics the girls seem to not have.” Sandy, in terms of confidence, did a personal survey with her students in a year when she taught co-educational mathematics classes. Her survey found “boys generally rate themselves higher than what they are actually achieving, and girls will often rate themselves lower than what they are achieving.” She noted that while achievement is equal there is clearly low confidence on the girl’s part and this survey was just one indication of it.

4.4.2 Confidence in the mathematics classroom

As mentioned above, both the literature and the findings indicate low confidence in girls. In Sandy’s all-girls classroom, for “a third of the class…mathematics is their favourite subject and they love mathematics and they feel good about math”. This left two thirds of the girls in her mathematics classrooms who are “either ambivalent or
actively thinking ‘oh I am so bad at math’”. Hall’s (2011) research reinforces what Sandy has observed: boys exhibit greater confidence as well as interest in mathematics across all grade levels as compared to girls. From her experience, Sandy found that being “strong in math, does not translate to confidence” as she has high achieving girls who are not confident. She instead felt confidence comes from “strength of character.” However, she does find that “success breeds success,” which means that the girls who do well can be confident due to the reinforcement of marks. Therefore, Sandy strongly recommended teaching in a way that shows girls the progress they made. Michelle in part reinforced Sandy’s beliefs calling academic ability “a confidence thing.” Michelle remarked that “if a girl has had success in mathematics when she is young, it will carry on” as she continues through school. Crombie et al. (2005) found that girls’ competence in mathematics affected their grades, which could support the findings by Sandy and Michelle that grades reinforced feelings towards mathematics. When it comes to self-esteem in the classroom, Sam found the opposite to Sandy; that during classroom discussions “boys tend to be more sensitive to the embarrassment side of things. The girls are more flexible…” His concern became more of how to make the boys feel comfortable and not embarrassed as opposed to the girls. His concern was not necessarily with building a girl’s self-confidence and was not able to recall this low self-esteem exhibited by the girls. This was an interesting finding because the literature on the topic of middle school mathematics confidence did not find boys as struggling in this area (Crombie et al., 2005; Hall, 2011; Ross et al., 2012).
4.4.3 Mathematics Class engagement

During class, Sandy found “it’s the boys who dominate the conversation so generally, [it’s] boys whose hands [are] up...boys guiding the direction of the class.” She found then that the boys will get questions answered during class, and the girls would come after class for help. Sandy noticed, “during the class I could see in their eyes that the girls are lost ... they would respond that ‘everything was good’ but at the end of the class all the girls would be at my table asking for me to explain”. From her experiences, though the girls want to do well, they could not do so in the whole class setting. From Michelle’s perspective in terms of seeking help, “girls are also more likely to cluster together and try to work through things. The boys will go up to you and say, “I don’t get it.” The girls will not see the teacher immediately.” Sam agreed with the point about class participation; he has both girls “with the knowledge [but] will not volunteer” as well as those “without the knowledge who will also not volunteer.” There is something holding back their ability to engage fully with the lesson, but Sam could not explain this. He, however, observed that while “primarily the volunteers of answers are [boys] directed...in a class of 28, split 50/50, there would be 4-5 [boys] that volunteer answers often but 8-9 girls who volunteer occasionally.” He found the boys volunteer more often, but there is more of a variety of girl volunteers. He found participation can be an issue for boys as well.

Conversely to what Michelle found, Sam observed that girls “are more likely to come forward and ask for clarification on a more consistent basis.” In an approximate
breakdown, he found “more girls are asking questions than boys...they are good at advocating for themselves”. As well, Michelle found that when girls do not see mathematics as “their strength” they will take on “a ‘giggly role’ or a ‘doodler role’” as opposed to asking for help. Looking generally, Sandy found any students, boy or girl, not doing well will “use masking like ‘I can’t find my work’”. Though some students try to “fly under the radar’, others are “very needy ask for a lot of attention.” This range exists with both boys and girls. In Yalcinkaya and Ulu’s study (2012), they consider classroom participation and behaviour in a single gender classroom. Yalcinkaya and Ulu (2012), support Michelle’s observations, as increased concentration on the lesson was cited by study participants because of single gender classrooms, which was found for both boys and girls.

4.4.4 Learning Styles

When it comes to learning, Sandy found, “boys are stronger with strategy and problem solving.” The boys need support with “working through the steps of the question...girls were almost the exact opposite, for them it’s the problem-solving and strategy” that they need support with. This directly contradicts Cavanagh’s research (2005), which found girls tend to perform better on problem-solving exercises while boys perform better on computational. Sandy also noticed “girls need organization and colour-coding” which is not necessary for boys. Consequently, Sandy struggled with engaging and supporting both groups and being in an all-girls school, mitigates the problem per her experiences. Michelle reports learning needs as a challenge as well: “girls need more wait
time and are a little more co-operative. Boys are a little more go-go-go and take more risks.” From Sam’s perspective, “boys tend to be more hands-on; they like to have manipulatives...girls are okay with being able to see it being done...they don’t need to have the tactile things with them.” All three cite learning differences across genders though the needs each observed may vary. Learning differences between boys and girls is supported by research by Yalcinkaya and Ulu (2012) who found the teachers they interviewed needed to alter how they taught to meet the needs of their girls and boys. While Sam does not see it as being a big challenge to manage, Michelle and Sandy have found it difficult to balance in one classroom. When it comes to learning styles, Cooper and Heaverlo (2013) also support all three teachers’ belief that the styles can vary for boys and girls. Their research especially agreed with Michelle, and less so with Sam who felt girls did not need hands on experiences: girls learn best in environments that “promote collaborative learning, hands-on experiences, creativity, and practical applications” (Cooper & Heaverlo, 2013, p.28).

4.5 Strategies for Support

The following strategies of support were discussed by all three teachers to varying degrees. The strategies include wait time, competition, role-modeling, positive praise, evidence based assessment, and an all-girls mathematics class. It was agreed that school initiatives were good for supporting students but little input was given towards implementation.
4.5.1 Wait time for Instructional Strategy

Wait time is a strategy suggested by all three participants. Sandy suggests that wait time “gives time for those who have a strong mathematics mind but aren’t as quick to come up with a solution, or they want to check it.” In a way, this gives the less confident students a chance to participate. Throughout the interview, the importance of wait time to give other students a chance to find their responses was brought up several times by Sandy. When asked outright for strategies, wait time was suggested first. Michelle agreed with the importance of wait time, finding it important in all lessons. She found that, “boys put the hands up immediately in class and are more willing to take a chance in mathematics. The girls typically...will wait it out... you can see them think.” As a strategy, when the girls are thinking, Michelle will “try to hold off until they look comfortable and start to raise their hand.” Sam agreed with wait time as an important strategy, but for boys. He felt “boys that aren’t volunteering answers tend to need more time. To develop their answers than the girls who aren’t volunteering”. For Sam, this means that wait time is an instructional strategy for his boys more than his girls. Literature from Maroni (2011) found longer wait times to be beneficial for both boys and girls, especially if it is used with “interventions by the teacher encouraging the pupils’ collaborative participation” (P. 2081).

4.5.2 Competition as an instructional strategy

Sandy found “gentle competition” to be a good strategy to “celebrate the people who do well...and encourage [girls]”. She found “some of the girls thrive on it and like it
and some of the other girls are really scared and worried by it”, highlighting that it is important to find the balance between the two. For example, when she gives tests back, she says the names of the “top five marks” but not what the marks were. The reason why this works as gentle competition is because “the girls want to have their name said.” Sandy noted. While “it is not the end of the world if their name does not get said” and there is no ranking, she found the girls become motivated to try hard in the mathematics classroom. She liked how this provides a challenge to encourage the girls. As she moves through the units, there is hope for everyone to get their name called. Sam is more hesitant about his use of competition because of how self-conscious students are at this age (11-12). In his classes “there is little competition”. Michelle did not speak to competition in her mathematics classrooms, and like Sam, she utilized other methods. Regarding competition, research from Burguillo (2010) says “friendly competition” provides “strong motivation for students” in the classroom generally, however this is the case for both boys and girls. The literature is not clear on how helpful it would be for girls in the mathematics classroom.

4.5.3 Role modelling

Role modeling was strongly encouraged by Sandy. Sandy noted:

If they never see a woman doing mathematics confidently, then it’s hard to imagine that they could do themselves…If they’re not seeing anyone at home that is strong, and they are not seeing it at school, it’s hard for them to think that, that is something that is normal.
She herself got into teaching for the girls and carries this strong belief with her. This is supported by Anderson and Gilbride’s (2007) research findings that a woman role model provided the greatest influence of a girl’s career choice regarding engineering (p. 114). Sandy’s strategies include showing “examples of women in the field that are using mathematics or showing yourself as enjoying mathematics.” In Michelle’s school, the best mathematics teachers are women and are “strong role models” for girls. She felt this supports how students can see themselves in her class. Research by Kerr et al. (2004) supports the use of role models to support the “strong identification with a particular profession or area of study” in girls (p. 87). Halpern et al. (2007) also agrees with the importance of role modeling for encouragement. If a girl can see herself in a role in math, she is more likely to “pursue it” (Kerr et al., 2005, p. 87). Sam did not consider role modelling to be a key strategy for supporting students in the classroom, for boys or girls.

Sandy’s concerns about teacher modeling are summed up in this passage: “they say some people aren’t good at mathematics and well yes I suppose that’s true but I think the students have to draw that conclusion themselves. They don’t really need the role modeling like that.” She sees it is up to the teachers to provide all the support they can so the students are deciding for themselves.

4.5.4 School-wide initiatives

Though all three of the teachers agreed school wide initiatives could be beneficial for supporting girls in math, Michelle and Sam found there were not many initiative at their schools for girls. Michelle started a mathematics club during a year when she found
a lot of girls needed the support, which was beneficial to their learning, but she did not continue it the following year. Her school also had tutoring clubs in grades three to six which she found are successful because of the social piece. Sam could not speak to anything specific at his school, other than the University of Waterloo mathematics contests. These contests were run at each of the three teachers’ schools. Sam found “maybe 55% more [boys] out of the 39 kids that wrote it.” However, because these contests are “totally voluntary” it does not provide an accurate sample of the school demographics and likely the confident girls are the ones writing these contests. Michelle acknowledges the girls writing the contests at her school are strong students only.

Sandy spoke about her school’s robotics team. At her all-girls school, all activities are girls only. She said robotics was great because students were “relying on the math” they learned to complete the robotics activities. This club gives another dimension to the math, making it more applicable. Sam and Michelle did not have a robotics team at their schools and could not name any board-wide or third party organizations that could support girls in mathematics either. Cooper and Heaverlo (2013) have found that providing students with real world problem solving opportunities (problem based learning) can motivate girls to learn and further girls’ interest in areas like mathematics. Unfortunately, these opportunities are not available across a board and can be specific to the school.

4.5.5 Positive Praise

All three agreed on the use of genuine praise to help students feel confident.
Michelle, found however, that girls especially “need the extra nurturing” and benefit from “sincere encouragement.” She has observed that “boys don’t seem to need the encouragement.” For some boys, she is “able to say ‘you’re wrong’” but would never say it to the girls. Instead would say “‘I understand what you are thinking, but…’” She described the girls as “sensitive” which directly contrasts Sam’s observation that “boys tend to be more sensitive” when it comes to being called out in class. Michelle’s teaching strategy is that, “if you can encourage the girls early on in academics, it will help with their confidence” and the confidence can stay with them. She stresses that the “encouragement needs to be sincere or the kids will know.” Sandy agreed and suggests “building little successes in class”. She felt “the more you can find those little successes and encourage them and praise them” the better they will respond. Sandy, like Michelle however, noted the importance of “using praise fairly.” Sam agreed as well with the importance of “celebrat[ing] successes of the students” but he stresses its value for boys as well as girls. From Sam’s perspective, both boys and girls “appreciate the praise” he uses it “to preserve [any] student's self-confidence self-esteem.” Just like Sandy and Michelle he found that in higher grades “the kids can figure out real[ly] quick[ly] whether you are genuinely complimenting them or you’re just saying it.” To be effective with your confidence building, all three agreed the genuineness needs to be there. Gunderson et al.’s (2012) research contrasts their practices and found teachers typically offer the same amount of feedback to boys and girls, but girls tend to “receive more non-intellectual feedback” –neatness, speaking clearly” and thus “devalues the positive feedback about their intellectual performance” over boys (p. 159). All three teachers stressed the importance of genuine feedback for all. Halperr et al. (2007) agreed, stating
that “positive prescriptive, informational feedback” is important to encourage girls” (p. 15). Heilbronner (2009), also suggested the value of positive feedback. Sandy specifically stressed feedback that can be based on assessment.

4.5.6 Evidence-based assessment

As a follow up to positive praise, evidence-based assessment was suggested by Sandy as a tool for students to see how far they have come to build confidence.

I think it’s important to quantify success for them so we do a lot of things like give them questions before unit ‘what you think you know about this unit?’ like a reflection...So we do it for all the topics and then at the end of the unit...they can see a progression...they can see they actually learned a lot...We don’t show them the pre-test until we give them their final test because then they again can see that growth...If you put it with their final test that they did well on, they can see ‘wow I learned so much’ it just helps build that confidence that ‘I am really learning.’

She suggested pre-unit reflection questionnaires and pre-and post-tests, to allow a student to develop self-awareness and help them to see their growth. Showing that growth, Sandy believed, can help build confidence. As seen in the previous section Michelle agreed, saying it is important to show girls their success to encourage them. She mentioned that certain units are easier to be successful in than others. An example she gave was “data management and probability” which she felt the “students don’t need a lot of skill to do well and you can build them up”. She builds up their confidence by finding anyway to
“compensate” for areas they struggle with. She uses this unit to build the confidence of her students because “the entry point is simpler and it is easier to be successful” in quantifiable ways. Sam did not consider this area as a strategy, though he did agree with the importance of building their success as seen in the previous section which he does through positive praise. Like the previous section, these findings disagreed with the observed feedback given to girls typically according Gunderson et al.’s (2012) research. All three teachers aim to give tangible and beneficial feedback about their mathematics more often than other forms. Halpern et al. (2007) and Heilbronner (2009), agreed and saw informational feedback based on what girls have done beneficial to their self-beliefs in mathematics class.

4.5.7 Single Gender mathematics classroom

Single gender mathematics classrooms were suggested as a possible beneficial compromise by Sandy and Michelle. Cherney and Campbell (2011) saw higher self-esteem and greater intrinsic motivation in their all girls’ mathematics class. Interestingly, Sam strongly opposed the use of a single gender mathematics classroom and cited the “calming influence of having the girls there would be taken away and the competitiveness of the boys would take over.” Sam only suggested “girls-only robotics or a girls-only construction class” for supporting girls’ confidence in mathematics. He felt that mathematics could be a component to a construction or robotics class to support girls but any pure mathematics classes should still be co-educational. Conversely, Michelle wished for separate classes because of the differences in learning needs which she
mentioned in a previous section. She has had very busy and distracting boys which she seated up front. By doing this the girls in her class “don’t get the attention they may need...because the [boys] demand so much attention.” Michelle and Sandy’s beliefs are supported by research from Picho and Stephens (2012). Picho and Stephen (2012) found single gender classrooms will be less threatening intellectually and girls in these classrooms will not be exposed to as much gender stereotyping. As well, when it comes to learning styles, as mentioned in section 4.4.4, learning preferences and overall peer influenced behavior makes it challenging to cater to both. Despite noting the difference in needs, Sam still said he would not split up the genders for the class. In Cherney and Campbell's (2011) research, boys’ achievement and intrinsic motivation in the co-educational mathematics classroom was higher than in a single gender setting. Comparing this to Sam’s observations, the girls may support the mathematics environment and motivate the boys to do well.

4.6 Conclusion

The findings reviewed in this section looked at the individual experiences of three middle school mathematics teachers. First, the research looked at the factors affecting girls’ behaviour in the class from teachers’ observations. The early and ongoing influences beyond the classroom were discussed, in which all three teachers found cultural background and parental beliefs to be key factors in how a girl would feel about mathematics. For the school and classroom environment, all three agreed it needed to be supportive and encouraging to keep students confident, which Sam stressed as important
for boys as well as girls. According to two of the participants, (Sam and Michelle) the gender of the teacher did not prove to be very influential to a girl’s view of mathematics class, but the divergence in in the overall opinion—as seen throughout the paper—between Sam and the women teachers suggests otherwise. Sandy strongly believed in women mathematics teachers. Peer dynamics included both how students behaved during group work and during larger class discussions. All three agreed that boys would typically take leadership roles in group work, though in high ability groupings, Michelle found it mattered less. In terms of mathematical ability on average, all three agreed was comparable between girls and boys, but self-confidence and engagement was found to have been less unanimous. Sandy and Michelle found lower self-confidence, engagement, interest and participation in class. Sam disagreed with Sandy and Michelle, and said boys asked for less help, are more sensitive than girls, and that girls’ confidence is mathematics not obviously lower than boys. All three agreed on the varying learning styles and needs between the two genders, which required varying teaching methods.

Strategies suggested included: longer wait times, gentle competition, positive praise, evidence based assessment, role modeling and all-girls mathematics classes. School initiatives which all three agreed were useful were not implemented by any of the three schools. Wait times were suggested for girls by Sandy and Michelle, but were suggested for boys by Sam. Gentle competition is believed a good motivator by Sandy but not Sam. Positive praise, if genuine was deemed effective by all three. Evidence based assessment as a follow-up to praise was suggested by Sandy and acknowledges the importance of evidence when giving feedback to students. Role modeling, was highly
stressed by Sandy to show girls possibilities for their futures. For all-girls mathematics classes, despite seen as highly effective by Sandy and Michelle, Sam disagreed with it as a strategy. The two women teachers seemed to relatively be on the same page, while Sam seemed to oppose a lot of the suggested strategies and contributing factors to girls’ lower confidence. In the following chapter, chapter 5, the implications of these findings will be discussed.
Chapter 5: Implications

5.0 Introduction

In this chapter, the final conclusions of the study are examined. First, the key findings are summarized and any co-relation to research is discussed regarding factors of influence and possible strategies. Next the implications of these findings are explored. Narrow implications from the research findings are discussed and the impact they have on teachers. Then broad implications are considered, specifically, in terms of impact on educational research and how this study has impacted me as a researcher and teacher. Recommendations are suggested for teachers, pre-service teachers, school boards and administrators—all educators working with girls. Future research suggestions are made based on the questions which arose from the findings. Finally, the research and significance are summarized within the concluding remarks.

5.1 Key Findings

The findings of this study indicate the systemic and complex issues that apply to girls in mathematics. The interviewees offered a variety of contributing factors and strategies which were supported by the literature. Unfortunately, the size of the study limits the perspectives included in this study, and consequently, teacher perception regarding these issues is painted in a certain light. The women (Michelle and Sandy) and the only man (Sam) had a lot of opposing views and the three teachers do not represent a full sample of the teaching community. Teacher gender, was not considered by the
teachers as especially influential for mathematics confidence in girls and the literature agreed (Carrington et al., 2008). However, it was only the women teachers who considered the confidence of girls as an issue observed in the class. Several of the strategies involving girls’ behaviour in the mathematics class were opposed only by Sam in this study.

When it came to a girls’ confidence in math, findings indicated this includes input by family, culture and parents. All three participants agreed that both the parents and the family ethnic culture were a big influence on a child’s view of mathematics and their confidence in the classroom. Parents can influence a girl’s confidence based on their beliefs about their own mathematics ability. Mothers especially, excused low ability or interest of their daughter a consequence of their own limited mathematics ability. Mentorship and role-modeling were suggested in the findings and literature to combat the biases and negativity of parents and families towards mathematics (Anderson & Gilbride, 2007). The role models, help students see themselves in the mathematics job role.

Suggested strategies for supporting girls include positive praise –which is supported by the literature (Halpern et al., 2007). Wait time, evidence based assessment and competition were also provided. While there is literature supporting the use in other academic settings, these strategies have not been considered in depth in the mathematics classroom context or for girls.

The literature suggests peers have great influence, but the teachers interviewed could only surmise the influence of peers on a girl’s confidence and interest, based on
their observations of student behaviour in class and group work. All teachers found the influence of “being judged” as a factor for all students’ actions, for boys and girls. In group environments, two of the teachers (Sam and Sandy) found girls took the submissive role, leadership being deferred to a boy. However, it was also observed by the other teacher (Michelle) that students will listen to the most knowledgeable individual, be them a girl or boy.

Academic ability was also confirmed by all three teachers and supported by the literature as not being different between boys and girls (Hyde et al. 2008). The ability of girls and boys in mathematics is comparable, and this was agreed upon by all three teachers. Low confidence and interest — the focus of this paper— however, has been the focus of more literature pertaining to the girls and mathematics problems (Blue & Gann, 2008; Gunderson et al., 2012; Hall, 2012 etc.). It was the two women who agreed that confidence was a problem and the man who disagreed. Despite their best efforts, the teachers found many girls were just mentally checking out of mathematics class.

Learning styles, according to all three teachers and the literature, vary between boys and girls (Cavanagh, 2005). While there was not a consensus between all three, two have found the boys to be louder, often demand more attention, and take more risks, while the girls need more time to think. The hands-on teaching was suggested as being beneficial to boys only by Sam, but research literature suggests this is a way to engage girls learning as well (Cooper and Heaverlo, 2013).

Finally, all three teachers suggested the benefit of including out of classroom
programming which promotes positive aspects of mathematics. While in a classroom, students think about mathematics as boring and out of classroom programming can bring a sense of realism. Robotics club, for example, combines mathematics with engineering and science, and gives students a chance to apply the concepts they learned. Mathematics clubs were recommended where girls who are higher academically can tutor students who are struggling academically to build the confidence of all students.

5.2 Implications

In this section, the implications of the research findings are reviewed. First the narrow implications and how they relate directly to teaching are considered. Next the broader implications for what it means to educational research and the teaching profession overall are explored.

5.2.1 Narrow: My Own Teaching Practice

It was strongly stressed in the findings that family culture and parental beliefs are strongly influential to how a girl will view and feel about mathematics. This means that if parents feel unconfident in math, or do not see it as an important subject for their daughter, as a teacher, it will be difficult to sway her. As a teacher, enjoying a subject and teaching it well are not the only factors needed to influence the academic path of girls. Parents could be engaged to better support student’s interests in mathematics.

In terms of other support, school-wide initiatives are an important way for girls to understand that mathematics is interesting and applicable to their lives. Despite a
consensus by the interviewees that these support programs are valuable, they themselves
could not recall an ongoing support programing in their school board. The participants
noted the start-up and continuation from year to year depended on teacher availability, a
factor which varied between each of their schools. Consequently, the perception girls had
of mathematics unless pursued outside of the school environment entirely, would be
generally negative, and that is it is too abstract and not relevant to them.

Single gender mathematics classrooms can help to meet the varying learning
styles of girls and boys (Cavanagh, 2005 & Yalcinkaya and Ulu, 2012). All three teachers
noted the different styles of learning for boys and girls, which can limit the ability for
girls and boys to grasp the material. In a single gender mathematics classrooms, all
children can feel more comfortable among their peers when they have fewer gender
dynamics to navigate.

Women role models, such as women in mathematics careers can help to support a
girl’s ability to see herself in a mathematics job. Girls need to see employment
possibilities to gain confidence as well.

5.2.2 Broad: The Education Community

The issue of girls and mathematics has evolved over the years; biology is no long
considered a factor for differences in boys’ and girls’ mathematics achievement. In fact,
mathematics achievement is considered comparable between boys and girls in this study
and most literature (Hall, 2012; Hyde et al., 2008; Lloyd, 2005 etc.). However, literature
and the research findings indicate there is still inequality in classroom group work and class discussion participation with a deficit for girls (Hall, 2012; Ross et al., 2012). This points to a larger complex systemic issue. While the research has shifted away from ability, the research is starting to shift to the social components regarding the girls and mathematics issue. Therefore, it is critical for parents, teachers and administrators to work together in supporting these girls. The recommendations consider strategies for boosting their confidence, but it is not an issue that is easily resolved, given the length of this problem. The issue goes beyond the classroom, and the strategies of the teacher.

As well in these interviews, the teachers had strongly varying views about the issue of girls in mathematics. There was not a simple consensus for any of the questions asked during the interviews. This became a challenge because it is not a large study. Consequently, teacher perception and their own emotional issues, and/or their own background, can influence their perceptions and observations about their students. The teacher’s observations seem to reflect some of their own bias and perspectives. Because students were not interviewed, this study is limited to a teacher lens. The lens and the individual perspective became more obvious when consensus was not reached. At the end of the day, while teachers are on the front lines viewing this issue, they still reflect the complexities of this issue.

5.3 Recommendations

Based on what has been shared, this study recommends that teachers, including me, as a future teacher, should be aware how they conduct themselves in their
mathematics classroom. Attention and focus is required when it comes to calling on students, as equality is important. While two of the teachers found boys typically demand more attention in the mathematics class—wanting to answer and ask questions more often—they tried to be unbiased in their attention and call on students equally. When dividing groups for projects and when choosing volunteers for answering questions, there needs to be awareness. Going down a class list or recording the names of volunteers chosen can help bring awareness to the teacher's actions.

Based on the influence of parents in a student’s life, it is recommended for teachers and administrators to consider how to best engage parents into mathematics education. The findings and literature suggest that parents can have a strong role, and this can be used to an advantage to encourage students. This could be done with mathematics nights, where enjoyable mathematics activities are organized for families to play together in a low-pressure environment and for parents and students to see the joy of mathematics. Extra mathematics games can also be sent home to build interest and confidence in mathematics and for parents to build their own comfort with mathematics.

Another recommendation is for school boards or schools individually is to split up girls and boys for mathematics lessons. This is a more complicated recommendation because of how the school system is set up and it requires a great deal of support from administrators as well as being logistically be difficult to co-ordinate. The teacher in the single gender school remarked on the positive difference she observed compared to her co-educational experiences. Another teacher agreed to the splitting up of boys and girls.
based on how she viewed their different learning styles. Literature on single gender schooling resulted positive results for girls (Cherney and Campbell, 2011). This may be challenging as there is not clear designation of how it can look, and it may be more for a principle to decide for their own school as a possible pilot project.

In terms of supporting all students in the mathematics classroom, role modelling of mathematics careers and positive praise have been suggested by all three teachers. Literature confirms the positive influence of role models (Kerr et al. 2005) and positive praise (Halpern et al., 2007). Doing so can benefit all students to be more confident and interested in mathematics. Teachers should try to bring in guest speakers from mathematics careers to talk and ‘mentor’ the students. This can help them see the possibilities of mathematics jobs for themselves. If students connect with the speaker, mentorship programs can be developed where people guide girls academically. Positive praise given needs to be accurate and meaningful to the student, not a generic ‘good job”. All students can thrive under positive constructive feedback (Halpern et al., 2007; Heilbronner, 2009).

A final recommendation is for the school boards and individual schools. All three teachers spoke of school wide initiatives to encourage girls and all students in mathematics. However, it was evident nothing was consistent. For teachers to be effective students need strong reinforcement outside of the classroom, and this is not feasible when there is no consistent programming for this reinforcement in schools. Consistent programming could include robotics club which combines science and
mathematics and which benefits kids already interested in mathematics. Also, mathematics clubs, for mathematics tutoring or homework completion can be for the students struggling and who need the extra encouragement. If students help one another this can also help them build their confidence.

5.4 Areas for Further Research

Extensive research has already been conducted on the issue of girls and mathematics with regards to factors affecting their low confidence and interest. Given the list of strategies suggested by the teachers, a future researcher might benefit from considering some of the less common suggested strategies for supporting girls. These strategies include specifically how wait time can benefit participation and engagement in the mathematics classroom and how evidence based assessment can encourage confidence and interest within the mathematics classroom. The study of ‘friendly competition’ as a motivation strategy, though used in other areas has not been explored for a mathematics classroom and could provide more evidence to support this suggested strategy.

It would also be interesting to see how parents’ careers and parents’ self-confidence and interest in mathematics influences a girl, particularly in mothers. All three teachers stressed the value and influence parents had on their children. The literature also touches on parental anxiety towards mathematics as influential (Gunderson et al. 2012; Sonnert, 2009). Two of the teachers especially noted how mothers used their own lack of confidence as reason for their daughter’s lack of confidence. Therefore, exploring how
the mathematics attitudes of mothers can bring greater depth to the parent influence research thus far.

Finally, though there is not much research to support that girls’ confidence is higher with women teachers as opposed to male teacher, the opposing views of Sam and the women interviewed regarding this issue introduced an interesting dynamic. An area for further exploration would be to see if the biases of men and women teachers vary and if this can influence their own perceptions of girls’ in mathematics class and in turn influence how they support the development of confidence in their girl students.

5.5 Concluding Remarks

The issue of girls and mathematics is a complicated issue. Given its long history, it is more complex than simple policy or classroom management changes. It is a systemic issue of how education is structured in mathematics and other classes. It is unlikely actions by teachers will be enough to change the issue entirely. However, to move forward the focus should be less on ability given the evidence supporting the lack of achievement gap including this study. Instead confidence and interest—which is one of the factors which can affect a girl continuing mathematics in the future—should be explored deeper. Moving forward the focus is on strategies of support, because the more strategies offered the more likely that there will be one that reaches those girls questioning their interest. While this issue is far reaching, and has existed for a long period, it remains critical as women continue to represent half the workforce today, and will continue to so in the future. If girls are not achieving their potential because of their
lack of confidence, educators need to question what they can do to provide support.
References


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Appendix A - Letter of Consent for Interviews

Dear ________________,

My Name is Alison Szawiola 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 focuses on middle school level girl student poor confidence in mathematics class. I am interested in interviewing teachers who have taught grade 7 mathematics in a single gender or co-educational class for 5+ years. If possible would you be able to direct me to a grade 7 mathematics teacher, in your school who would be willing to share their experiences and provide insights into this topic?

Their participation in this research will involve one 45-60 minute interview (which can be broken up into shorter sessions), which will be transcribed and audio-recorded. 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. They will be assigned a pseudonym to maintain their 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. 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 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,

Alison Szawiola
Email
Course Instructor’s Name: Dr. Rose Fine Meyer
Email

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 Alison Szawiola and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ______________________________________

Name: (printed) ____________________________________________

Date: _____________________________________________
Thank you for agreeing to participate in this research study, and for making time to be interviewed today. This research study aims to learn teacher perspectives and strategies on the topic of middle school girls’ confidence in mathematics class for my Masters Research thesis at Ontario Institute for Studies in Education. This interview will last approximately 45-60 minutes, and I will ask you a series of questions focused on your experiences with middle school girls and their confidence and participation in mathematics class. 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. Please outline your experience teaching middle school level mathematics (grades 7-8).
2. Describe your personal interest in teaching math, was it your teachable or preference?

Teacher Perspectives and Beliefs

1. A lot of current literature suggests that while girl achievement is comparable to boys, boys seem to prefer math, and have greater confidence in mathematics class, what do you think about this?

1. Literature also suggests that family values, social stereotypes (“girls are not as good at mathematics as boys”, “mathematics is un-feminine”) and peer pressure are big factors to a girls’ lack of confidence and participation in mathematics. What do you think about this? In your experience, have you seen other factors?

1. Did you notice an even split between boys and girls in terms of participation in the mathematics class? (Hand raises to answer questions, leadership in group activities, seeking of extra help; if possible please speak to each of these areas individually) as compared to English/Language Arts or any other classes?

1. Did you notice a difference in mathematics achievement/ assessment performance between boys and girls in the mathematics classroom as opposed to the English/
Language Arts class? Or any other classes?

1. Have you noticed a peer dynamic between the boys and girls in your classes? Could this dynamic contribute to academic behaviour or performance in either of the genders? Or do you believe it is unrelated?

1. How do boy and girl students interact with you and other authority figures in the school?

Supports and Challenges

1. What sorts of challenges have you overcome or are still grappling with in terms of peer influence on academics between single gender and co-ed friendships for boys and girls? In the mathematics class? Do you find any challenges exist?

2. Have you had any challenges in the past encouraging girls’ participation in any subject? Math?

3. What supports are in place in your school or board to support girls’ confidence and participation if any? Are there any programs?

Next Steps

1. What advice would you give a new teacher looking to better support girl confidence in the mathematics class?

2. What do you wish you had to support girl participation and confidence in mathematics class?

Thank you for your participation in this research study.