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Rachelle Glynn

The University of Notre Dame Australia, rachelle.glynn@nd.edu.au

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What gendered constructs about mathematics do parents have as their children begin school in Australia?

Rachelle Glynn
University of Notre Dame Australia
<rachelle.glynn@nd.edu.au>

This study investigated whether parents have gendered constructs related to mathematics. Parents and their kindergarten-aged children from three primary schools in Sydney were interviewed to see what their understandings of boys' and girls' interests and abilities in mathematics were. Parents completed the Who and Mathematics questionnaire and were interviewed to determine if there were any gendered understandings and exactly what they were. The data shows that parents believe that boys are more likely to have an aptitude and interest in mathematics. In contrast, girls are perceived as more anxious, harder workers and in addition, that they have to work harder to do well in mathematics.

There are many researchers who believe that stereotypical values regarding mathematics as a male domain are continuing to be observed and are having a negative effect on students, particularly girls (Cvencek, Meltzoff, & Greenwald, 2011; Passolunghi, Ferreira, & Tomasetto, 2014; Plante, Theoret, & Favreau, 2009). The fact that differences in gendered achievement have diminished, while stereotypes favouring males remain intransigent, is a paradox that has attracted a great deal of exploration (Forgasz, Leder & Kloosterman, 2004).

Parents are a major environmental influence on the development of their children's self-perception of ability in numerous academic domains (Eccles, Freedman-Doan, Frome, Jacobs, & Yoon, 2000). Parents' beliefs intersect with their children's understandings of themselves and their innate abilities. Where parents hold stereotypes about domains, for example, that mathematics is a male domain, it shapes children's self-perceptions of their own ability, self-concept and self-efficacy (Eccles, 2011). Recently, a study of Year 5 students showed that girls rated themselves as 25 per cent less confident in their mathematical ability than boys (Li & Koch, 2017). When it comes to Science, Technology, Engineering and Mathematical (STEM) subjects, research has shown that the main influences on students' participation are identity, perceived ability and aspiration (Prinsley, Beavis & Clifford-Hordacre, 2016)

This study evaluated the ways in which parents' views of gender and mathematical ability intersect. Results from this study will allow educators to understand the way that parents view their child's mathematical ability in their first year of formal schooling.

Research Aims and Significance

Access and equity are two key concerns for educators. Creating equitable classroom environments for learners relies on understanding learners' needs. Girls and women are consistently under-represented in STEM fields of study and employment (Spearman & Watt, 2013; Wang & Degol, 2017). In addition, research has been conducted on the impact of gender stereotypes, parent expectations and the way they impact on children's self-efficacy and achievement after Year 2. Specifically, Gunderson, Ramirez, Levine and Beilock (2012) showed that negative attitudes towards mathematics occur in girls as young as first grade. Gunderson et al. (2012) asserted that children at this age are especially likely to internalise mathematics-gender stereotypes as they are "at the peak stage of gender rigidity" (p. 154). However, there is currently a lack of research about the source of children's mathematical

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stereotypes in the early years of formal schooling. This gap in the literature is regrettable, as children depend on their parents to model concepts about their academic competence, especially in the early years of school (Spinath & Spinath, 2005). There is value in understanding exactly when children begin to understand the interplay between their self-concept as learners and the cues they take on about their gender. If teachers and parents can understand where and when negative self-concepts about mathematics are introduced to children, interventions can be made.

Methodology

Research Participants

This research was conducted at three primary schools situated in South-West Sydney. There were 78 Kindergarten students at School A, 93 students at School B and 114 students at School C during this study. 35 parents from School A participated in the survey, 8 parents from School B and 18 parents from School C. The three schools are part of a 'Community of Schools' made up of three primary schools and one high school in the same locality.

Candidates for this purposive study were made up of the parents/ caregivers of these kindergarten students. Participants were recruited during Kindergarten orientation evenings and supplied with a Google forms survey link. Both parents/ caregivers could complete the survey resulting in some data collected from both the mother and father of the same child. A total of 61 parents completed the *Who and Mathematics* survey online and 7 parents took part in an extensive interview to draw out their responses more fully. Amongst the parents/ caregivers, 50 participants were female and 11 were male. The lack of equalisation in the survey is a limitation. However, amongst the interviews, participants were more representative of both genders with 3 fathers and 4 mothers participating.

The parameters of this sample were that the participants must be parents/ caregivers of kindergarten students. This is the first year of formal education in New South Wales. A parallel study with kindergarten students to understand their mathematical views using a modified *Who and Mathematics* survey was conducted concurrently. This data will be analysed at a later date for comparison and any correlations.

Survey and Interview Items

A questionnaire was given to Kindergarten parents at all three schools to gauge gendered attitudes using the *Who and Mathematics* scale. It contained 30 items on gendered attitudes that was subsequently used as data for analysis. Instructions and an example were included for the participants in an attempt to reduce errors and the risk of invalidated data.

The Who and Mathematics scale

This is an existing tool that has been used in the past to measure and document gendered attitudes and stereotypes. It is based on the *Mathematics as a male domain* subscale of the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976). In 2000, Leder and Forgasz revised the *Mathematics as a male domain* instrument to allow for greater validity and to allow respondents to select an item as a female domain instead of the previous instrument which only offered *male* or *neutral* options. The *Who and Mathematics* scale includes 30 items with statements such as: 'Mathematics is their favourite subject', 'Need mathematics to maximise future employment opportunities' and 'Expect to do well in mathematics'. Participants are asked to choose 1 of 5 possible responses on a Likert scale: BD (boys definitely more likely than girls), BP (boys probably more likely than girls), ND (no difference between boys and girls), GP (girls probably more likely than boys) and GD

(girls definitely more likely than boys). Leder and Forgasz (2000) found that beliefs had been changing from the perception of mathematics as a male domain in their *Who and Mathematics* survey. When compared to previous Fennema-Sherman results, it was girls rather than boys who viewed mathematics as their favourite subject, enjoyed mathematics, found it easier than the boys did and thought mathematics was interesting. Leder and Forgasz regarded these results as evidence that views were shifting towards mathematics being viewed as a female domain and “consistent with the now prevalent perceptions of boys as the educationally disadvantaged group” (p. 375). Repeating this survey 18 years later allows us to see if this trend has continued or not.

Parent interview

The *Who and Mathematics* scale questionnaire provided a snapshot of parent views. It was important to gain a clearer and more detailed picture from parents in an attempt to capture their understanding and the reasoning behind their beliefs. Interview questions were directed at the participants’ own experiences, feelings, beliefs and observations about mathematics and gendered ability. Purposive sampling was carried out followed by purposeful random sampling. This was conducted in an attempt to equalise the representation of mothers and fathers. There were 4 mothers and 3 fathers that took part in the interview, they were parents of 3 kindergarten girls and 4 kindergarten boys.

Data Analysis Process

Parent responses to the *Who and Mathematics* survey were analysed using GraphPad Prism analysis software (version 8.0.1). Values were assigned to the parents’ responses in a similar manner to the Leder and Forgasz study in 2000. These values ranged from -2 (BD), -1 (BP), 0 (ND), +1 (GP) and +2 (GD). Mean and standard deviation (SD) were included in the data for comparison. All figures were represented by horizontal column graphs, showing the mean and SD. Questions were grouped into the categories of; enjoyment and interest, aptitude, attitude and behaviour, confidence or anxiety, sense of value and importance, encouragement from role models, relationship to later life and employment.

Results and Discussion

Enjoyment and Interest

More parents thought that boys would choose mathematics as their favourite subject (Figure 1). Only 3 out of 61 parents nominated that it would be a favourite subject for girls. Parents also believe that boys enjoy mathematics more than girls. They believe boys tend to like using computers more and find mathematics more interesting. Remarkably, girls were perceived to enjoy challenging mathematics problems more than boys. This is unusual given the response by parents to earlier questions about girls’ enjoyment of mathematics overall.

When elaborating on who would like mathematics more, parents considered a range of views; noting their own experiences, their child’s and other parents. Parents made the following comments during the interview:

I think that from talking to a lot of other dads that I know their sons are keen on maths and my son is definitely keen on maths and I was as well so that's probably why, yeah, I just think that boys need to be, I think they need to be stimulated a bit more. I think Maths is a bit more exciting than English and other stuff. Father 1 of Boy 28

He finds it very interesting. But girls can too, but for me, I think I've seen, a lot of boys find it even more interesting. It's like a competitive thing. Mother 1 of Boy 28

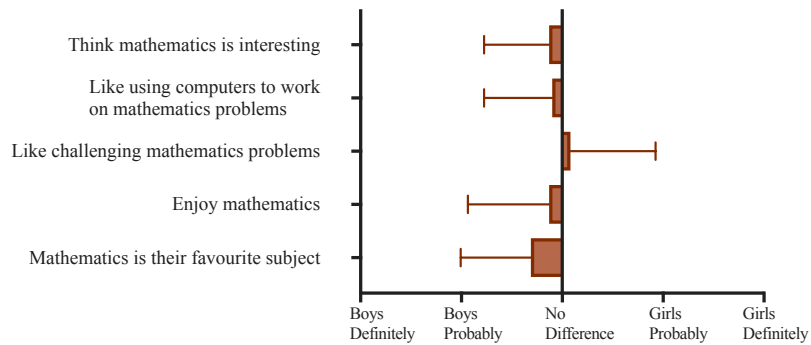


Figure 1. Parents' perceptions of which gender shows more enjoyment and interest in mathematics.

Aptitude

The results in Figure 2 support the stereotypical narrative of girls not being naturally capable in mathematics and requiring more help, with the reverse being true for boys. Twice as many parents believed that girls rather than boys would find mathematics difficult and need more help. Interestingly, more parents believed that boys would get the answers wrong despite their belief that boys find mathematics easier.

I think boys are really good at that (engineering and construction) and moving and building. This is just what I see from my son and what I see from boys playing and moving things around. I think in terms of space, understanding what space is and how to move things in space. Boys are much better at that. Father 2 of Girl 2

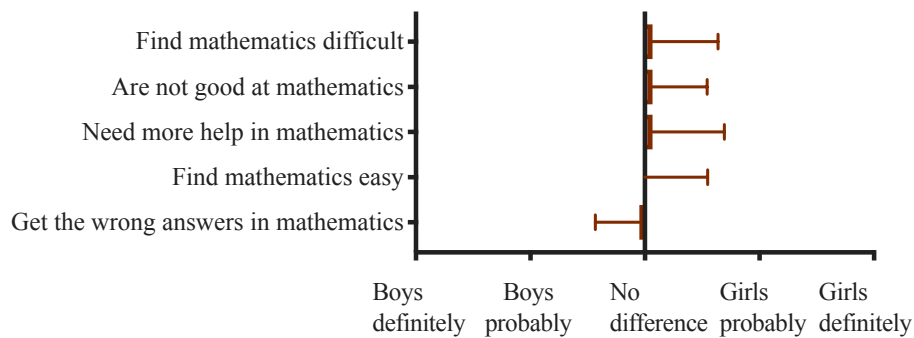


Figure 2. Parents' perceptions of which gender has more of an aptitude for mathematics.

Attitude and Behaviour

We see some stereotypical views in the data shown in Figure 3 that girls have to work hard to do well and in fact, they are nominated as being harder workers. Boys are viewed as being more likely to tease both boys and girls and give up when they find mathematics difficult. The most significant response in the survey was for the statement that boys are more likely to distract other students from their work with 26 parents believing that boys are either probably or definitely distracting others in class. In contrast, only 3 parents thought that girls might be distracting to others. If we consider the data in Figures 2 and 3 together, we can see a narrative building of girls as hard workers who lack natural ability.

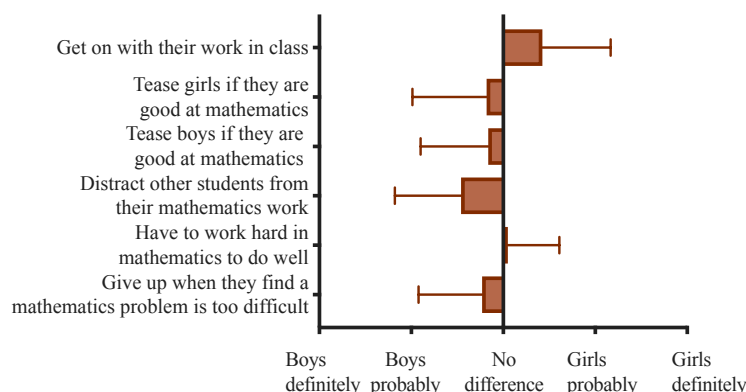


Figure 3. Parents' perceptions of which gender has particular attitudes and behaviours in mathematics.

Confidence or Anxiety

Parents show a preference towards the girls expecting to do well in mathematics (Figure 4). This is at odds to previous statements (Figure 2) that girls don't do well in mathematics.

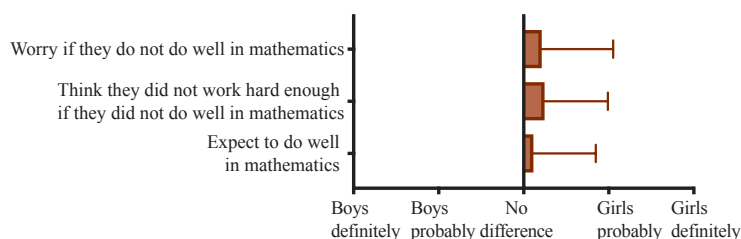


Figure 4. Parents' perceptions of which gender shows confidence or anxiety in mathematics.

Overall, twice as many parents believed that girls rather than boys would worry about their results and four times as many parents thought that girls would attribute their poor results to their own lack of effort. Parents elaborated on these ideas in the interview.

I think in general, from my personal experience, the girls seem to worry a bit more about marks and perfecting, getting the right answer, whereas the boys were more sort of practical, and sort of easy going towards maths. Mother 2 of Boy 2

Yeah. Because when she comes home and she tells me, oh, I didn't do good. I should have done this and that, but with (my son), like, he's like, it's alright, I can do better next time. Mother 3 of Boy 0

Sense of Value and Importance

Twice as many parents believe that girls rather than boys care more about doing well in mathematics (Figure 5) but girls are perceived as finding it boring and undervaluing its importance. This is an apparent contradiction as parents seem to believe that girls disregard mathematics as unimportant but still care more than boys about doing well anyway. It does align with the perception of girls as hard workers. Parents appear to believe that girls will continue to work hard regardless of the subject's interest or importance to them.

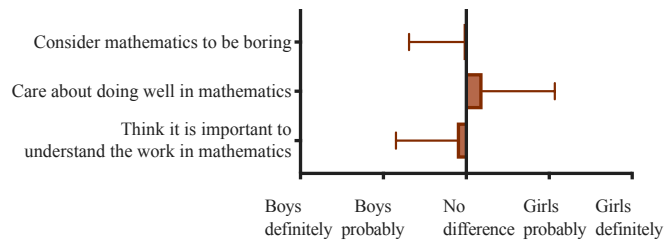


Figure 5. Parents' perceptions of which gender has a sense of value and importance of mathematics.

Encouragement from role models

Parents perceive that mathematics is more important for boys to study (Figure 6) with only 1 parent specifying that it would be more important for girls. They would be more disappointed if their son performed more poorly than their daughter. They believe teachers encourage boys more, ask them more questions and spend more time with them. Parents don't believe that teachers have a fixed idea of one gender as doing better than the other.

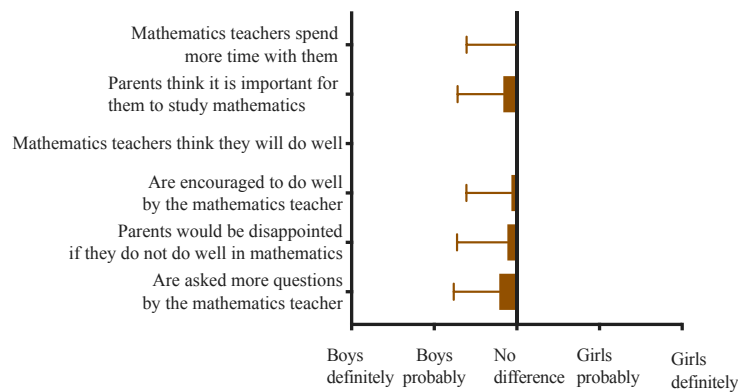


Figure 6. Parents' perceptions of which gender receives encouragement from role models in mathematics.

Interestingly, when interviewed, many of the parents stated that they themselves were not good at mathematics but that it was important that their children were. Parents were asked to roleplay a scenario where they comforted their child who was finding mathematics challenging:

(Daughter), I want you to do maths. I would get you a tutor if you have to. I can't say I can help you, because I'm not good, but yeah. Because she needs, you need it in life. And you want to be a teacher, so ... Mother 3 of Girl 0

I would ... it depends. I think maths is really important. And I would probably put my, I would say to him, Well, mummy doesn't like maths. But it is sometimes maths is things that you need to do. I would probably try to encourage him. Mother 1 of Boy 28

Relationship to later life and employment

Parents believe that mathematics is more important for boys as they grow older (Figure 7) as well as for future employment. Only 3 out of the 61 parents specified that mathematics would be more important for girls, both in their adult life and for employment. In contrast,

17 parents responded that boys needed mathematics in their adult life and 14 parents selected boys as needing mathematics to maximise employment opportunities.

Maths for boys I found is more important for completing school. If they didn't want to go in an office. I think if girls had to fall back onto a career or what not, they could always fall back into an office, and you've got calculators and that thing, being more literacy types they would need (them). Whereas boys would be in an apprenticeship, building, that sort of hands-on skills where they would need to rely a bit more on maths. Mother 2 of Boy 2

I believe that a lot of parents still will push their boys into doing maths to get further ahead post school. They don't then push girls to do maths just for the same chance. I don't think it'll be the same push to get women to have those opportunities. Father 2 of Girl 2

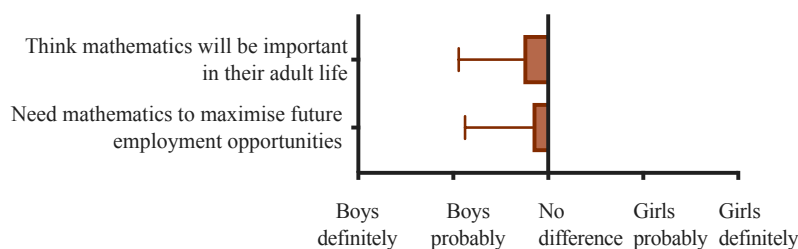


Figure 7. Parents' perceptions of which gender needs mathematics for later life and employment.

Conclusion

Stereotypical thinking regarding mathematics as a male domain is evident in parents' responses in this study. It appears that parents attribute positive associations with girls' behaviour and work ethic but not their mathematical aptitude. They believe that girls are more anxious about their ability in mathematics. Despite believing that girls work harder than boys, parents think that girls will worry more about their lack of effort if they receive poor results. There are expectations that both teachers and parents will be more supportive of boys as they learn mathematics, and that mathematics is more relevant for boys as they move into adulthood and use mathematics for day-to-day life and to gain employment.

When comparing the results of this study to the study conducted by Leder and Forgasz in 2000, it is clear that the trend they saw of mathematics becoming viewed as a female domain, with boys at an educational disadvantage, has not continued. While most parents responded with 'no difference' for the majority of questions, when they did consider there to be a difference, it usually favoured boys. Further data analysis is needed to determine which views are held by the male parent/guardian compared to the female parent/guardian and if there are any key differences.

Understanding the way parents of Kindergarten students think is an important consideration for researchers, educators and parents. These students are beginning to build their own learner identities and understandings, not only about mathematical content but also whether they can be capable and successful mathematicians. If students at this young age are exposed to messages that they are less capable due to their gender, it is reasonable to expect some sort of uptake of these negative ideas.

There are a multitude of researchers who believe that understanding parents' mathematical gender stereotypes will bring to light an inter-generational transmission of mathematics attitudes that impact on children's mindset as well as achievement (Eccles, Jacobs, & Harold, 1990; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005). They believe that the development of a negative attitude to mathematics in a child's formative years contributes to life-long patterns of avoidance and anxiety.

It is important for educators and parents to understand the interplay between self-concept and the various messages about mathematical capabilities that students receive. In this way, educators and parents can work together to ensure that the key principles of equity and access to education are realised for all students.

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