Mathematical Mindsets – Improving Student Attitudes Toward Math
South Hull Elementary School

Report Completed By: Courtney O'Halloran
Email: cohalloran@wqsb.qc.ca

Mathematics is a word that is often associated with either love or hate. For generations, students have come to either love or hate mathematics as a result of their perceived ability to complete mathematical tasks. Often, this love/hate association with mathematics is passed down from generation to generation as parents and grandparents say things like "I was never good at math," "I don't expect my child to do well in math because I never did well," or "I hate math." Similarly, success in mathematics has often been gender specific – with the boys outscoring the girls. This PDIG, comprised of five teachers, was developed to investigate and improve student mindsets in mathematics, and to create innovative, hands-on activities for teachers of Grade 5 and 6 to use in their classrooms to improve both teaching and learning.

The main goal of this project was to improve student attitudes toward mathematics through the development and implementation of creative and innovative math activities which seek to challenge student thinking and encourage collaboration amongst peers. Through the teacher development of such activities, it is believed that students will be more engaged in the learning process. With less emphasis placed on pencil and paper tasks and more toward student to student dialogue as they work together to solve problems, students will feel more empowered and will take more responsibility for their learning. By implementing student centred activities, students will have access to hands-on materials and manipulatives and will be encouraged to express their thinking in multiple ways. By engaging students in these activities, it is believed that students will become more resilient and persevere through challenges, while also improving their conceptual understanding of the math concepts presented at the Grade 5 and 6 level at South Hull School.

Mathematical Mindsets

According to Jo Boaler (2016), a guru in mathematical mindsets, "Mathematics, more than any other subject, has the power to crush students; spirits, and many adults do not move on from mathematics experiences in school if they are negative. When students get the idea that they cannot do math, they often maintain a negative relationship with mathematics throughout the rest of their lives" (p. x). Changing the negative messages students receive from all sources in society but particularly in the classroom to messages of growth will help students move from a negative fixed mindset to one of positive growth mindset. If a student is to persevere through challenging problems it is imperative that a positive mindset of "I can do it" is embedded in the

belief statement he/she has about his/her abilities. Similarly, students are more likely to engage in mathematics and persevere through challenges when "curiosity, connection making, challenge, creativity and collaboration" are at play (Boaler, 2016, p. 16).

Many children and adults alike who reflect on math during their educational career have negative memories and associations. For some, the negative associations with math result from an experience with a particular teacher, while for others the associations result from a perceived inability to do math. A learner's perceived innate inability to do math often results in a lack of effort to improve their mathematical abilities and therefore, results in increased math anxiety (Making Math Meaningful). As a pedagogical leader, it is important to consider that there are teachers for whom mathematics was challenging in school and whom themselves may also experience feelings of anxiety as a result of their own weaknesses or perceived weaknesses and experiences/or in mathematics.

According to Marian Small (2008), "People who feel math anxious are unable to prevent their stress and worry about doing math from interfering with their ability to perform. Their worry about math so occupies their thoughts, it is hard for them to actually think about the math" (p. 828). Math anxiety is a global phenomenon defined as: "feelings of fear, tension, and apprehension that many people experience when engaging with mathematics" (Maloney, Fugelsang & Ansari, 2017). This has significant repercussions for students and teachers alike for whom math is a trigger for anxiety. For students, their worry could result in a decrease in academic achievement which in turn can impact their confidence and well-being. If students with math anxiety are taught to shift their view of math from one of a threat to one of a challenge, they are more likely to engage and persevere in the task, leading to increased academic achievement and increased well-being for learners (Maloney, Fugelsang & Ansari, 2017). When students shift their thinking from that of a fixed mindset, to that of a growth mindset, they believe in their ability to grow and change as a learner, thus improving their levels of achievement (Boaler, 2013, p. 150).

Similar to the experiences some students have in classrooms today, some of our teachers, during their educational journey, have also been told "*they* cannot do mathematics or that mathematics is not for them" (Boaler, 2015, p. 8). Comments like these further perpetuate the fear of mathematics. This worry or fear of mathematics could result in surface teaching and learning, avoidance of challenging concepts and/or perpetuating a dislike for math to future

generations. Maloney, Fugelsang and Ansari (2017) suggest that, "when teachers are high in math anxiety this can translate into their students learning less math across the school year and being more likely to endorse negative stereotypes about mathematics." While it is important for teachers to reflect on their own experiences and attitudes toward mathematics, it is equally important to consider gender biases in mathematics and to be aware of how the negative consequences that these biases can have on learners in the classroom. According to Boaler (2016), "…the extent of negative emotions elementary teachers held about mathematics predicted the achievement of girls in their classes, but not boys," further perpetuating a gender achievement gap in math (p. 9). Girls in elementary school identify with their female teachers more so than their male teachers and notice their teachers' negative messages about mathematics; however subtle they may be (Boaler, 2015). Consequently, it is important that educators be cognizant that, "Teachers hold students' mathematical futures in their hands, and they should never underestimate the power of your words and actions to inspire or defeat students" (Boaler, 2015, p. 193).

Use of Manipulatives

The use of manipulatives, as hands-on tools for learning, has been recommended as a strategy to improve teaching and learning. The use of manipulatives as "concrete representations of mathematical ideas" has been studied since the 1960s and determined that they are "essential to develop mathematical understanding" (Small, 2008, p. 4). According to Marian Small, using manipulatives in the classroom can be a strategy used by teachers to reduce teacher anxiety toward math because it helps them deepen their conceptual understanding of the mathematical concepts before and as, they teach their students. Similarly, "The use of manipulatives helps ensure that the math makes sense and also provides a starting point for students who may not be sure how to begin. Students who may be less certain of themselves with written work or even oral work feel more comfortable if they can explain themselves using concrete materials" (Small, 2008, p. 629). Therefore, using manipulatives as a teaching and learning tool, allows students a level of autonomy that they otherwise would not have resulting in less reliance on the teacher for learning to occur (Small, 2008). Using manipulatives helps students make sense of mathematics in a non-threatening and enjoyable manner. Manipulatives provide students with concrete tools to engage them in their thinking about abstract concepts.

Paul Halmos, a famous mathematician, once said: “The only way to learn mathematics is to do mathematics.” Accordingly, students must be provided with rich and meaningful learning opportunities that help them to make sense of math. Teachers themselves are the “key to many students’ ability to learn mathematics” (Small, 2008, p. 2). Therefore, it is important that teachers themselves contextually understand mathematical concepts and have the necessary skills and strategies to support the learning of their students as they guide them through meaningful activities and tasks which help students make meaning of new concepts. “Research supports the importance of teachers’ development of pedagogical knowledge, built upon a deep understanding of how students think and develop mathematically” (p. 2). When teachers understand that students learn best with concrete materials which represent abstract ideas, they can adapt their teaching to accommodate the learning needs of their students.

Day-by-Day Progress

Day 1

Teacher were surveyed on their attitude toward math and the use of manipulatives, pencil paper tasks. We reviewed Growth Mindset as described in Jo Boaler's book Mathematical Mindsets. We co-created a 10-question survey to be used to gage student attitudes and perceptions in math. The survey was created and copied for each teacher to carry out in their classrooms before the next meeting. We discussed the importance of using hands-on manipulatives and activities in Cycle 3 math classes and created a list of topics that are particularly challenging for students (as identified by teachers). Once this list was developed, we discussed potential manipulatives that could be used to support student learning and then started to co-create activities to address areas of concern. As a group we developed a lesson for all teachers to take back to their classroom and carry out. Teachers will return on the next meeting date with the completed student surveys and reflective notes from the lesson that they are going to implement in their classrooms.

Day 2

We worked together to create new activities for Grade 5 and 6 students. Teachers developed lessons on square numbers, creative problem solving, area and perimeter using colour tiles. Once the lessons were created, teachers shared lessons with one another and tweaked the lesson using feedback from one another. Teachers sorted colour tiles into bags for each student

so that the lessons are ready to go. A lesson with an enrichment activity was also created for fractions using pattern blocks. Materials were prepared in preparation for carrying out the lesson on October 31. Teachers have set up a time to work together in a classroom to co-teach and make observational notes on the activities. The next meeting will be held on November 13.

Day 3

We met and discussed the lessons teachers co-taught. Lessons were tweaked as a result of the feedback and observation notes made during the lessons. Teachers continued to work together to create more activities using manipulatives and hands-on acitivties. The teachers will co-teach more of the lessons created today and will bring feedback on the lessons and activities back to our next meeting. Activities created today include: lessons on mean (average) using basketball statistics, geoboard fraction activity as an urban planner, place value flexibility and an equivalent fraction activity using the text If the World Were a Village. Our next and final meeting will be on November 29th.

Day 4

We reviewed post-student survey results and discussed the positive impact these lessons have had on student engagement and mathematical understanding. As a group, we reviewed some of the lessons that were carried out since the last meeting and made adjustments as necessary to the lessons and activities to ensure directives are clear and concise. Teachers worked in pairs to complete activities that were started from the last meeting and to continue making activities as discussed from our previous meeting. Teachers completed a post-survey as well which indicated that since beginning this project, they have all increase the use of manipulatives in their classroom and feel more confident creating and implementing lessons/activities in their classrooms which require hands-on manipulatives and student collaboration.

Collection of Teacher Data for This PDIG

Prior to beginning this PDIG, the four teachers involved were asked to complete a survey on their attitudes toward mathematics and the type and frequency of the activities they use in their classrooms (Appendix A). Each teacher was then asked to complete a survey at the

completion of the PDIG to help gage the learning that occurred as a result of the PDIG (Appendix B).

Collection of Student Data

Prior to carrying out the activities in the classrooms, we developed a ten question survey for students using the EQAO questionnaire and the Attitudes Toward Mathematics Inventory (Tapia, 1996) as a guide. All students in Grade 5 and 6 were asked to complete the survey; however, as a result of a teacher being absent for the majority of the PDIG and because there was not a consistent teacher in that classroom afterward, the activities were not carried out with the French Immersion students and thus, all data compiled from the surveys for French Immersion students has been removed from the results.

Clearly articulated results/recommendations

Overall, I think this PDIG was a great success. I believe that the teachers involved in the PDIG engaged in reflective practice which resulted in changes in their current teaching practice. Teachers involved in the PDIG developed a total of 17 new lessons or activities that can be used at various times throughout the year to provide students with opportunities to participate in a collaborative and productive struggle, making sense of Mathematics along the way. The activities that were designed were designed to encourage Grade 5 and 6 teachers who may otherwise shy away from the use of hands-on manipulatives in the classroom to try something new. Each activity that was created requires students to work in pairs, triads or small groups to collaborate with one another and engage in meaningful math discussions in order to further develop their conceptual understanding. Feedback from teachers and students alike suggested that students enjoyed working with their peers to problem solve and preserved when the answer was not obvious or apparent.

Feedback from the teachers suggests that in comparison to their teaching methods before the PDIG, all three teachers involved now use manipulatives more often in their classrooms. Similarly, since engaging in this PDIG, all three teachers feel more confident designing and implanting lessons with manipulatives and all three teachers indicate they are more likely to use the activities developed from the PDIG in the future. Reflecting on the use of manipulatives at the end of each term will help to emphasize the importance of such activities and lessons. A

further investigation to examine student results over time and the use of manipulatives in the classroom may also help to impress the importance of hands-on collaborative learning opportunities for student-centred learning.

Feedback from students during and after the activities suggested that students enjoyed using hands-on manipulatives as a tool for learning. Teacher observations led teachers in the PDIG to conclude that when students were given the task and the manipulative, they were more likely to participate in a productive struggle because it was fun, which is unlike observations made when students engage in many paper and pencil tasks. Therefore, the use of manipulatives, in addition to meaningful and context driven tasks, allowed students to remain on task in an enjoyable and supportive environment, engaging in math talk. Through many observations, even students who struggle with math were able to reach a deeper understanding of the math concepts and in some cases, with the use of the manipulatives, students who struggle with math were the first to successfully complete the task. This speaks volumes to the importance of using manipulatives as a tool for both the teaching and learning of Mathematics. The use of manipulatives as a concrete tool for learning helped students to achieve a level of success that may have been unattainable with pencil and paper tasks and therefore, improved student self-confidence.

It is important to note that one's beliefs and attitudes toward math cannot be changed overnight and is instead a gradual process. Changing an individual's mindset toward mathematics and ultimately changing their outlook on mathematics will require more time than this project allotted. In addition to this, while students may receive growth mindset messages from their teachers, the messages students receive about mathematics from their parents, peers and the media can be equally, if not more damaging. Therefore, while students may be engaged in a task and have the ability to persevere when challenged by a task, this does not indicate that their attitude toward math has changed. When looking at attitudes toward math, it is much more likely that you would see results after the whole school and the community has been trained on growth mindsets and internalize the impact that negative messages have on students, especially girls. While there was a hint that mindsets may have changed slightly for these students, the only way to show that the positive mindset continues to exist in their future is to do a longitudinal study with all the students which spans their school careers.

When comparing pre and post survey results, it is important to recognize that there was a small sample size for both boys and girls who completed the surveys and therefore, one student accounts for a more significant change than if the sample size were larger. When comparing results from the pre and post survey, we were surprised to see that there were more changes in attitudes for boys than for girls, given the research by Boaler and others in her field. There was a change in the percentage of boys who looked forward to going to math class from 54.8% to 71.3%. There was also a similar change in the percentage of boys who feel confident in math class. In reflecting on these changes, I believe that the use of manipulatives helped to give boys an outlet for their energy but also gave them a concrete tool to manipulate so that the math was perceived as a challenge and not a threat. Similarly, the percentage of boys who said they like math problems that challenge them to think increased from 38.7% to 45.2% over the course of four months. For both boys and girls, the percentage of students who said they like math changed over the course of the PDIG. For boys, the percentage grew from 54.8% to 64.5% and for girls, the percentage changed from 51.6% to 65.4%. Lastly, the percentage of boys and girls who believe that they are able to express their ideas in math changed drastically. In September, 42% of boys responded that they agreed or strongly agreed that they were able to express their ideas in math; whereas, 71% of boys agreed or strongly agreed with the same statement in December. Similarly, 48.3% of girls strongly agreed or agreed with the statement in September compared to 57.7% in December. As noted in the literature, manipulatives provide students with concrete learning tools that can be used to help student explain and justify their responses in mathematics.

While these results are quite promising and demonstrate changes in attitudes over time, it is important to note that other factors may also be at play including: comfort level with the teacher over time, accessibility to resource support and the use of technology in the classroom and at home to enhance learning.

Benefits to teaching and learning

This PDIG has been beneficial to both the teaching and learning at South Hull School. Both teachers and students have benefitted from work done through this PDIG. When we began discussing this PDIG last year, teachers commented that they recognized the importance of using manipulatives in the classroom and wanted to provide students with collaborative learning

opportunities but did not have the time and in some instances the conceptual understanding to create such activities. This PDIG has provided teachers with the time to work together to develop 17 activities that are ready for use in any Grade 5 or 6 classroom. Through this PDIG, teacher have taken the time to get to know what manipulatives and resources are available to them in the Math Resource room and have identified and purchased more materials to add to the resource room. Through this PDIG, the Grade 5 and 6 teaching team has worked closely together to develop activities which has helped to enhance the cognitive understanding of the teachers and has also strengthen the comradery amongst staff. Through my observations of the staff, this group feels comfortable and supported by one another and are able to critically reflect on their own teaching practices with the support of the team. They recognize their own strengths and areas for growth and support one another in addressing these areas. As a result of this PDIG, the teachers involved are incorporating more hands-on activities in their classrooms and relying more on student talk rather than teacher talk to drive instruction.

It has been a very reflective process to observe students who are engaging in a variety of activities. Prior to the use of such activities and the use of manipulatives, many students appeared to be engaged in the process of learning at the level of compliance (because the teacher told them to), while other students waited to be called on or waited for one-on-one support from the teacher before working on a task. While observing the students actively engaged in the activities, it became clear to us that students were engaged in the activities not out of compliance, but rather with high attention and high commitment because they were genuinely interested in the challenge that the activity provided. Despite the presence of a challenge, students were having fun and were committed to the challenge, thereby, persevering through a challenge. Students made comments to teachers like, “This is fun,” “Can we do another activity?” Engagement in the activities created through the PDIG has also promoted more student-centred talk in the classroom. The activities were created with a collaborative group approach in mind. Students were encouraged to work in pairs, triads or groups of 4 to work through the activity, to make meaning of the math concepts. In one such activity, students working together to play a fraction game with pattern blocks, students had to identify the fraction of their game piece that was covered by pattern blocks. One student said “One-twoth of my game piece is covered,” to which her partner corrected her and said “You mean one-half of your game piece is covered.

Instead of one-twoth, we say one-half." This example shows that students were supporting one another in their learning journey and refining their fraction vocabulary.

Connections to school plans and district initiatives

Western Quebec School Board –Strategic Plan (4 Directions)	
Safety and Security To provide a healthy and safe environment for students and staff to maximize student achievement	In order to participate and engage in a productive struggle, students must feel safe and valued by their teachers and peers. The activities provided to students forced students to make mistakes through trial-and-error in a safe and non-judgmental environment. Mistakes were viewed as opportunities for learning and part of the challenge of the activities
Professional Responsibility – Management and Accountability To maximize the use of all resources to support teaching and learning	Through this PDIG we obtained a ministry grant for 4 days to reflect on teaching and learning. We addressed the need for more hands-on activities for mathematics for students in Cycle 3 and developed activities to support teaching and learning in math with manipulatives.
Focus on Pedagogy to Improve Teaching and Learning To continually improve the quality of instructions so that students have the best possible opportunities to learn and to achieve their potential	The focus of this PDIG was entirely based on improving the quality of teaching and learning in mathematics for Cycle 3 students. This PDIG addressed the need to revert from paper and pencil tasks and promote student talk through hands-on activities in a group setting. While these activities were used by the teachers involved in the PDIG this year, they will be shared to all staff at South Hull, within the Western Quebec School Board and with all English Language Schools in the province of Quebec thus helping to improve instruction at a school, district and provincial level.
Professional Learning, Feedback and Growth To ensure that all employees have on-going opportunities to improve so that students' educational experience continues to improve year after year	This PDIG provided all teachers in Cycle 3 time to work together to learn and grow. Through this PDIG, teachers have co-created activities and co-taught the activities, providing each other with feedback for growth and next steps. Teachers in this PDIG refined their teaching practice through observation of one another, through collaboration with one another and the

	collaborative inquiry of math attitudes and manipulatives.

Western Quebec School Board's five-year educational commitment is to increase success rates in the Cycle 3 Elementary math exam from 66% to 85 %. Two of the strategies that have been identified to support our commitment to improving student results include: improving the quality of teaching and learning, and providing quality professional development.

APPENDIX A

Teachers Responses – Pre-Survey

1. I incorporate manipulatives into my math lessons.			
0 times per week	**1 or 2 times per week**	**3 or 4 times per week**	**Everyday**
	4 (100%)		

2. I enjoy teaching math.				
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
3 (75%)	1 (25%)			

3. My students are actively engaged in math.				
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1 (25%)	3 (75%)			

4. I ensure my students have a conceptual understanding of math concepts (rather than procedural).				
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
2 (50%)	2 (50%)			

5. During class time, my students use their math workbook (or pencil and paper tasks).			
0 times per week	**1 or 2 times per week**	**3 or 4 times per week**	**Everyday**
		1 (25%)	3 (75%)

6. When working on math, students work in groups.			
0 times per week	**1 or 2 times per week**	**3 or 4 times per week**	**Everyday**
	1 (25%)	3 (75%)	

7. I incorporate math talk into my math lessons.			
0 times per week	**1 or 2 times per week**	**3 or 4 times per week**	**Everyday**
		1 (25%)	3 (75%)

8. I have the resources necessary to implement engaging and interesting lessons				
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
		3 (75%)	1 (25%)	

APPENDIX B

Teacher - Post-Survey

1. In comparison to your teaching before this PDIG, how often do you use manipulatives in your classroom?		
More often	**The same amount**	**Less often**
3 100%		

2. How effective was this PDIG in meeting your needs as a Mathematics teacher?				
Very effective	**Effective**	**Neutral**	**Not very effective**	**Ineffective**
1 33.3%	2 66.7%			

3. Since engaging in this PDIG, how confident do you feel in designing and implementing lessons with manipulatives?		
More confident	**The same amount of confidence**	**Less confident**
3 100%		

4. How effective do you feel our meetings together were?				
Very effective	**Effective**	**Neutral**	**Not very effective**	**Ineffective**
1 33.3%	2 66.7%			

5. How comfortable do you feel to seek the support of other teachers when teaching mathematics?				
Very confident	**Confident**	**Neutral**	**Somewhat confident**	**Not confident**
3 100%				

6. In the future, how likely are you to use the activities we developed together?			
Very likely	**Likely**	**Somewhat likely**	**Not likely**
2 66.7%	1 33.3%		

APPENDIX C

Student Surveys – English Program Student Responses (Boys and Girls)
Pre-Test – September 2018

	1. Math is important in life.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	23 (74.2%)	6 (19.4%)	2 (6.5%)	0 (0%)	0 (0%)
Girls (Total #31)	22 (71%)	6 (19.4%)	3 (9.7%)	0 (0%)	0 (0%)

	2. I look forward to going to math class.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	5 (16.1%)	12 (38.7%)	11 (35.5%)	3 (9.7%)	0 (0%)
Girls (Total #31)	9 (29%)	11 (35.5%)	7 (22.6%)	1 (3.2%)	2 (6.5%)

	3. I feel confident in math class.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	8 (25.8%)	9 (29%)	14 (45.2%)	0 (0%)	0 (0%)
Girls (Total #31)	12 (38.7%)	8 (25.8%)	6 (19.4%)	4 (12.9%)	1 (3.2%)

	4. I think I will do well on the math exam.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	6 (19.4%)	9 (29%)	14 (45.2%)	0 (0%)	2 (6.5%)
Girls (Total #31)	6 (19.4%)	12 (38.7%)	7 (22.6%)	5 (16.1%)	1 (3.2%)

	5. I like math problems that challenge me to think.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	7 (22.6%)	5 (16.1%)	12 (38.7%)	5 (16.1%)	2 (6.5%)
Girls (Total #31)	3 (9.7%)	12 (38.7%)	8 (25.8%)	5 (16.1%)	3 (9.7%)

	6. I like math.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	10 (32.2%)	7 (22.6%)	6 (19.4%)	4 (12.9%)	4 (12.9%)
Girls (Total #31)	9 (29%)	7 (22.6%)	9 (29%)	4 (12.9%)	2 (6.5%)

	7. I am able to express my ideas in math.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	6 (19.4%)	7 (22.6%)	13 (41.9%)	3 (9.7%)	2 (6.5%)
Girls (Total #31)	5 (16.1%)	10 (32.2%)	9 (29%)	4 (12.9%)	3 (9.7%)

	8. I believe I am good at solving math problems.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	11 (35.5%)	10 (32.2%)	8 (25.8%)	2 (6.5%)	0 (0%)
Girls (Total #31)	9 (29%)	10 (32.2%)	4 (12.9%)	6 (19.4%)	2 (6.5%)

	9. I can accurately answer questions using basic operations (+, -, x, ÷).				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	15 (48.4%)	7 (22.6%)	8 (25.8%)	1 (3.2%)	0 (0%)
Girls (Total #31)	13 (41.9%)	11 (35.5%)	6 (19.4%)	0 (0%)	1 (3.2%)

	10. I find math dull and boring.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	4 (12.9%)	1 (3.2%)	9 (29%)	6 (19.4%)	11 (35.5%)
Girls (Total #31)	1 (3.2%)	2 (6.5%)	12 (38.7%)	5 (16.1%)	11 (35.5%)

APPENDIX D

Student Surveys – English Program Student Responses (Boys and Girls)
Post-Test (December 2018)

	1. Math is important in life.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	21 (67.7%)	8 (25.8%)	1 (3.2%)	0 (0%)	1 (3.2%)
Girls (Total #26)	16 (61.5%)	9 (34.6%)	1 (3.8%)	0 (0%)	0 (0%)

	2. I look forward to going to math class.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	8 (25.8%)	11 (35.5%)	9 (29%)	2 (6.5%)	1 (3.2%)
Girls (Total #26)	8 (30.8%)	11 (42.3%)	3 (11.5%)	3 (11.5%)	1 (3.8%)

	3. I feel confident in math class.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	11 (35.5%)	11 (35.5%)	8 (25.8%)	1 (3.2%)	0 (0%)
Girls (Total #26)	9 (34.6%)	8 (30.8%)	4 (15.4%)	3 (11.5%)	2 (8%)

	4. I think I will do well on the math exam.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	9 (29%)	13 (41.9%)	7 (22.6%)	1 (3.2%)	1 (3.2%)
Girls (Total #26)	9 (34.6%)	8 (30.8%)	6 (23.1%)	3 (11.5%)	0 (0%)

	5. I like math problems that challenge me to think.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	6 (19.4%)	8 (25.8%)	11 (35.5%)	3 (9.7%)	3 (9.7%)
Girls (Total #26)	7 (26.9%)	6 (23.1%)	6 (23.1%)	2 (8%)	5 (19.2%)

	6. I like math.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	11 (35.5%)	9 (29%)	7 (22.6%)	1 (3.2%)	3 (9.7%)
Girls (Total #26)	10 (38.5%)	7 (26.9%)	2 (8%)	2 (8%)	5 (19.2%)

	7. I am able to express my ideas in math.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	7 (22.6%)	15 (48.4%)	7 (22.6%)	2 (6.5%)	0 (0%)
Girls (Total #26)	6 (23.1%)	9 (34.6%)	7 (26.9%)	4 (15.4%)	0 (0%)

	8. I believe I am good at solving math problems.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	9 (29%)	11 (35.5%)	8 (25.8%)	3 (9.7%)	0 (0%)
Girls (Total #26)	7 (26.9%)	8 (30.8%)	9 (34.6%)	1 (3.8%)	1 (3.8%)

	9. I can accurately answer questions using basic operations (+, -, x, ÷).				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	17 (54.8%)	11 (35.5%)	3 (9.7%)	0 (0%)	0 (0%)
Girls (Total #26)	10 (38.5%)	10 (38.5%)	3 (11.5%)	1 (3.8%)	2 (8%0

	10. I find math dull and boring.				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Boys (Total #31)	4 (12.9%)	0 (0%)	6 (19.4%)	9 (29%)	12 (38.7%)
Girls (Total #26)	2 (8%)	2 (8%)	4 (15.4%)	6 (23.1%)	12 (46.2%)

APPENDIX E

Comparison of Pre and Post Student Surveys

Yellow highlights indicated significant changes in results

I look forward to going to math class. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	54.8%	71.3%
Girls	74.5%	73.1%

I feel confident in math class. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	54.8%	71%
Girls	64.5%	64.5.%

I think I will do well on the math exam. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	48.4%	70.9%
Girls	40.1%	65.4%

I like math problems that challenge me to think. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	38.7%	45.2%
Girls	48.4%	50%

I like math. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	54.8%	64.5%
Girls	51.6%	65.4%

I am able to express my ideas in math. **Response: Strongly agree + Agree**		
	Pre-Survey Results	**Post-Survey Results**
Boys	42%	71%
Girls	48.3%	57.7%

RESOURCES

Boaler, J. (2013). *Ability and Mathematics*. Volume 55, Number 1. Retrieved on December 1, 2018 from: www.wwwords.co/uk/FORUM.

Boaler, J. (2015). *What's Math Got To Do With It?: How teachers and parents can transform mathematics learning and inspire success.* New York: Penguin Books.

Boaler, J. (2016). *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. United States: Jossey-Bass.

Maloney, E., Fuselgang, J. & Ansari, D. (November 17, 2017). *Math Anxiety: An Important Component of Mathematical Success.* Retrieved on December 1, 2018 from: https://thelearningexchange.ca/resources/mathematics.

Small, M. (2008). *Making Math Meaningful to Canadian Students, K-8*. Toronto: Nelson Education.

Tapia, M. (1996). *Attitudes Toward Mathematics Inventory (ATMI)*. Retrieved in August 28, 2018 from: http://www.pearweb.org/atis/tools/