Mathematics Anxiety: Year 7 and 8 Student Perceptions

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Studies, such as Programme for International Student Assessment 2012, indicate that there are gender based differences in measures of mathematics anxiety, self-concept and self-efficacy among students. In this study we explore self-efficacy, self-concept and mathematics anxiety in a sample of Year 7 and 8 South Australian students to examine if these differences still exist. The findings indicate that high levels of mathematics anxiety is present among Year 7 and 8 students and that gender based differences are also evident in both self-efficacy and anxiety.

Outputs from the office of the chief scientist have, over the past five years, repeatedly referenced the need for greater student participation in STEM (Science, Technology, Engineering & Mathematics) subjects. However, studies such as Mack and Wilson (2015) continue to highlight how the numbers of students opting for STEM subjects continues to decline. They identified that since 2001 there has been no substantial growth in science participation despite numerous initiatives to address this. They also note that mathematics participation continues to decline and where there is participation in mathematics, students tend to opt for elementary mathematics rather than intermediate or advanced mathematics. There are many reasons cited for such changes including expressed dissatisfaction with mathematics (Hine, 2017), pressure to choose subjects most likely to yield higher Australian Tertiary Admission Rank (ATAR) scores (Mathematical Association of New South Wales, 2014), students' self-efficacy in regard in their mathematics performance and the presence/absence of mathematics anxiety (Sax, Kanny, Riggers-Piehl, Whang, and Paulson, 2015). The aim of this paper is to explore year 7 and 8 student dispositions towards studying mathematics, by examining students mathematics; self-efficacy, self-concept and anxiety. In addition, gender differences that were identified in the 2012 Programme for International Student Assessment (PISA) survey will be examined to see if they are still evident in the project schools.

Literature

According to the 2012 PISA (Organisation for Economic Co-operation and Development (OECD), 2013) survey almost one third of fifteen year olds reported some level of mathematics anxiety. Also, variation in performance in mathematics is explained

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by mathematics anxiety in 14% of OECD countries. This suggests that while it is important to analyse and understand subject choices at senior secondary level, the issues in regard to avoiding mathematics begin much earlier. The transition from primary to secondary school is well documented as a time of upheaval and distress for many students (Hanewald, 2013; Maguire & Yu, 2015). It is a time when anxiety can manifest itself, impacting on general engagement and hence academic performance (Howard & Johnson, 2004; Hanewald, 2013). This transition can lead to the development of negative perceptions and attitudes towards mathematics and towards school in general (Attard, 2012)

Mathematics anxiety, described as a fear or state of discomfort when faced with mathematics tasks/problems (Hembree, 1990; Hoffman, 2010), is widely accepted as an issue in mathematics education which can hinder the true ability of students. Hoffman (2010) discusses the negative correlation between mathematics anxiety and achievement and also how this anxiety can be triggered by factors such as low self-efficacy and previous lack of success. The concept of self-efficacy, which stems from Bandura's social learning theory (Bandura (1977), affects choices of both activity and behaviour which impacts on how much effort and persistence one applies (Brown & O'Keeffe, 2016). Someone with high self-efficacy is deemed to be more likely to show greater interest in and commitment to working with problems and greater effort and perseverance as they have a "heightened sense of optimism that they can ultimately succeed" (Pajares, 1996, p.326). This is important given that non-cognitive characteristics such as effort and perseverance have been known to predict student success in education in general. For example, Pajares and Miller (1994) found that self-efficacy beliefs about problem solving are a strong predictive indicator of performance. They found that self-efficacy is a greater predictor than factors such as gender or mathematics background or variables such as mathematics anxiety, self-concept, or perceived usefulness of mathematics. PISA 2012 (OECD, 2013) and more recently Bettinger, Ludvigsen, Rege, Solli and Yeager (2018) reiterate that a student's self-efficacy is a predictor of their perseverance and hence on their overall performance in mathematics.

The 2012 PISA survey looked specifically at mathematics self-efficacy and mathematics anxiety, (along with mathematics self-concept among students and student engagement). The data indicated that "almost "30% of students reported that they feel helpless when doing mathematics problems" (OECD, 2013, p.80). Of this 30% it was clear that girls and socio-economically disadvantaged students are more likely to have lower self-efficacy levels. This PISA survey found that girls were less confident at calculation tasks, such as how much cheaper a TV would be after a 30% discount, than they were at abstract/classroom tasks such as solving a linear or a quadratic equation (OECD, 2013, p.83). The findings also indicate that girls were less likely to be confident (75% were confident or very confident) than boys (84%) with such calculation tasks (as evident in the responses to specific survey items). This gender gap was even more evident with tasks that the OCED describe as being associated with 'stereotypical gender roles'.

PISA 2012 also highlighted that 43% of students believed they were not good at mathematics, despite 59% reporting that they get good grades. The data also suggests gender differences for self-concept and self-efficacy, with more boys believing they are good at mathematics than girls. Similar outcomes were found for mathematics anxiety. Students also reported feeling anxious about mathematics class (59%), homework (35%) mathematical problems (31% reported feeling nervous, 30% helpless) and about getting poor grades (61%) (OECD, 2013, p.90). Gender was also a factor (in 56 of the 65 OECD countries, including Australia) with mathematics anxiety, with girls recording higher levels

of mathematics anxiety than their male counterparts. The findings also suggest that students in 2012 were more likely to be anxious about mathematics than those in the 2003 survey, with 13 countries, including Australia, exhibiting statistically significance increase in the mathematics anxiety recorded by their students.

Methodology

A student survey was distributed online to all students (approximately 1780 students) involved in the study. A total of 1,240 Year 7 and 8 students completed the survey; 618 Year 7 students (approximately 880 students sent survey) and 622 Year 8 students (approximately 900 students sent survey). The survey was designed and distributed by the Department for Education and Child Development (DECD), South Australia and the sections relevant to this paper, mathematics self-efficacy, self-concept and anxiety were based on the PISA 2012 survey. Students were asked to respond on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree) and a total of 13 questions were included, as presented in Table 1 below:

Table 1
Survey items

	Secondary school student survey statements	Primary school student survey statements
Mathematics Self-Efficacy	I feel good about myself when I do mathematics.	I am good at mathematics.
	I would consider a career in mathematics.	When I leave school I will need mathematics for my future work
	I can usually give good answers to test questions on mathematics topics.	I learn mathematics quickly.
	Knowing mathematics will help me make good decisions in the future.	Knowing mathematics will help me make good decisions in the future.
Mathematics Self-Concept	I can understand most subjects well, but mathematics is difficult for me.	I can understand most subjects well, but mathematics is difficult for me.
	I am sure I could do advanced work in mathematics.	I am sure I can solve challenging problems in mathematics.
	When I am being taught mathematics, I can understand the concepts very well.	I have always believed that mathematics is one of my best subjects.
	I get good marks in mathematics.	I get good marks in mathematics.
Mathematics Anxiety	I often worry that it will be difficult for me in Mathematics classes.	I often worry that it will be difficult for me in Mathematics classes.
	I don't enjoy trying to solve mathematics problems.	I like to solve mathematics problems.
	I get nervous doing Mathematics problems.	I get nervous doing Mathematics problems.
	I feel helpless when doing a Mathematics problem.	I feel helpless when doing a Mathematics problem.
	I worry that I will get poor marks in Mathematics.	I worry that I will get poor marks in Mathematics.

The questions in Table 1 were part of larger initial survey given to all students involved in a STEM project. The project is, in part, examining; "What impacts on students' understandings and dispositions around STEM are evident from their involvement in the

Years 7 and 8 STEM Collaborative Inquiry Project?" The questions were completed by students in Years 7 and 8, across 36 schools in South Australia (5 High Schools, 1 R-12 School, 2 Community Schools and 28 Primary Schools). This paper examines the student responses to the questions in relation to gender, some reference to the relevant socio-economic status (SES) data is also discussed. The results will be compared to the PISA 2012 results to identify if patterns are similar in the current sample of schools. Statistical comparisons between data sets will not be made given that the survey was undertaken with Year 7 and 8 students while PISA is completed by 15 year olds (Year 9). While not part of this paper a post survey will then examine if being involved in a STEM collaborative inquiry project has any impact on these and is able to narrow any evident gaps.

Findings

Mathematics Self-Efficacy

Table 2 presents the summary data for all Year 7 students (primary school) and Year 8 (secondary school) for their responses to the four self-efficacy statements. The maximum score for each statement was 5 (Strongly Agree) and the minimum 1 (Strongly Disagree). Both male and female primary students report positive self-efficacy scores across the four questions [3.28, 4.05], however the female primary students are less likely to think they are good at mathematics and to believe that they learn mathematics quickly. While similar scores were found with the Year 8 cohort, ranging from 2.64 to 3.90, statistically significant differences between female and male responses were not found in the same questions (see Table 2).

Table 2
Year 7 & 8 Student Self-Efficacy Values by Gender

	Year	**Gender**	**n**	**$\bar{x}$***	***SD****	***p-value***
I am good at mathematics.	**7**	**F**	325	3.28	1.165	
		M	293	3.72	1.127	0.00
I feel good about myself when I do mathematics	**8**	**F**	343	3.33	1.216	
		M	287	3.45	1.258	.251
When I leave school I will need mathematics for my future work	**7**	**F**	324	3.98	1.066	
		M	296	4.14	.977	.062
I would consider a career in mathematics	**8**	**F**	347	2.64	1.107	
		M	291	2.92	1.284	.003
I learn mathematics quickly.	**7**	**F**	325	3.37	1.149	
		M	295	3.69	1.117	0.00
I can usually give good answers to test questions on mathematics topics	**8**	**F**	347	3.22	1.164	
		M	292	3.46	1.158	.013
Knowing mathematics will help me make good decisions in the future.	**7**	**F**	328	3.88	.953	
		M	296	4.05	.990	0.30
Knowing mathematics will help me make good decisions in the future	**8**	**F**	348	3.83	1.023	
		M	292	3.90	1.057	.373

* $\bar{x}$ = mean **SD= Standard Deviation

The data suggests that Year 8 male students are less inclined to believe they are good at Mathematics than Year 7 students, with little difference between the female students. All Year 8 students, both male and female, perceive mathematics to be less likely for their future career than their Year 7 counterparts. This question resulted in the greatest difference between cohorts, with male scores reducing by over one unit (-1.22) and female scores by an even greater margin (-1.34). Examining this data by SES indicates only one instance of statistically significance differences, with low SES students being less likely to believe they are good at mathematics in both Year 7 (p=0.003) and in Year 8 (p=0.035) than the high SES students. The lowest scoring statement across SES was gain the need for mathematics in future work/careers.

The results are similar to those from the PISA 2012 survey. For example, for the statement "*I learn mathematics quickly*", 52% of the Primary students responded as Agree or Strongly Agree, the same as the average for OECD countries for the same statement and similar to that for Australian average of 54%, (OECD, 2013). The positive response to the statement "*I am good at mathematics*" was also similar, with 53% of students indicating Agree or Strongly Agree, 10% less than the Australian PISA 2012 equivalent and just 4% lower than the OECD average (57%). However, 19% of students indicated that they Disagree or Strongly Disagree that they are good at mathematics, much lower than the 43% OECD average for the PISA 2012 equivalent.

Mathematics Self-Concept

Table 3 presents the summary data for the four self-concept questions for all students. Female Year 7 and Year 8 students are more likely to find mathematics difficult than the male students, with the gap between genders closing by Year 8. Male students are also more likely to believe in their own ability to do challenging/advanced mathematics tasks and in their ability to do learn mathematics, with a statistically significance difference between genders at both Year 7 and in Year 8 (see Table 3). While all students report positive scores for the statement about getting good grades [3.31, 3.70], the gap between genders reduces by Year 8, from 0.31 in Year 7 (with a *p-value* is 0.000) to 0.14 in Year 8 (*p-value* is 0.132).

Table 3
Year 7 & 8 Student Self-Concept Values by Gender

	Year	**Gender**	**n**	$\bar{x}$	***SD***	***p-value***
I can understand most subjects well, but mathematics is difficult for me.	**7**	**F**	329	2.68	1.209	
		M	295	2.47	1.236	.028
I can understand most subjects well, but mathematics is difficult for me.	**8**	**F**	347	2.67	1.398	
		M	294	2.61	1.245	.514
I am sure I can solve challenging problems in mathematics.	**7**	**F**	324	3.44	1.076	
		M	295	3.74	1.016	.001
I am sure I could do advanced work in mathematics.	**8**	**F**	346	2.91	1.240	
		M	292	3.22	1.227	.002
I get good marks in mathematics.	**7**	**F**	326	3.39	1.094	
		M	293	3.70	1.050	.000
I get good marks in mathematics.	**8**	**F**	347	3.31	1.209	
		M	292	3.45	1.125	.132

I have always believed that mathematics is one of my best subjects.	**7**	**F**	329	2.90	1.282	
		M	295	3.49	1.293	.000
When I am being taught mathematics, I can understand the concepts very well.	**8**	**F**	346	3.25	1.153	
		M	292	3.48	1.171	.014

Further analysis of this data indicates that there are also socio-economic differences between students. Year 7 students from low SES schools are less likely to believe they can solve challenging problems (*p-value* is 0.018) or to receive good grades for mathematics (*p-value* is 0.003). The difference between cohorts is reduced by Year 8, with students from low SES schools responding more positively to the statement about good grades in Year 8 ($\overline{x}$ =3.43) than in Year 7 ($\overline{x}$ =3.19). The biggest change is also evident in responses to this statement, with little difference between Year 8 low ($\overline{x}$ =3.43) and high ($\overline{x}$ =3.42) SES. However, Year 8 students from low SES students are less likely to believe they understand what they are being taught in mathematics (*p-value* = 0.025).

Again, comparing like statements to the PISA 2012 counterparts presents similar patterns. For example, for the statement "*I have always believed that mathematics is one of my best subjects*", 40% of Primary school students Agreed or Strongly Agreed which is similar to both the OECD (38%) and Australian (40%). However, the response to the statement "*I get good marks in mathematics*", present lower percentage scores. 53% of Primary students and 50% of Secondary students Agreed or Strongly Agreed with this statement. While this is similar to the OECD average of 59% (OECD, 2013), it is more than 10% lower than the Australian average for PISA 2012 which is 64.5%.

Mathematics Anxiety

The mathematics anxiety data represents the greatest difference by gender in this dataset, with female students consistently exhibiting higher levels of anxiety than their male counterparts. Each of the statements related to mathematics anxiety reflect a statistically significant difference between Year 7 males and females (see Table 4). Year 8 students exhibit similar responses, with all statements except for *I feel helpless when doing a Mathematics problem* present statistically significance differences between gender.

Table 4
Year 7 & 8 Mathematics Anxiety Values: Gender

	Year	**Gender**	**n**	$\overline{x}$	***SD****	***p-value***
I often worry that it will be difficult for me in Mathematics classes.	**7**	**F**	331	3.09	1.202	
		M	297	2.71	1.278	.000
	8	**F**	347	2.83	1.277	
		M	293	2.64	1.243	.057
I like to solve mathematics problems.	**7**	**F**	332	3.25	1.162	
		M	296	3.58	1.135	.000
	8	**F**	347	3.11	1.244	
		M	292	3.28	1.232	.071
I get nervous doing Mathematics problems.	**7**	**F**	330	2.98	1.229	
		M	295	2.57	1.273	.000
	8	**F**	346	2.77	1.306	

		M	286	2.45	1.266	.002
I feel helpless when doing a Mathematics problem.	**7**	**F**	331	2.55	1.149	
		M	296	2.31	1.238	.013
	8	**F**	348	2.53	1.291	
		M	290	2.39	1.210	.175
I worry that I will get poor marks in Mathematics.	7	**F**	329	3.14	1.383	
		M	295	2.65	1.336	.000
	8	**F**	347	3.11	1.368	
		M	293	2.75	1.306	.001

The overall combined mean anxiety scores were also calculated; the maximum 'anxiety score' a student could receive was 25 (five questions answered on a Likert scale 1-5, with statement 2 reversed) which would equate to being extremely anxious and the minimum score is 5 (not very anxious). For female Year 7 students the overall combined mean anxiety score is 14.46 (n=325, SD = 4.9), whereas the combined mean score for male Year 7 students is 12.66 (n=293, SD 4.94). This indicates a statistically significant difference (p= 0.00) between genders, which female Year 7 students likely to be more anxious than their male counterparts. Similarly the combined mean anxiety score for female Year 8 students is 14.1079 (n=343, SD = 4.7), whereas the combined mean score for male Year 8 students is 12.84 (n=279, SD 4.39). This also represents a statistically significant difference (p= 0.01) between genders.

In Table 5 below the equivalent questions from the DECD and the PISA 2012 surveys show a similar pattern, with the South Australian students showing less concern with the difficulty of mathematics and getting good grades but very similar responses in regard to nervousness and helplessness.

Table 5
Percentage of Students with Agree or Strongly Agree Responses to Mathematics Anxiety Statements

	Survey Year 7	**Survey Year 8**	**Australian average**	**OECD average**
I often worry that it will be difficult for me in Mathematics classes.	33	38	59.7	59
I get nervous doing Mathematics problems.	31	27	28.9	31
I feel helpless when doing a Mathematics problem.	18	21	24.6	30
I worry that I will get poor marks in Mathematics.	35	37	61.8	61

Summary and Conclusion

Between the 2003 and 2012 PISA the Australian male student data for self-efficacy and self-concept remained high and unchanged, while that for mathematics anxiety remained unchanged but lower than the OECD average. While, for female Australian students self-concept, which declined from 2003 to 2012, and self-efficacy were both lower than the OECD average and anxiety remained high in 2003 and grew again in 2012.

The South Australian data presented in this paper suggests that male students remain more confident than their female counterparts and while the students present with varying levels of mathematics anxiety, the data suggests this is a deeper issue with female students.

While some studies may suggest the gender gap is declining, the data presented here suggests this is still an issue in the South Australian context, particularly in Year 7. The data also indicates that the gender differences are reduced in Year 8. However, this appears this has more to do with males losing confidence than the girls 'catching-up' suggesting more still needs to be done to address issues such as self-efficacy, self-concept and anxiety. This is not surprising as it is in line with Attard's (2012) work on transition from primary to secondary school, however it is significant to the South Australian context, particularly as SA moves towards integrating Year 7 into secondary school settings (in line with other Australian states).

In summary, it would seem that mathematics anxiety is still an issue for about one third of students in South Australian schools and that gender based differences still persist in mathematics anxiety as well as self-efficacy and self-concept. These differences follow a similar pattern to those identified in the PISA 2012 survey. While this is only a sample of schools the results would indicate that further work is needed to overcome these challenges.

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