STEM: Rooting out Gender Differences: A study of confidence amongst elementary students in Vancouver, Canada

Authors:
Alexa Bailey and Dr. Toni Schmader, unpublished manuscript, UBC, 2019

Abstract

The purpose of this study is to investigate the relationship between confidence in math and gender throughout elementary school. It was hypothesized that 1) gender confidence differences in math will appear around grade three, 2) girls will be less confident in math than boys, 3) as they get older, girls will become less confident in math 4) as they get older, boys will become more confident in reading, 5) the confidence in reading will even out later in elementary 6) in math, we will continue to see a gender difference in later elementary 7) boys will show a preference over girls for tasks that are timed. A survey was designed and administered to grades K through 7 in one east Vancouver, public, coeducational, elementary school. Three hundred and twenty-six students completed the survey: 169 boys, 142 girls and 15 who did not define their gender. The results showed that there was no statistical difference between boys and girls in their confidence in both math and reading. There was, however, a decline in girls' confidence in math as they got older and there was an increase in confidence in reading for boys as they got older. Girls' confidence did not decline across any other domain. The decline becomes apparent by Grade 6. This decline in girls' math confidence has important implications for understanding gender differences in STEM related fields that appear in post-secondary. The findings also give evidence of the need for early intervention, in early elementary grades, to improve girls' confidence in math.

Introduction

Purpose

This study will help us to better understand the relationship between confidence in math and gender in elementary school aged children.

Question

Does confidence in math differ between genders throughout elementary school?

Background

Multiple studies have shown that girls and boys score similarly in math. In a meta-analysis of cross national patterns of gender difference done in 2010 (Else-Quest et al), researchers concluded that there is a negligible difference in ability between boys and girls in math. Researchers have found that despite similarities in math ability, girls have lower math confidence (Else-Quest et al, 2010). This confidence difference starts in Grade 3 in Ontario as shown by research completed by Dr. Mary Reid (Reid et al. 2018). Daigle and Guiomard, 2011 also found differences in confidence between genders starting to appear in grade 3 and widening through elementary school. In 2017/2018 the standardized test done by EQAO (Research on student achievement, 2011) shows that only 49 percent of grade 3 girls agreed with the statement that they were good in math compared to 62 percent of boys. The difference becomes greater in 6th grade where 46 percent of girls said they were good at math compared to 61 percent of boys. In a study by Thomas et al, 2017, the highest performing math students with the same observed ability each rated their ability. Amongst the strongest math students, boys are significantly more confident than girls in their math ability. Boys rated their ability 27% higher than girls.

Gender differences may also be apparent in other subjects. For example, in reading, girls tend to outperform boys in reading in the early years (Ganley and Lubienski, 2016). However, reading gender gaps narrow during the elementary grades, whereas gender gaps in math grow during early elementary school (Robinson and Lubienski, 2011) like math, gender difference is small, but girls show greater confidence in reading and in school in general (Logan and Johnston, 2009).

The difference in confidence in math may be explained by gender stereotypes. Some of the reasons we see these attitudes are well known; stereotypes spread the false idea that men are better at math and science while women a better at nurturing careers. This leads to fewer women in science related fields. Gender stereotypes get passed down. If a mother tells her daughter, “Don’t worry, I wasn’t good in math”, it sends the

message that girls are no good in math and that this will never change. Although these stereotypes should have weakened over time, because women's representation in science has grown stronger in the United States, research asking children to "draw a scientist" showed that children's drawings of scientists tend to be more inclusive of women in the younger years yet more associated with men in the older years (Miller et al. 2018). Another reason that has been getting a lot of research attention recently is what's known as math anxiety. A study in 2009 by the National Academy of Sciences of the United States, (Levine et al. 2010) showed that female elementary teachers pass on their anxiety in math to girls in their classes but not to boys. Reid's research (Reid et al. 2018) shows that there is a strong correlation between math anxiety and teacher's knowledge of the subject. Math anxiety might also increase with the requirement of timed tasks. Research by Shurchkov (2012) showed that amongst adults, men performed better than women in high-time-pressure tournament math tests, but women performed better than men in low-time-pressure tournament verbal tests. Both performed equally well in low-time-pressure tournament math tests and high-time-pressure tournament verbal tests.

Although there is no difference in ability, we still see an imbalance in female roles in STEM fields even though there are more women than men in post-secondary. This has been replicated across many studies (Else-Quest et al., 2010). According to a Swedish study, research by Wennerås & Wold (1997) found that women in STEM fields have to work much harder than men to get the same grades or benefits. Between 1901 and 2017, the Nobel Prizes and the Nobel Memorial Prize in Economic Sciences were awarded 585 times to 923 people and organizations. With some receiving the Nobel Prize more than once, this makes a total of 892 individuals (including 844 men, 48 women) and 24 organizations. This is a ratio of more than 17:1, men to women receiving the Nobel prize. It is therefore important for us to understand why there is this imbalance in the representation of females in STEM fields, despite equality in ability.

Hypotheses

1. Gender confidence differences in math will appear around Grade three.
2. Girls will be less confident than boys in math overall.
3. As they get older, girls will become less confident in math as they get older.
4. Boys will become more confident in reading as they get older.
5. Confidence in reading will be the same in higher grades.
6. Confidence in math will be different in higher grades.
7. Boys will show a preference over girls for tasks that are timed.

Method

Subjects

Three coeducational, public schools in East Vancouver, British Columbia, Canada agreed to participate in the study. These students came from a middle class neighbourhood. Three hundred and twenty-six students participated, ranging from kindergarten to grade seven.

Variables

Independent: Gender; girl, boy, other

Dependent: Confidence; general academic confidence, math confidence, reading confidence, timed tasks confidence, confidence in teacher's ability.

Controlled:

The following aspects to the experiment were kept the same (did not vary:

- questions in the questionnaire
- instructions for completion
- the questionnaires were administered by the same person
- the order of the questions were counterbalanced. This means that half of the students got questions on reading first and the other half were given questions about math first.

Materials

- Survey
- Instructions to be read by the administrator

Procedures

1. Develop a survey using visuals so that it can be understood by Kindergarten students with little to no reading ability.
2. Create questions looking at general confidence, confidence in math, reading, timed tasks and puzzles and teacher's ability.
3. Obtain ethics approval.
4. Create consent form for parents.

I administered the consent twice. First, all students were given the form. The second time, I gave the form to all those who had not responded, modifying the request to send back the form with a "no" if the student/parent did not consent to participation.

5. Give consent forms to all children in school.
6. The principal of the school read out the surveys in every class.
7. Questions were counterbalanced. Half of the students got questions about math before reading and half were given questions about reading before math.

Results

Table 1
Number of Surveys Collected

Grade:	K	1	2	3	4	5	6	7
Male	17	18	26	34	8	24	20	22
Female	7	17	16	24	12	22	16	26
*Other	6	2	2	1	1	0	0	3
Total	30	37	44	59	21	46	36	51
								324**

*Other= includes those who circled "other" or when nothing was circled
**Two students left their grade blank but were from a Grade 6-7 class

The data was statistically analyzed using SPSS software.
Data was analyzed by gender, grade split (K-3, 4-7), and for trends over grades.

Table 2 Summary of results

Overall males vs females.
There is no correlation between students perception of their own ability and that of their teacher (male & female, math & reading)
There is no correlation between perception of ability on timed vs non-timed reading & maths (for gender)
There is no correlation between perception of ability on timed vs non-timed reading & maths (for gender)
There is no significant difference in perception of ability in math, timed math, reading, timed reading & puzzles between male & female
The kids who think they are good at timed math also think they are good at timed reading and vise versa
Between grades (grade split)
Differences found are not statistically significant
Math averages show drop from K-3 to 4-7, bigger drop in females. NOT statistically significant.
For timed math K-3 versus 4-7, females down, males up, NOT statistically significant
Puzzles as for math, bigger drop in females
Reading shows increase in confidence - consistent with learning to read process - marginally significant
Grade analysis
Girls: a significant reduction in perceived ability in math with increasing grade. (Graph 1)
Boys: a significant increase in perceived reading ability with increasing grade. (Graph 2)

Table 2 shows a summary of all results from the statistical analysis.

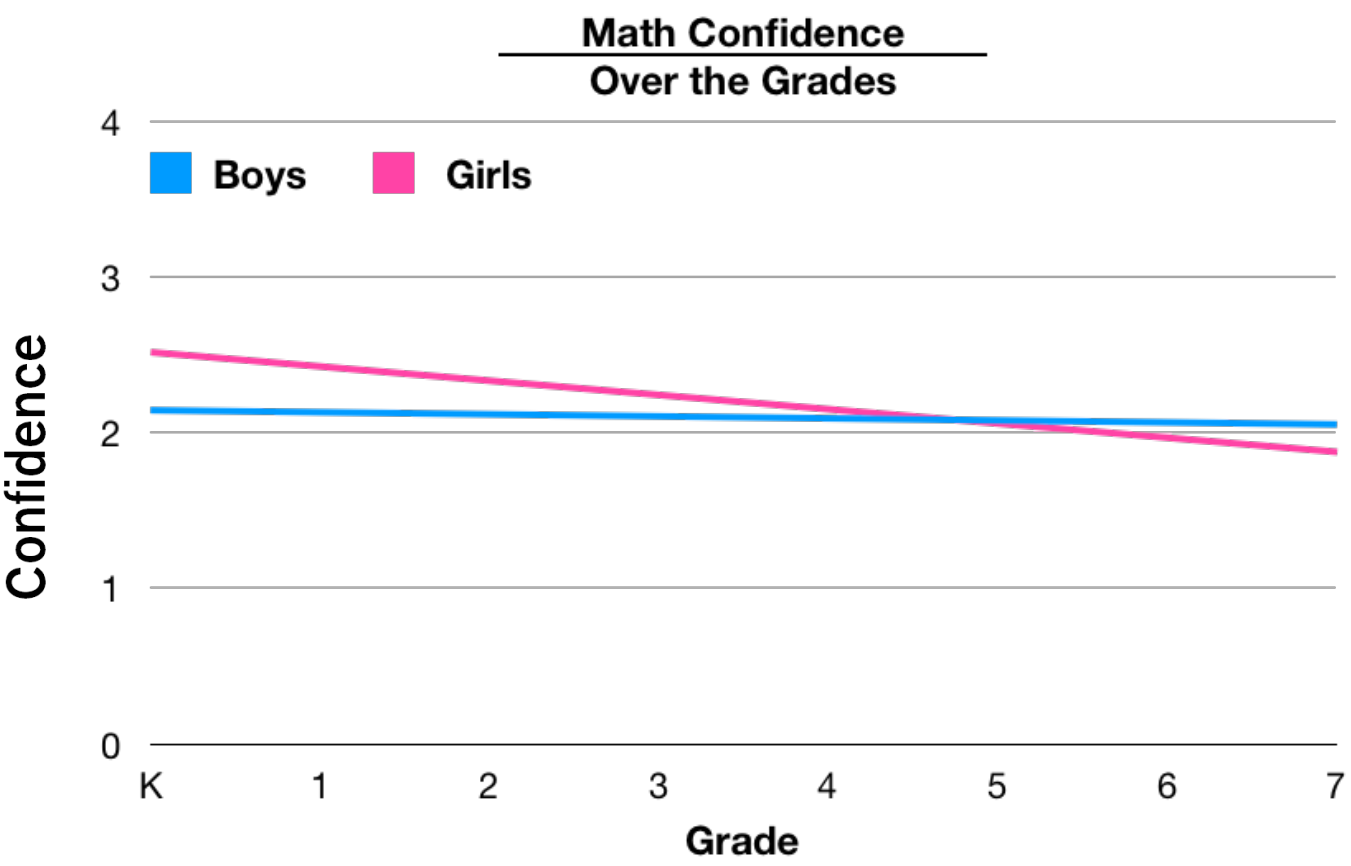
Table 3: Confidence in Math

	Young (K-3)	Old (4-7)
Girls	3.02	2.74
Boys	2.94	2.89

Table 3 shows the average ratings on the question “I am good at math” between genders, split into younger grades and older grades (primary versus intermediate). The difference between confidence ratings in younger girls versus older girls is statistically signifiant.

Legend for the graphs:
1=strongly disagree
2=disagree
3=agree
4=strongly agree

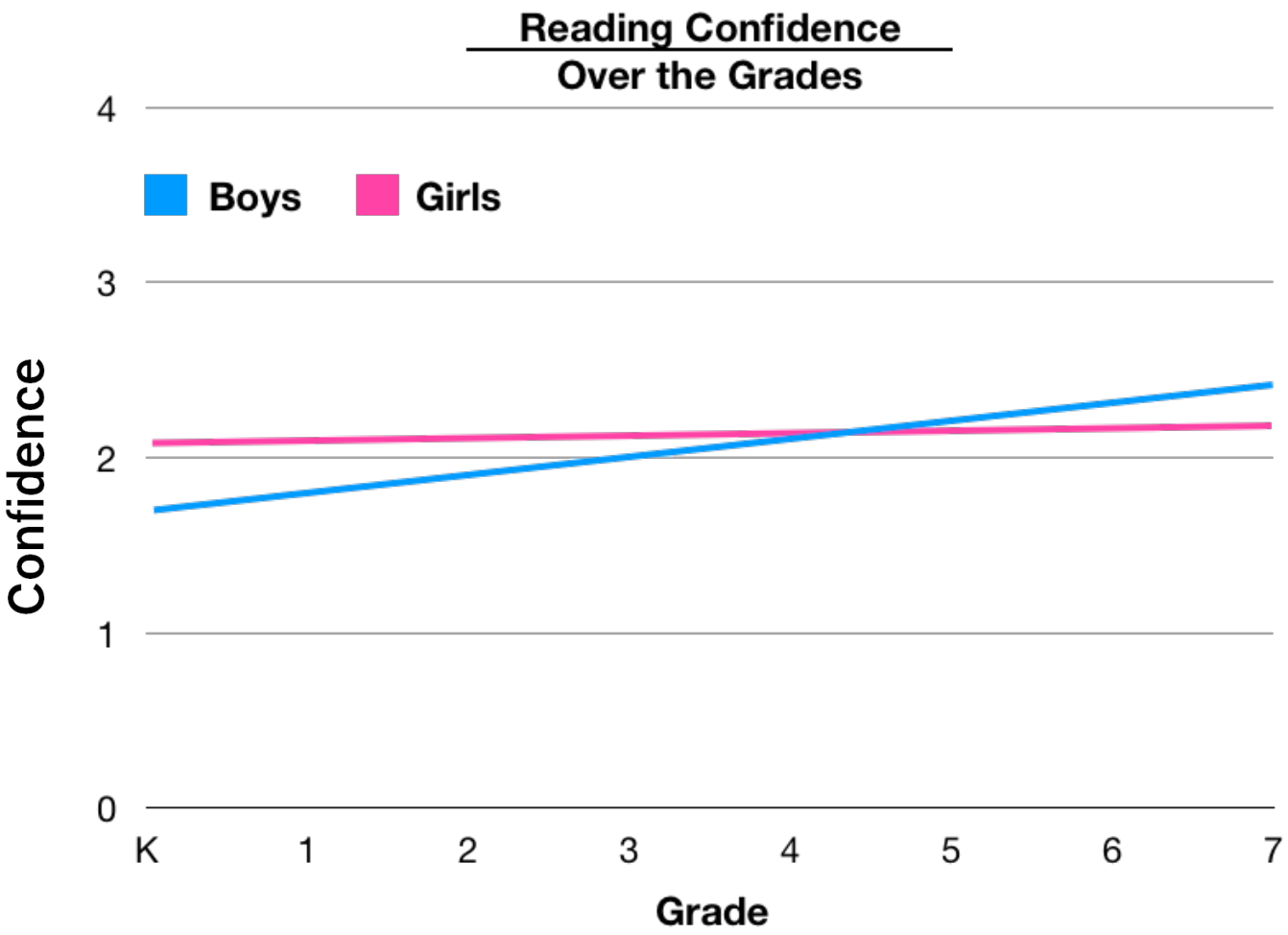
Graph 1



Graph 1 illustrates that girls confidence in math goes down over the grades. Boys confidence stays the same.

Legend for the graphs:
1=strongly disagree
2=disagree
3=agree
4=strongly agree

Graph 2



Graph 2 illustrates that boys confidence in reading goes up over the years. Girls confidence in reading stays the same.

Analysis

The data were analyzed using the statistical program SPSS. There were three ways that the data were analyzed: between gender, between grades grouped K-3 and 4-7, and across grade and gender. The results show no significant difference in confidence between girls and boys in either math or reading. However, there was a significant trend for boys to become more confident in reading over time and girls to become less confident in math.

Hypothesis 1: (unsupported) Gender confidence differences in math will appear around Grade three.
The results of this study did not support my first hypothesis that there would be a gender difference in confidence which would appear in grade 3. Although Table 3 shows an apparent drop in confidence for both genders, and a larger drop for girls, these differences are not statistically significant. There was no significant confidence difference between boys and girls in math at any stage of elementary (Table 2)

Hypothesis 2: (unsupported) Girls will be less confident than boys in math.
This hypothesis was not supported by my results. There was no significant difference between girls and boys confidence in math.

Hypothesis 3: (supported) As they get older, girls will become less confident in math.
The results did support this hypothesis. The results showed that as they get older, girls' confidence in math declines. In graph 1, we can clearly see a decline of confidence in girls in math throughout the grades. These results are statistically significant.

Hypothesis 4: (supported) Boys will become more confident in reading as they get older.
The results did support my hypothesis that as they get older, boys will become more confident in reading. In graph 2, we can observe an increase of boys confidence in reading. These results are statistically significant.

Hypothesis 5: (unsupported) The confidence in reading will even out later in elementary.
There was no significant difference between boys' and girls' confidence in reading at any point in time. However, we do see a significant increase in boys' confidence in reading as they get older.

Hypothesis 6: (unsupported) In math, we will continue to see a difference in confidence between genders later in elementary.
There was no significant difference between boys' and girls' confidence in math at any point in time.

Hypothesis 7: (unsupported) Boys will show a preference over girls for tasks that are timed.
The results did not show a significant difference for timed tasks between boys and girls.

Discussion

Conclusion

In conclusion, while my results did not support a significant difference in confidence between genders in either math or reading, at any stage of elementary school, there was a significant trend for loss of confidence in math amongst girls and a significant trend for boys to improve in confidence in their reading. Girls tend to lose confidence by Grade 6. This is consistent with previous research that has shown that girls become less confident in math, particularly in later grades (Daigle and Guiomard, 2011). This lack of confidence may contribute to fewer girls pursuing STEM related fields in post-secondary.

The limitations to this study include a small scale for the questions. I used a 4 point scale from strongly disagree to strongly agree. This may not have been a big enough scale for students who felt that they were in-between points in the scale. Using a 10 point scale may tease out more subtle differences in confidence between the genders. I also noticed that some students tended to answer similarly (e.g., all “strongly agree”) suggesting that they may not have fully considered their responses before answering. To go further, I would include some questions that ask the same thing but are worded differently. For example, I could include a question like, “I am good at math” and “I am not good at math”. This would give me a way of checking if the students were answering truthfully. Lastly, the question, “I am a good student” may have been interpreted by the students as meaning “good” in terms of behaviour, whereas I meant it to be a measure of being a strong student.

Finally, the results of this study are limited to the demographics of an inner city, co-educational school that pulls from a mainly middle class population. The results may not generalize to other types of settings such as a private, same gender school.

Recommendations

To further this study, I would want to divide the questions into a larger scale. It will be important, however, to keep the simplicity of the language so that the survey can be understood by Kindergarten students. I am also interested in asking more questions to determine why there is a decline in girls' confidence in math. Could their perception of stereotypes be playing a role? Do girls believe that girls can be good in math and have careers in math? Do they perceive a gender difference between boys and girls in math? I would be interested in knowing how teachers rate confidence between their students and how gender might play a role in this. I would also like to know how confidence differs across gender and ability levels. I think it would be particularly interesting to link confidence to actual ability. This was difficult to do for me but I wonder if I could access data from math competitions.

The finding that girls lose confidence in math could be further explored by extending the study into later grades. It would be interesting to see if girls' confidence continues to drop and if this could affect the numbers of girls going into STEM related fields.

Applications

This study provides that girls' confidence in math declines over time. These data have inspired me to create a girl-to-girl mentoring program called Girls to the Power of Math. This program has high school girls mentoring grade 3 girls. Through fun games and encouragement, we aim to boost their confidence levels and stop the decline in confidence in math. Hopefully, this will inspire them to pursue STEM related careers.

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