Perceptions of Girls' Math Abilities: "It's a good thing you're so cute"

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Abstract

Social factors, such as gender, can play a significant role on girls' mathematical abilities. We explored the research on issues such as gender (differences and stereotypes), math self-concepts, parental education, and schooling influences including teachers' development and curriculum on girls' experiences learning mathematics. Our considerations were guided by the following questions: How young are girls when some of them decide they cannot do math? Where does this bias start? Who and what are the greatest influences on girls' perceptions of their abilities in mathematics? The research findings on teaching mathematics for girls reveal their anxieties and fears. These responses contribute to a gap between boys and girls with regard to math achievement; gender stereotypes can begin to influence girls' self-concept and mathematics achievement at a young age. To demonstrate the experiences of girls and women who have been exposed to gender biases relating to mathematical perceptions, we interweave research findings with one teacher's stories of teaching mathematics, to show the importance of intersecting social factors. Stories of professional practice can be a powerful pedagogical tool to encourage pre-service teachers to reflect on their past experiences and perceptions of mathematics, and to question and think critically about their future planning and implementation of the mathematics curriculum. Suggested implications and recommendations are related to our explorations of the influences of gender, teacher education, STEM careers, and intersectionality.

Perceptions of Girls' Math Abilities

I was reflecting on my years of teaching the other day and thinking about the special stories that happened over the years. When I was teaching a class for pre-service teachers at the Elementary level, I remember the time that one of my students dropped in to see me during my office hours. The marks had just been released for the end of term classes in the Education Department at one of our local universities. I expected that this young woman might want to discuss her grade. Almost immediately, she burst into tears, causing me concern that a family member or friend was gravely ill. In a few minutes, she

calmed herself and thanked me for giving her an A+. Her response surprised me, so I replied, "I did not 'give' you that mark... You earned it. Why would you think I gave you that mark?" She told me that when she had been a grade 2 student, her teacher said to her, "It's a good thing you're so cute, because you're really dumb in math." [Author 1]

In the story above, it is obvious that one comment made to an impressionable young girl had stuck with her for many years, causing her anxiety and fear relating to math and, worse, compromising her perceptions of her ability to be successful in math. We recognize that teaching is not just about the curriculum. Our students remember how we made them feel more than the fractions we teach. In this paper, we interweave research findings and practical experiences about perceptions of teaching mathematics and specifically highlight girls' experiences. Questions driving this study centered on various effects related to girls' achievement in math: Where does this bias start? How young are girls when some of them decide they cannot do math? Who and what are the greatest influences on girls' perceptions of their abilities in mathematics?

The research literature suggests that studies are needed on how to decrease the math achievement gap between girls and boys, and how to help girls to succeed in, and enjoy doing, mathematics (Guiso, Monte, Sapienza, & Zingales, 2008). For the purposes of this paper, we explore issues from the research in which gender inequality of girls and mathematics (specifically, math self-concepts, gender stereotypes, parental involvement, as well as teacher and curriculum influences) are illustrated in one mathematics teacher's stories of teaching girls.

Gender Differences

When considering the mathematics achievement of girls and their potential for a future in math-related careers, it is necessary to examine these gaps, especially in children during their early years of schooling. Gender gaps in mathematics achievement have been reported for children as young as the early childhood years (Markovits & Forgasz, 2017; Penner & Paret, 2008). High achievement in boys is usually attributed to their ability, while the high achievement of girls is often attributed to their effort (Meelissen & Luyten, 2008).

In search of ways to bridge this gender gap, Guiso et al. (2008) analyzed data from 276,000 children in 40 countries. The large number of subjects and the broad range of social systems represented were key to the validity of the study. Each child took this 2003 Programme for International Student Assessment (PISA) at the same age, and every question was approved by every participating country to eliminate cultural bias. Not only did the boys outperform the

girls, but a gap also existed between the best male and female students. Interestingly, there were only a few countries such as Iceland and Indonesia where the girls outperformed the boys.

The achievement levels in the gender gap in mathematics is unique. The gender gap in reading (in favour of girls) is present when students begin their primary year, but it narrows somewhat during the elementary school years, whereas, the mathematics gap becomes more prominent as students move through the school system (Robinson-Cimplan, Lubienski, Ganley, & Copur-Gencturk, 2014). It therefore appears that something happens with the experiences of boys and girls that contribute to the mathematics gender gap in those early years.

Regardless of which measures of gender equality Guiso et al. (2008) used, they found that improved social conditions for women were related to improved math performance by girls. Not only did girls' average scores improve as equality improved, but the number of girls reaching the highest levels of performance also increased. The findings indicate that improved roles for women in society can address gender inequalities in girls' achievement in math (Guiso et al., 2008). This demonstrates the far-reaching effects of gender attitudes and how minimizing the gender gap has the potential to have broad benefits for improving social benefits for girls.

Math Self-Concepts

Researchers have shown that having a positive self-concept is an important outcome and yields a positive impact on a wide range of scenarios, including academic achievement (Lindberg, Linksdorfer, Ehm, Hasselhorn, & Lonnemann, 2013). Lindberg et al. (2013) state that "the first two years of schooling are critically important in developing [math-related] self-concepts" (p. 2), and stress the need for additional studies on boys' and girls' self-concept in math in the early years of schooling. Their longitudinal study focused on possible gender differences in the formation of math self-concept with 81 elementary school children in the first and second grades in Frankfurt, Germany. In looking at mathematics achievement, they compared scores on mathematics achievement on standardized arithmetic tests with students' responses to questions regarding their perceptions of their math self-concepts. Findings showed that self-concept for all children declined from the first grade to the second grade, and more significantly for girls (Lindberg et al., 2013). The authors suggest that the discrepancy is due to culturally communicated messages girls receive that 'math is for boys.' Even at this early stage, some girls in the second grade might be more self-critical than boys, and their math self-concept declines more than their overall academic development (Lindberg et al., 2013).

Cvencek, Kapur, and Meltzoff (2015) found individual differences implicit in math self-concept indicate positive relations to mathematics achievement; however, gender stereotypes of “boys as ‘liking math more’ may have implications for how girls construct their own liking, interest, and identification with math” (p. 7). It is believed that children with low achievement at the end of their early years of elementary school (grades one and two) may continue to struggle as they move through the school system (Thomas, 2009). Even with intervention, students who struggle in their early years may not catch up with their peers (Thomas, 2009). Self-concept factors into students' perceptions of themselves as capable learners and adds to the number of considerations that contribute to the gender gap in mathematics.

Gender Stereotypes

Have you ever been involved in an animated conversation at a cocktail party when an interested stranger asks, “And what do you do?” The reply is “I teach.” The discussion continues with great eagerness: “Oh, what do you teach?” The answer is quite simply “Math.” Silence follows... (with a great rolling of eyes), followed even further by one of these statements: “Oh no, I hated math in school”; “Yeah, math was always my worst subject”; “Amazing... I didn't think women could do math”; “I can't even balance my cheque book; I don't know how you teach the stuff.” [Author 1]

With the aim of combating traditionally held notions that boys are better than girls in math, researchers have studied gender stereotypes in relation to ability and attitudes towards mathematics (Schwartz & Sinicrope, 2013). Implicit in these messages are discussions of what constitutes gender, gender identification, and how one understands gender as a facet of ability.

In exploring whether activating gender identity has an effect on children's self-perceptions of their mathematics abilities, Martinot and Désert (2007) found seventh-grade boys and girls both exhibited lower self-esteem with regard to math, when gender identity was made salient (i.e., through reference to ‘typical’ activities or interests for boys and girls); however, girls rated their mathematics performance higher when gender identity was activated. Future research in gender identity may have the potential to help reduce the mathematics gender gap for girls.

Cvencek, Meltzoff, and Greenwald (2011) aimed to design new measures to assess children's math gender stereotypes and math self-concepts by adapting adult work from social psychology (p. 768). In examining 247 students in grades one to five from private and public elementary schools, researchers found that both girls and boys strongly associated math with boys (Cvencek et al., 2011, p. 771). This math gender stereotype was evident throughout the implicit and self-report measures (Cvencek et al., 2011). By the time the girls were in the second grade, they already exhibited a weaker identification towards mathematics (Cvencek et al., 2011). They claim that these gender differences in math self-concepts arise from combinations of both societal influence on cultural stereotypes about gender roles and intrapersonal cognitive factors (p. 776). The results from this study show that even young children may be influenced by gender. The influence of stereotypes is strong, as is shown in this anecdote:

I've been volunteering in a math enrichment club in an elementary school. The woman who works in the cafeteria orders the food, prepares the food, and keeps track of the cafeteria budget. She works with mathematics every working day. One day, she called me over to tell me she thought it was a wonderful idea that I was in the school helping some of the students who needed math enrichment. She said, "When I was a little girl, my teacher told me that it was perfectly fine that I cannot do math... I would never need it anyway since I was a girl. [Author 1]

Gender stereotypes may prove difficult to overcome in determining methods for closing the gender gap for girls in mathematics, for as this story informs us, they may have long lasting effects.

Parental Education and Involvement

My dad had the biggest influence on me towards mathematics. He was an engineer and would always ask me about my math in school. He told me when I got older, that I should continue in the field of mathematics, because as a female who was so good in math, I would always have a job. I continued to study mathematics in university. We literally used to talk about the acronym SOHCAHTOA in trigonometry and what it meant! [Author 1]

Parental involvement in their children's education, and even the parent's education level itself, has been a topic of many research studies, in determining the effects on a student's academic achievements and their future pursuit of math-related fields.

Researchers have indicated there is a positive association with children's grades in mathematics when there is parental involvement in their homework. After following the effects of homework help with junior high students from low income families, it was shown that the parents in the study tended to provide structure, and arranged for a set of circumstances conducive to homework completion more frequently than becoming directly involved with the homework process (O'Sullivan, Chen, & Fish, 2014). With help and encouragement from parents, students may come to identify themselves as capable of succeeding in mathematics. There are many children in families in which the parents have limited formal education, yet, they become very successful in mathematics and their careers in general, due to the parents' strong encouragement and support (O'Sullivan, Chen, & Fish, 2014). There was a significant effect for success in mathematics for middle school students, where the parents with higher education held higher aspirations in mathematics for their children (Svoboda, Rozek, Hyde, Harackiewicz, & Destin, 2016).

To date, there does not appear to be evidence there is a gene that links directly to our ability to learn mathematics; however, that does not stop many students struggling in mathematics to believe that genetics prevents them from succeeding. Anderson (2007) notes that, "As a result, they view themselves, and are viewed by others, to be peripheral members of the community of mathematics learners" (p. 11). As a teacher, I have often heard parents say to their child who has a low grade in math, "Don't worry dear; math was not my strong point either" (Author 1).

Furnham, Reeves, and Budhani (2002) found that daughters' math and spatial skills were estimated to be lower than sons' skills by both mothers and fathers. They suggest that young girls learn to undervalue their competence through messages received from their parents and society. Adults are not immune to the weight of stereotypes, unfortunately, visiting them upon their children in some cases. Parents' stereotypes about mathematics gender differences were found to affect performances of young Caucasian girls aged 5-7 years, following the activation of a salient gender identity exercise during testing (Furnham, Reeves, & Budhani, 2002). According to Tomasetto, Romana Alparone, and Cadinu (2011), stereotype threat could be

countered with the creation and maintenance of a family environment specifically designed to resist and invert stereotypes. Parents, and therefore families, also play a role in closing the gender gap.

Schooling Influences

I continue to be amazed at the impact a teacher has on their students. When my four young grandchildren started in two different schools this year, their biggest concern was whether their teacher would be nice and not yell! [Author 1]

Children spend a great deal of the day and all of their early developing years in the school system. Matusov and Hayes (2000) argue that it is an oversimplification and misunderstanding of society to assume Piaget's neglect of the social nature of human development was the only part that mattered for a child's development. Vygotsky believes that people become who they are depending on what they have experienced in their own social contexts (Matusov & Hayes, 2000). The important fact is that the classroom environment, where children spend much of their developing years, is a strong influence on their development.

Pre-service teachers represent a significant population who have the capacity to inform how and why children come to perceive a gender gap in mathematics. The majority of pre-service elementary teacher education programs consist of female students, and research has found that in this group, more than any other discipline, students have the highest level of math anxiety (Beilock, Gunderson, Ramirez, & Levine, 2010). Students who are anxious about math tend to avoid it, and Beilock et al. (2010) claim that these students also perform more poorly when they are exposed to mathematics. Unfortunately, as is the case for elementary school teachers, teaching mathematics is unavoidable, and the consequences of those who are anxious about math could instill this anxiety in their students and affect their students' math achievement. They also suggest that "children are more likely to emulate the behavior and attitudes of same-gender vs. opposite-gender adults" (para 4). In particular, this has consequences for girls.

It is likely that the level of a student teacher's mathematics anxiety could be lowered and begin to address the gender stereotypes in students as early as the first and second grades, according to Beilock et al. (2010). However, Schwartz and Sinicrope (2013) state that teachers' attitudes and anxiety toward mathematics may not present the whole picture, and that teachers'

expectations need to be examined in how students view mathematics. Pre-service teachers need to learn, in addition to the subject principles they will teach, that there is a way to teach that promotes understanding, equality, and optimism for all students. By modelling these approaches, teacher educators can offer pre-service teachers pedagogical approaches that promote an awareness of the gender stereotypes, and the need to give agency to girls in a way that changes girls' experiences in math.

Teachers need to have an overall desire to make mathematics meaningful to the students which, when connected to real-life situations, becomes meaningful and fun. According to Anderson (2007), several mathematics researchers are strongly suggesting that teachers should provide a cooperative learning environment, in which teachers engage their students in learning experiments and group activities that relate to their real life situations. For example, one of the benefits of this pedagogical approach is how students begin to imagine the role of mathematics in their world, in everyday life, and the possibility of mathematics for future careers (Anderson, 2007).

Over the last number of years, we have had many fundamental changes in mathematics education in Canada. The curriculum has been changed to integrate far more Canadian and consistent content into the program, which has allowed families that frequently move across our country to be able to 'pick up where they left off' in their mathematics progress. We have moved to a problem-solving approach where the problems are created in such a manner as to be contextualized to their specific community. Although Canadian provinces are in charge of their specific education systems, the National Council of Teachers of Mathematics (NCTM) was a major influence in the 1990s in curriculum design and in helping the provinces construct a national curriculum, at least until the secondary grades (O'Shea, 2003). Therefore, other areas to consider, in order to address the gender gap in mathematics, are the structures and underlying beliefs that form the foundations of both provincial and international curricula.

The focus is on curriculum that is not only standardized, but also designed for all learners to achieve. For example, the use of concrete manipulatives is a way for teachers to empower all children in their learning, and to help them develop a sense of self that could counteract the mathematics gender gap, yet this does not always happen in schools.

During the first year I was teaching in one of our community schools, I was shown a 'math room,' which held all of the school's manipulatives. I was thrilled to see this until I realized that almost all of the bags were unopened. If our future teacher candidates who will be entering our schools can be shown how to integrate math manipulatives into their lessons, then that will allow the children to actively move through the stages of acquiring mathematical concepts. It builds on the essential order in mathematics. The actual manipulatives are gender neutral, which is an effective step in helping with our gender equality issues. [Author 1]

There is the need for further research on the relationship between the content of curriculum, how it is delivered and the influences of gender stereotypes (Nowicki & Lopata, 2017).

Classroom Instruction: Bridging Theory and Practice

I have been at two different schools now for six years. The teachers choose the students. They give me the grade four, five and six students who would benefit from an enrichment program, and they let them come out of class. So, that's really good. And I take in a lot of things to do with food because for some reason, they love that. I'll tell you one thing. If you take just a regular computer piece of paper, scotch tape it and then take another piece of paper the same size, roll it the other way and scotch tape it, [it] is sort of tall and thin. Now, the other one, we call it the short, wide one. We fill it with popcorn, and that's one of their popcorn experiments, and then I ask, "Which one do you think is bigger, or are they the same size?" We vote on it. "I've even had the principal and the vice-principal in to vote, and what's really interesting—most people think it's the same piece of paper, so it should hold the same amount of popcorn, but the volume is different. Now some of the children, they're just starting volume, so they have an idea of what volume is, but the difference is, the one that holds more, is the short, wide one. It actually holds more because the radius is bigger than in the tall, thin one. The radius is squared in the formula, and they're just learning about that, so we have a lovely discussion about the volume and then what a radius is, and the exponential function. So, we're doing that, and then they get to eat the popcorn later on. And one other really cute thing, when we did the popcorn experiment—I've had this happen twice in both the schools, one of the children had said,

“Do you have any butter Mrs. Teacher?” I went, “No, this is not the movie theatre.” They come out with the cutest things.

I bring them activities from my grade 11 and grade 12 classes, and this is actually topology, that's a university course. One little boy came to me in the second class and said, “Mrs. Teacher could you please write a note that the lily pad problem was really grade 11, because my parents don't believe that I can do a grade 11 problem.” He was grade five; they're very proud of themselves when they do this.

Approximately 20% to 40% of the students who are sent to me are female. These children are 8 – 12 years old. The girls that I have in the club are every bit as strong as the boys in their enthusiasm and their achievement. I wonder... Why are there so few girls? Are the boys viewed as more demanding at this age? Does society suggest that our girls be more demure and quiet than boys, and therefore they are not noticed as much as their male counterparts? [Author 1]

The setting and delivery of where mathematics instruction takes place is no less responsible for perceptions about gender differences. In a study conducted by Kenny-Benson, Pomerantz, Ryan, and Patrick (2006) that examined how teachers rate mathematical proficiency in boys and girls, it was found that their achievement was linked to their behaviour. Girls tend to exhibit ‘good girl’ conduct, demonstrating fewer issues of disruptive and off-task behaviour than their male counterparts. Teachers actually perceive girls as working harder than similarly achieving boys in order to rate them equally. Teachers were found to have a tendency to continually underrate girls in their math proficiency (Kenny-Benson et al., 2006). Researchers also imply that girls may stay ‘under the radar’ during mathematics classes out of fear of being embarrassed or judged by teachers and peers (Beilock et al., 2010; Tichenor, Welsh, Corcoran, Piechura, & Heins, 2016).

Lim (2012) noted that the traditional and procedural mode of mathematics instruction has been widely criticized for the lack of relevance to the life experience and societal norms in which our students exist. Lim's study tracked three girls in an advanced grade six class taught by an award winning and hard-working teacher. This was part of a larger ethnographic study across the United States. These participants were of different races and different socioeconomic classes representing the diverse population of the different areas. The study was primarily based on in-

depth interviews, as well as the collection of data on participant observation, teacher interviews, and school records and documents. The findings demonstrated that the three participating girls' experiences with, and achievements in, school mathematics were grounded in the cultural characteristics of their mathematics classroom, which tended to emphasize authoritative, procedural, individual, and competitive work.

Teachers have a substantial impact on how students recognize their own abilities and those of others, and they have the possibility of promoting an awareness of systemic inequities, such as the gender gap for girls in mathematics. The story below demonstrates the wonderful outcomes when such goals are achieved:

[Author 2]: Now, just before we end, I know that teachers always have special stories.

[Yes.] They always carry something with them about a student that touched their heart.

I'm just wondering, what's a special moment for you, [Author 1]?

[Author 1]: Oh, I have lots. [I'm sure.] One of my calculus classes; I've brought a picture with me... One morning when I had to attend a dental appointment, my high school calculus students went out into the parking lot and took a picture of the class; they framed it and gave it to me. I still meet those kids every Christmas, and we have breakfast together once a year. They're just a wonderful bunch of young people, both females and males, who have a strong self-concept about their abilities in mathematics. They are all happy in what they do, many in math-related careers. One girl has taught mathematics at an Ivy League university in the United States; another is teaching at a Canadian university. There's a medical technician and a geologist, too. These young people are in very different fields, many of them math-related. They're just fantastic. So, that's just one of my wonderful classes that I had the privilege of teaching.

Implications and Recommendations

Current educational research literature from so many different perspectives—students, teachers, and teacher educators—indicate that there exists a mathematics achievement gap for girls in elementary school. A major concern of this research is how to address the gap. Halpern, Benbow, Geary, Gur, Hyde, and Gernsbacher (2007) found that a range of factors – among them experiences in early youth, evolutionary biology, and sociocultural environments – all play a role

in math and science gender differences between males and females; they refute the possibility that a sole theory can explain these differences.

Gender

Plante, Theoret, and Eizner Favreau (2009), in noting girls' beliefs that math is a female domain, suggest that this reversal in gender stereotype is attributed to measures taken in promoting girls' achievement in mathematics over the past decades and in the removal of biased messages from pedagogical material (p. 399). We can support students when they are made aware of these challenges and given the opportunities to understand systems that show the fallacy of these beliefs. One study showed that nearly 580 girls aged 13-18 and from varying ethnic backgrounds were more strongly motivated to pursue careers in math and science had they previously learned about feminism or gender discrimination in the sciences (Leaper, Farkas, & Spears Brown, 2012). In the future, it is important to continue to explore the various experiences girls and young women have with mathematics. In our society, which attempts to promote diversity, we should be cognizant of what factors affect our girls with mathematics and its related fields.

Teacher Education

Tichenor et al. (2016) implied that professional development opportunities for teachers are important to translate research on gender differences into pedagogical approaches that implement gender-sensitive teaching practices. Malinsky, Ross, Pannels, and McJunkin (2006) found that females exhibit math anxiety to a greater degree in secondary school and in college, therefore "it is incumbent upon ... teacher educators to find ways to lessen the math anxiety of ... students" (p. 279). Carmichael (2013) suggests that research needs to focus on teacher biases and how they rate girls' abilities in comparison to boys, especially in the early years.

STEM Careers

"The gender stereotype that promotes 'math is for boys' is one of the complex factors contributing to the underrepresentation of girls in science, technology, engineering, and mathematics (STEM), influencing their educational interests and choices" (Cvencek et al., 2015, p. 1). While technology additions to curriculum can affect greater uptake of STEM careers, Jarvis and Rennie (1998) claimed that "to be beneficial, curriculum change needs to be based on adequate in-service training of teachers" (p. 277). Here is the lived experience of a teacher

working to counteract the belief that young girls are less equipped to succeed in mathematics and so forego STEM careers:

Last year I had the honor of being a guest speaker for a two-hour Brownie meeting with approximately 20 girls who are part of the Canadian Girl Guides movement. There is a relatively new badge, the STEM badge, for which the young girls are encouraged to complete the requirements. I was thrilled to learn of this addition to the program. I prepared the materials for the one-hour workshop for the Mathematics portion of the badge. The girls would break into four groups with different stations in which they would participate. Each leader was in charge of a station so I demonstrated how to use the math materials. Before starting the workshop, one of the leaders of the group introduced me and proceeded to ask these seven- and eight-year old girls, "How many of you like math?" Every single one of them yelled, "Boo!"

The girls started on the stations and fully participated with all the mathematical manipulatives for the entire hour, where each leader was in charge of one of the stations. They returned to the original circle very excited and were asked a second time, "Now, how many of you like math?" There was a loud, resounding, "Yay, Yay, Yay!" The group then went on to complete their badge work at the [science centre].

I left the meeting questioning what had just happened? Why had the girls not shown any interest in math, at the beginning of the meeting? Why had the attitude of the group changed at the end of the meeting? Did the use of the manipulatives, working in a group setting, the attention of the leaders or simply having fun lead to a different answer at the end of the meeting? [Author 1]

Intersectionality

The confounding factors of gender, race, and socioeconomic status are involved in a better understanding of the gender gap, and how measures can be taken to address it. Rieggle-Crumb, Moore and Ramos-Wada (2010), in a finding for their study examining science career aspirations of White, Black and Hispanic eighth-grade American females and males, reported that "achievement may be an instrumental part of the story, as once differences are held constant, Black females are as likely as White males to aspire toward a science career" (p. 472).

Lim (2012) also found that the backgrounds of students, their ethnicities, and the peer groups to which they belonged had a significant and various effect on girls' experiences with school mathematics. Nowicki and Lopata (2017) believe that other influences, such as culture, family beliefs, peer group values, and media portrayals of gender-related abilities may need to be considered, in addition to school experiences, in order to improve stereotypes affecting children's abilities and perceptions in math.

Cvencek et al. (2015) recommended that longitudinal studies examine developmental influence and design interventions for exploring causal relationships. Other researchers suggest that:

Future research will profit from targeted large-scale studies that focus on a representative subsample of students from multiple cultures and grade levels, and administer implicit and explicit measures of math-gender stereotypes and math self-concepts to these same students, allowing large samples to examine the development of, and the interrelation between, stereotypes, math self-concepts, and achievement across many cultures.

(Cvencek et al., 2015, p. 8)

A combination of these factors, math self-concepts, gender stereotypes, parental influence, and classroom instruction, broadens our understanding about the gender gap for girls in mathematics. We can continue working together to ensure these factors contribute to enhancing student engagement and achievement in mathematics. As these stories and others remind us:

Teaching is an amazing profession, one in which I am proud to have entered. As teachers, we never know what impact we might have on our students. For some young people, we may be the only kind face they see all day who believes in them. To think that that young woman who spent so many years thinking she was dumb in math, cried when she received her final mark of A+, is heartbreaking. We can all do so much more in our schools to help inspire these young minds and break the mould where many of our girls think they cannot do mathematics as well as our boys. [Author 1]

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References

- Anderson, R. (2007). Being a mathematics learner: Four faces of identity. *The Mathematics Educator*, 17(1), 7-14.
- Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences of the United States of America*, 107(5), 1860-1863. Retrieved from <https://www.pnas.org/content/107/5/1860>
- Cameron, B. (1986). Parents – On math anxiety. *The Bedford Viewpoint*, 1(4), 16.
- Carmichael, C. (2013). Gender differences in children's mathematics achievement: Perspectives from the longitudinal study of Australian children. *Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia*. https://www.merga.net.au/Public/Public/Publications/Annual_Conference_Proceedings/2013_MERGA_CP.aspx
- Cvencek, D., Kapur, M., & Meltzoff, A. N. (2015). Math achievement, stereotypes, and math self-concepts among elementary-school students in Singapore. *Learning and Instruction*, 39, 1-10. [doi:10.1016/j.learninstruc.2015.04.002](https://doi.org/10.1016/j.learninstruc.2015.04.002)
- Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children. *Child Development*, 82(3), 766-779. [doi:10.1111/j.1467-8624.2010.01529.x](https://doi.org/10.1111/j.1467-8624.2010.01529.x)
- Furnham, A., Reeves, E., & Budhani, S. (2002). Parents think their sons are brighter than their daughters: Sex differences in parental self-estimations and estimations of their children's multiple intelligences. *The Journal of Genetic Psychology*, 163(1), 24-39.
- Guiso, L., Monte, F., Sapienza, P., & Zingales, L. (2008). Women and math, the gender gap bridged – Social equality frees women to match men. Retrieved from <https://insight.kellogg.northwestern.edu/article/women-and-math-the-gender-gap-bridged>
- Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. C., & Gernsbacher, M. N.

- (2007). The science of sex differences in science and mathematics. *Association for Psychological Science*, 8(1), 1-51.
- Jarvis, T., & Rennie, L. J. (1998). Factors that influence children's developing perceptions of technology. *International Journal of Technology and Design Education*, 8, 261-279.
- Kenney-Benson, G. A., Pomerantz, E. M., Ryan, A. M., & Patrick, H. (2006). Sex differences in math performance: The role of children's approach to schoolwork. *Developmental Psychology*, 42(1), 11-26.
- Leaper, C., Farkas, T., & Spears Brown, C. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English. *Journal of Youth and Adolescence*, 41, 268-282.
- Lim, J. H. (2012). Adolescent girls' construction of moral discourses and appropriation of primary identity in a mathematics classroom. In H. Forgasz & F. Rivera (Eds.), *Towards equity in mathematics education: Gender, culture, and diversity* (pp. 63-83). New York, NY: Springer. (Reprinted from *ZDM: International Journal on Mathematics Education*, 2008, 40(4), pp. 617-631).
- Lindberg, S., Linkersdorfer, J., Ehm, J. H., Hasselhorn, M., & Lonnemann, J. (2013). Gender differences in children's math self-concept in the first years of elementary school. *Journal of Education and Learning*, 2(3), 1-8.
- Malinsky, M., Ross, A., Pannells, T., & McJunkin, M. (2006). Math anxiety in pre-service elementary school teachers. *Education*, 127(2), 274-279.
- Markovits, Z., & Forgasz, H. (2017). "Mathematics is like a lion": Elementary students' beliefs about mathematics. *Educational Studies in Mathematics*, 96(1), 49-64.
- Martinot, D., & Désert, M. (2007). Awareness of a gender stereotype, personal beliefs and self-perceptions regarding math ability: When boys do not surpass girls. *Social Psychology of Education*, 10, 455-471.
- Matusov, E., & Hayes, R. (2000). Sociocultural critique of Piaget and Vygotsky. *New Ideas in Psychology*, 18, 215-239.
- Meelisen, M., & Luyten, H. (2008). The Dutch gender gap in mathematics: Small for achievement substantial for beliefs and attitudes. *Studies in Educational Evaluation*, 34(2), 82-93.
- Nowicki, E. A., & Lopata, J. (2017). Children's implicit and explicit gender stereotypes about mathematics and reading ability. *Social Psychology of Education*, 20, 329-345.
[doi:10.1007/s11218-015-9313-y](https://doi.org/10.1007/s11218-015-9313-y)
- O'Shea, T. (2003). The Canadian mathematics curriculum from the new math to the NCTM standards. In G. M. A. Stanic & J. Kilpatrick (Eds.), *A history of school mathematics* (pp. 843-890). New York, NY: National Council of Teachers of Mathematics.
- O'Sullivan, R. H., Chen, Y.-C., & Fish, M. C. (2014). Parental mathematics homework involvement of low-income families with middle school students. *School Community Journal*, 24(2), 165-188.
- Penner, A. M., & Paret, M. (2008). Gender differences in mathematics achievement: Exploring the early grades and the extremes. *Social Science Research*, 37, 239-253.
[doi:10.1016/j.ssresearch.2007.06.012](https://doi.org/10.1016/j.ssresearch.2007.06.012)
- Plante, I., Theoret, M., & Eizner Favreau, O. (2009). Student gender stereotypes: Contrasting the perceived maleness and femaleness of mathematics and language. *Educational Psychology*, 29(4), 385-405. [doi:10.1080/01443410902971500](https://doi.org/10.1080/01443410902971500)
- Riegle-Crumb, C., Moore, C., & Ramos-Wada, A. (2010). Who wants to have a career in science

- or math? Exploring adolescents' future aspirations by gender and race/ethnicity. *Science Education*, 95, 458-476.
- Robinson-Cimplan, J. P., Lubienski, S. T., Ganley, C., & Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematical proficiency may exacerbate early gender gaps in achievement. *Developmental Psychology*, 50(4), 1262-1281.
- Schwartz, C. S., & Sinicrope, R. (2013, December). Prospective elementary teachers' perceptions of gender differences in children's attitudes toward mathematics. *School Science and Mathematics*, 113(8), 410-416.
- Svoboda, R. C., Rozek, C. S., Hyde, J. S., Harackiewicz, J. M., & Destin, M. (2016). Understanding the relationship between parental education and STEM course taking through identity-based and expectancy-value theories of motivation. *AERA Open*, 2(3), 1-13.
- Thomas, E. M. (2009). *Canadian nine-year-olds at school*. Children and Youth Research Paper Series. Catalogue no. 89-599-M 006. Retrieved from <https://www150.statcan.gc.ca/n1/pub/89-599-m/89-599-m2009006-eng.htm>
- Tichenor, M., Welsh, A., Corcoran, C., Piechura, K., & Heins, E. (2016). Elementary girls' attitudes toward mathematics in mixed-gender and single-gender classrooms. *Education*, 137(1), 93-100.
- Tomasetto, C., Romana Alparone, F., & Cadinu, M. (2011). Girls' math performance under stereotype threat: The moderating role of mothers' gender stereotypes. *American Psychological Association*, 47(4), 943-949.