The experiences of homeschooling parents with mathematics

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Homeschooling, where parents take on the prime responsibility for their children's education, is a growing phenomenon in Australia. Homeschooling is different from distance education or the education at home that has taken place in the Covid-19 pandemic in that the parents make all the decisions about their children's education, including planning, implementation and assessment. This study examined the experiences of homeschooling parents in the field of mathematics and adds to the sparse literature in this area. The study investigated the parents' own experiences of mathematics at school, their confidence in their role as parents of learners of mathematics, and their beliefs about the nature of mathematics and its teaching. It was found that the parents were mixed in their views about the nature of mathematics and how mathematics should be taught, were confident in their role as the parent of mathematics learners, and had good knowledge of their children's mathematics learning.

Introduction

Homeschooling, where parents take on the prime responsibility for their children's education, is a growing phenomenon in Australia. Education is compulsory for all children in Australia until the ages of 16 to 18 (depending on state legislation), and whilst homeschooling is a legal option, parents are required to register their children as being homeschooled with the state governments. Finding the numbers of children who are homeschooled is difficult, as registration of homeschooling is maintained by the individual states. In 2019, however, it was estimated there were approximately 20,000 children registered as being homeschooled and an unknown number of children, believed to be in the thousands, being homeschooled who are not registered (English, 2019).

In this study homeschooling refers to those children whose parents make all the decisions about their children's education, including planning, implementation, and assessment (Victorian State Government Department of Education and Training, 2019). It does not include distance education run by a government or registered non-government school, or school directed learning at home (such as occurred during the COVID pandemic). This research took place before the various lockdowns that occurred in Australia; therefore this form of schooling at home is not included.

The reasons for parents choosing to homeschool include the belief that children's education is the responsibility of their parents; the desire to protect children from beliefs different to their own (possibly religious); concerns over the quality of teaching (Farris, 2013); the desire to protect children from unwanted influences such as alcohol and violence (New South Wales Parliament, 2014); to remove their children from negative school experiences such as bullying; to educate their children with special needs; to provide an individualised education; and because of distance (Croft, 2013; Townsend, 2012; Varnham, 2008).

Previous research on homeschooling has focused on why parents homeschool (Farris, 2013; New South Wales Parliament, 2014), academic achievement (e.g. Martin-Chang, Gould & Meuse, 2011), socialisation (e.g. McGlaughlin, 2018) and parental roles when homeschooling (e.g. Cai, 2003). There is little research on mathematics and homeschooling, and what there is has mainly focused on the academic achievement of the students.

There is considerable research on teachers' and pre-service teachers' attitudes, beliefs, and practices about mathematics teaching (e.g. Barlow & Cates, 2010; Cooke & Walker, 2015). Despite the growing number of children being homeschooled, little is known about the experiences of homeschooling parents in the mathematics education of their children. This study adds to this literature.

Literature review

Effects of parental involvement on academic achievement

Parental involvement in children's schooling takes many forms. It can refer to parent-initiated involvement such as help with homework, volunteering at school, and involvement in organisations such as Parents and Friends groups. It can also refer to school-initiated involvement such as attendance at parent-teacher meetings and school workshops (Driessen, Smit & Sleegers, 2005). In general, it has been found that such parental involvement is beneficial for their children's academic success, except for help with homework which has a minimal to negative effect (Castro et al., 2015). The most positive benefits to academic achievement, however, arise from the parents having high academic expectations of their children, followed by the development and maintenance of communication with their children about school activities, and the promotion of reading habits (Castro et al., 2015).

When it comes to parental involvement in mathematics for mainstream schooled children the results are mixed. For example, Cai (2003) found that the schoolchildren with supportive parents scored higher on mathematical problem-solving tasks than those without supportive parents. In contrast, if parents who are anxious about mathematics provide "frequent" help to their children on mathematics homework, their children learned significantly less than their peers over a school year (Maloney, Ramirez, Gunderson, Levine & Bellock, 2015). If these anxious parents did not assist their children, their children's achievement was not affected. When it comes to the mathematics achievement of homeschooled children, the results are again mixed. Wilkins, Wade, Sonnet and Sadler (2015) found that homeschooled students achieved significantly higher grades at the end of a college calculus course. In contrast, other studies have demonstrated that whereas homeschoolers score above average on language-based subjects, they score below average on mathematics subjects in U.S. college entrance tests such as the SAT and ACT (Belfield, 2005; Qaqish, 2007).

Previous research into parents of traditionally schooled children has demonstrated that few parents have a good understanding of how their child is taught mathematics (Muir,

2009). Peressini (1988) has also found that parents often wish to help their children in mathematics but may be unsure how to do this. Surveys of adults show that many adults believe mathematics is difficult, and they feel anxiety, fear and embarrassment when faced with a mathematical task (Bibby, 2002; Haylock & Mannning, 2014). This is of concern because it has been demonstrated that parents' attitudes to mathematics influences their children's attitudes towards mathematics (Mohr-Schroeder, Jackson, Cavalcanti, Jong, Schroeder & Speler, 2017).

Beliefs and attitudes about mathematics

Richardson (1996) defined beliefs as "psychologically held understandings, premises, or propositions about the world that are felt to be true" (p. 103) and this definition was used in this study. Beliefs are very closely linked with a person's attitudes which are defined as "a person's general feeling of favorableness or unfavorableness towards a stimulus object" (Fishbein & Ajzen, 1975, p. 216). Beliefs and attitudes are intertwined: "as a person forms beliefs about an object, he [sic] automatically and simultaneously acquires an attitude toward that object" (Fishbein & Ajzen, 1975p. 216).

Beliefs and attitudes are important in mathematics not only because of their influence on how a person performs in mathematics, but also because of their influence on how teachers teach mathematics. Teachers who believe that mathematics is a set of rules to be learned (a traditional view) place an emphasis on mastering procedures and getting correct answers. It has also been found that these teachers do not see mathematics as creative and tend to believe that mathematics ability is fixed. In contrast, teachers who believe that mathematics is a way of looking at the world will encourage their students to engage in problem solving and let students explore solutions for themselves. These teachers also tend to believe that mathematics is creative and that mathematics ability is amenable to change (Stipek, Givvin, Salmon & MacGyvers, 2001). The teachers who are more traditional in their view tend to be less confident in teaching mathematics and find it less enjoyable than their counterparts (Stipek et al., 2001). If teachers' beliefs about mathematics affect the way they teach this subject, it is possible that that parents' beliefs about mathematics may also influence the way they interact with their children during their mathematics learning.

Self-efficacy and mathematics anxiety

Much of the literature on self-efficacy is based on the work of Bandura (1997a) who described two forms of *efficacy expectations*. An *outcome expectancy* was described as a "person's estimate that a given behavior will lead to certain outcomes". An *efficacy expectation* was described as "the conviction that one can successfully execute the behaviour required to produce the outcomes" (p. 193). Self-efficacy influences behaviour, in that people will avoid situations which they believe are beyond their coping skills and get involved in activities in which they judge themselves capable (Bandura, 1997a, p.194). Ashcraft and Rudig (2012) adapted Bandura's definition of self-efficacy to mathematics, "self-efficacy is an individual's confidence in his or her ability to perform mathematics and is thought to directly impact the choice to engage in, expend effort on, and persist in

pursuing mathematics" (p. 249). Collins (1982, cited in Bandura, 1997b) found that school children who had a stronger belief in their self-efficacy were more likely to solve more exercises, to rework exercises that were incorrect, and made fewer errors than the children with equal ability but a lower belief in their self-efficacy.

Low self-efficacy in mathematics may result in feelings of apprehension so severe that the person's working memory may be affected, resulting in poor performance even in the simplest mathematical tasks – this is known as mathematics anxiety (Ashcraft & Kirk, 2001). People affected in this way make more errors in school tasks than non-anxious people and are less able to realise when an answer is unreasonable (Moore, Rudig & Ashcraft, 2015). They also find every day mathematical tasks such as calculating change difficult. Consequently, they avoid any course of study or career path where mathematics is required.

Self-efficacy also affects how teachers approach their mathematics teaching in the classroom. Teachers who believe that they have self-efficacy as mathematics teachers devote more time to instructional activities, provide more guidance to students with difficulties, and are more likely to praise their students. In contrast, teachers with low self-efficacy as mathematics teachers spend less time on instructional activities and are more likely to be critical of their students (Bandura, 1997b, p. 241). It is therefore possible that the mathematics self-efficacy of parents as doers of mathematics may also influence the way they interact with their children during the children's mathematics learning.

Innate ability

Previous research on adults' attitudes to mathematics have found a common belief is that people who are good at mathematics are very intelligent and are born with the innate ability to do mathematics (Allexsaht-Snider & Hart, 2001; Lim, 1999). Such a belief is reflected in what Dweck (2006) described as "growth" and "fixed" mindsets in students. Students who believe that intelligence and ability are fixed spend less time on mathematics, and perform more poorly than those students who believe that mathematical ability is due to effort (Ashcraft & Rudig, 2012). When faced with a challenge these students give up (Boaler, 2013). In contrast, students who believe that ability can grow will enjoy challenges and have been found to learn more effectively (Boaler, 2013). The parents of children of high mathematics ability are likely to attribute children's high mathematics ability to "talent", not effort. In contrast, the parents of children with average mathematics ability tend to attribute this to lack of teacher help and lack of effort (Yee & Eccles, 1988).

Gender

There is considerable evidence indicating that teachers and parents consider mathematics to be a male domain (Heyder, Steinmayr & Kessels; Hand, Rice & Greenlee, 2017). By the end of their schooling both boys and girls regard mathematics as a male area, with teachers and students perceiving that boys are better than girls in mathematics and the sciences (Hand, Rice, & Greenlee, 2017). Teachers and students also attribute masculine

characteristics to those who work in STEM areas. This is reflected in the higher proportion of males who enrol in advanced mathematics subjects in the later years of secondary school (Australian Mathematical Sciences Institute, 2020). The evidence, however, is that males and females have equal aptitude for mathematics and STEM subjects (Spelke, 2005). International comparisons show that differences in mathematics achievement are generally very small, but overall, boys are more confident and less anxious about their mathematics ability and are more motivated to do well in mathematics (Else-Quest, Hyde & Linn, 2010). There is also a connection between the anxiety about mathematics of the teachers, and the way their students perceive mathematics. Female students in early primary school (but not males) whose teachers (mainly females) are anxious about teaching mathematics, are more likely to state that boys are better at mathematics and tend to achieve less well than boys (Beilock, Gunderson, Ramirez & Levine, 2010).

The effects of changing teaching

Modern mathematics teaching in primary school concentrates less on the teaching of formal algorithms and concentrates more on the use of hands-on manipulatives, than in the past. It is known that this can cause tension between parents and teachers of children in traditional schools, with parents giving higher value to their own forms of doing mathematics (Muir, 2011). In addition, the unfamiliarity parents experience with their children's work also can lead to uncertainly about how to help their children (Civil, 1999).

Aims

Whilst there are several studies examining beliefs about mathematics amongst parents of traditionally schooled children (e.g. Marshall & Swan, 2010; Muir, 2009; Onslow, 1992), to date no studies have been found that explore these beliefs and attitudes to mathematics by homeschooling parents. This study was exploratory with the aim of answering the following questions about homeschooling parents' role in the learning of mathematics by their children:

- What are their attitudes to mathematics?
- What beliefs about mathematics do they hold?
- What beliefs about the teaching of mathematics do they hold?
- What level of self-efficacy do they have in their role as parents of learners of mathematics?
- What support do they need in their role as parents of learners of mathematics?

Method

Recruitment

To locate potential participants, an Internet search was carried out to identify homeschooling associations in Australia. By this means, ten state and national associations (see Appendix) were contacted via email with a request that an introductory email and

information letter be sent to their members. Included in the explanatory email was a link to an anonymous survey in *Qualtrics*. It is not known how many associations sent out the information or how many individuals were contacted, but 80 responses were received. The distribution of the number of children who are homeschooled in each family is given in Table 1, and the distribution of the ages of the children is given in Table 2. At the time of the study, there had been some negative media attention on homeschooling, therefore the decision was taken not to ask personal questions so data on gender and the reasons for homeschooling were not collected.

Table 1: Number of children being homeschooled

Number of children per family	Frequency	Percent
One	29	36.3
Two	31	38.7
Three	14	17.5
Four	6	7.5
Total	80	100

Table 2: Age of the children being homeschooled

Age range	No. children
3-5	9
6-8	41
9-11	58
12-14	28
15-17	20
Over 17	1
Total	157

Table 3: Length of time the parent has homeschooled

How long parent has homeschooled	Frequency	Percent
Under 1 year	14	17.5
Greater than 1 year but less than 3 years	11	13.8
Greater than 3 years but less than 6 years	21	26.2
Greater than 6 years but less than 9 years	11	13.8
Greater than 9 years but less than 12 years	15	18.7
Greater than 12 years	6	7.5
No response	2	2.5
Total	80	100

The instrument

Based on the literature, three tentative hypotheses were made that guided the questions selected for the survey described in this section. These were:

- That the parents' own experiences as mathematics students may affect how they approached the mathematics learning of their children;

- That the parents' own experiences as mathematics students may affect their self-efficacy as they approached the mathematics learning of their children;
- That the parents' own beliefs about the nature of mathematics may affect how they approached the mathematics learning of their children.

After the demographic questions, the participants were asked about the importance of mathematics (a) in everyday life, and (b) to their children's education. These were scaled as: (1) Very important; (2) Important; (3) Neither important nor unimportant (4); Unimportant; and (5) Not at all important. This was followed by a set of 18 items that addressed three areas: (a) Beliefs about mathematics (b) Beliefs about the learning of mathematics, and (c) Knowledge of their own children's learning of mathematics. These items and their sources are listed in Table 4. Responses to each item were on a 5-point Likert Scale: (1) Strongly agree; (2) Agree; (3) Neither agree nor disagree; (4) Disagree; and (5) Strongly Disagree. A final question asking about their level of confidence when their child asked for help in mathematics was also included with the Likert items. The word "confident" was used as it was not expected that the participants would be familiar with the term "self-efficacy". This question was scaled as: (1) Very confident; (2) Confident; (3) Neither confident nor unconfident; (4) Not confident; (5) Not confident at all.

Open-ended questions

Parents who homeschool their children are not required to have teacher training or experience in a classroom (New South Wales Parliament, p.10). Therefore, the questions used to determine their previous experience in mathematics asked about their personal feelings about mathematics and not their academic achievement in mathematics. Specifically, these questions were: how did you feel about mathematics when you were a student? And, how do you feel when the word "mathematics" is used? The participants were then asked about their homeschooling experiences in mathematics for each individual child who was being currently homeschooled. For each child they were asked: the age of the child, the mathematical resources used by this child, and their level of confidence in assisting this child in mathematics. Following Marshall and Swan (2010), the parents were then asked to describe an incident when they felt confident in assisting this child and then to describe an incident when they did not feel confident in assisting this child; whether there was any particular mathematical topic that caused particular difficulty for them or their children, and the nature of any assistance they believed they might require.

Data analysis

A factor analysis (using *SPSS v. 22*), was conducted to identify the constructs underlying the items of the questionnaire. Cronbach's alpha was then used to measure the internal consistency of the subsequent subscales. Composite scores were automatically created for each of the factors using the items that loaded onto each factor. Correlations were then investigated between each of the composite scores with the number of children being homeschooled, the length of time the parent had homeschooled, and age of the child. The open-ended questions were subjected to a thematic analysis (Braun & Clarke, 2006; Charmaz, 2006). After the factor analysis, to report on individual items, the answers

"strongly agree" and "agree" were combined to simplify reporting. Similarly, the responses "disagree" and "strongly disagree" were combined.

Table 4: Likert questionnaire items (the order of appearance was determined by the random number generator in Microsoft *Excel*)

Item no.		Statement	Source
Beliefs about mathematics	1	You either have a maths mind or you don't	Beswick & Dole, 2001; Kogelman & Warren, 1978.
	5	Most problems done in everyday life are calculated mentally	Northcote & McIntosh, 1999*
	15	Men are better at maths than women	Beswick & Dole, 2001; Kogelman & Warren, 1978.
	16	People who are good at maths are born like that	Muir, 2009.
	17	Maths is creative	Cooke & Walker, 2015.
Beliefs about the learning of math-ematics	2	Learning tables by heart is very important	Muir, 2011.
	3	It is important that my child/ren learns the correct procedures	Muir, 2011.
	4	Maths is best learned by practising the set procedures	Van de Walle, Karp & Bay-Williams, 2013*
	6	Being able to explain your answer is important	Pritchard, 2004*
	9	Games and activities are a good way to learn maths	Muir, 2009.
	10	It is important that my child/ren does things the way I show them or are in their books	Howard, Perry & Lindsay, 1997*
	11	Worksheets and textbooks are a good way to learn maths	Muir, 2011.
Knowledge of their own children's learning of mathematics	7	My child/ren learns methods that are different from the methods I learned	Muir, 2011.
	8	I have a good understanding of how my child/ren is learning mathematics	Muir, 2009.
	12	I enjoy helping my child/ren with mathematics	Pritchard, 2004.
	13	I know what types of mathematical skills and understandings my child/ren has	Muir, 2009.
	14	I regularly engage in mathematics-related activities with my child/ren	Muir, 2009.
	18	It worries me if my child/ren learns different methods than I learned	Muir, 2011.
	19	I feel confident when my child/ren asks for help in mathematics	Marshall & Swan, 2010.

* These questions were not directly taken from these sources but were developed from material within them.

Findings

Factor analysis

Each item in Table 4 was reverse scored so that higher numbers indicate higher levels of agreement These items were then checked for suitability for factor analysis. Eighteen of

the items correlated with at least one other item at 0.3 or above, the exception being Item 6 (Being able to explain your answer is important). The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.673, above the commonly recommended value of 0.6 (Pallant, 2013) and Bartlett's test of sphericity was significant ($\chi^2(153)=494.48$, $p<0.05$). The diagonals of the anti-image correlation matrix were all over 0.5, apart from Item 6. The communalities were all over 0.3; values lower than this indicate that an item does not fit well with the other items in a component (Pallant, 2013). Principal components analysis was used because the primary purpose was to identify factors and, if suitable factors were found, to compute composite scores. Five factors had an eigenvalue of over 1.0, and these explained 63.13% of the variance.

After examining the results, it was decided to repeat the analysis without Item 6 as it did not load with any other item. The results from the oblique rotation were used as it is considered unlikely that the factors would be uncorrelated (Pallant, 2013). Loadings with less than an absolute value of 0.4 were suppressed to ease interpretation. Because of the insufficient number of primary loadings onto the fourth and fifth factors, and the difficulty of interpreting these two factors, a three-factor solution was chosen (explaining 48.53% of the variance). Therefore Item 9 (Games and activities are a good way to learn maths) and 7 (My child learns methods that are different from the methods I learned) do not appear in this solution. Internal consistency was determined using Cronbach's alpha and found to be moderate for all three factors: 0.63 for Factor 1, 0.73 for Factor 2 and 0.75 for Factor 3. Eliminating further items did not result in any substantial improvement. The loadings for each factor are displayed in Table 5. No item loaded onto more than one factor.

Table 5: Factor loadings for the Parents and Mathematics (PAM) items

	Item	F1	F2	F3
3	It is important that my child learns the correct procedures	.84		
4	Maths is best learnt by practicing the set procedures	.83		
10	It is important that my children do things the way I show them or are in their books	.81		
18	It worries me if my children learn different methods than I learned	.64		
2	Learning tables by heart is very important	.52		
11	Worksheets and textbooks are a good way to learn maths	.51		
5	Most problems done in everyday life are calculated mentally	.43		
8	I have a good understanding of how my children are learning mathematics		.87	
13	I know what types of mathematical skills and understandings my children have		.82	
12	I enjoy helping my child with mathematics		.70	
14	I regularly engage with mathematics-related activities with my child		.56	
19	I feel confident when my children ask for help in mathematics		.40	
16	People who are good at mathematics are born like that			.85
1	You either have a maths mind or you don't			.82
17	Mathematics is creative			.71
15	Men are better at maths than women			.48

Items not included: Items 6, 7 and 9

The first factor to be extracted (here called *Tradition*) accounted for 21.7% of the variance. The second factor (here called *Awareness*) accounted for an additional 16.5% of the variance and the third factor (here called *Beliefs*), accounted for an additional 10.4% of the variance.

Composite scores were automatically calculated in *SPSS* of the items that loaded onto each factor. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that the difference between at least two of the means of the composite scores was statistically significant ($F(1.186, 147.241) = 225.99$, $p<0.0001$). Post hoc tests using the Bonferroni correction revealed that the differences between the means of all three scores were significant ($p< 0.0001$). The highest mean score was for *Awareness* (4.25) followed by *Tradition* (3.08) and then *Beliefs* (2.18).

The first extracted factor (*Tradition*) partially aligned with the *a priori* items listed under "Beliefs about the learning of mathematics" in Table 4. The items in this factor reflect traditional ways of learning mathematics such as learning tables, practising procedures, and using worksheets and textbooks. This factor also reflects the feelings of insecurity that parents may have when their children learn procedures with which they are not familiar (Civil, 2006).

The second extracted factor (*Awareness*) aligns closely with the *a priori* items listed under "Knowledge of their own children's learning of mathematics" in Table 4. Of interest is that Item 18 (It worries me if my children learn different methods than I learned) was not found in this factor, but aligned with *Tradition*. This factor indicates, that in general, the parents believe that they are aware of their children's mathematical learning, engaged in their children's learning, and enjoyed this engagement. This factor did not have a significant correlation with *Tradition*.

The third extracted factor (*Beliefs*) closely aligned with the items listed a priori under "Beliefs about mathematics". These beliefs were about mathematics ability being innate (see below) and that mathematics is creative. An examination of the latter item shows that 68.75% (55 of the respondents) agreed with this statement. This factor had a positive correlation with *Tradition* ($r= 0.303$, $p<0.05$), and a negative correlation with *Awareness* ($r = -0.262$, $p<0.01$).

Specific aspects and beliefs

The importance of mathematics

The mathematics that is used in everyday life, known as numeracy, has become prominent in education over recent years (Australian Association of Mathematics Teachers, 1997). Numeracy may differ from the mathematics carried out in school, which may be abstract (Steen, 2007). When asked about the importance of mathematics to everyday life, all the participants apart from four answered either "Very important" or "Important" (Mean score: 3.4, reverse scored). When asked about the importance of mathematics to their children's education, all the participants apart from two answered "Very important" or "Important" (mean score: 3.7, reverse scored). Four participants answered "Neither

important nor unimportant" to the first question, and two gave this answer to the second. No participant stated that mathematics was unimportant in either context.

The parents' own experience of mathematics at school

There were 36 positive comments from the participants to the open-ended questions about their own experiences of mathematics at school, and 23 negative comments. The positive comments referred to enjoying mathematics and problem solving, achieving at mathematics, and the satisfaction of getting the correct answer. For example:

> Maths was generally my favourite subject – I liked the objectivity – you could learn something and it was always right.
> I've always loved numbers and mathematics and studied it to the highest level possible at school.
> I enjoyed the puzzle aspect of maths … enjoyed it when the math [sic] question was solved.

The negative comments focused on non-enjoyment, finding mathematics difficult, and having a non-supportive teacher.

> I failed every maths test from age 8 and was told every day I was rubbish at maths.
> My year six teacher told me I was stupid and would never be good at maths.
> [I] didn't understand and felt stupid that I couldn't do it.

When asked about how they felt when hearing word "mathematics" (open-ended question), there were 65 responses; 44 of these were positive (e.g. "excited", "good", "great", "interested"). Nine of the participants replied "neutral" or similar. Nine of the responses were negative (e.g. "intimidated", "uneasy") and a further five responses did not answer the question (e.g. "it is a formal term"). However, not all the negative responses were related to not being confident in helping their own children in mathematics: "I realise now that I know more maths than I realised". There was no correlation between level of confidence reported in Item 19 and time homeschooling and number of children.

Confidence as parents of learners of mathematics

All respondents answered item 19 (I feel confident when my children ask for help in mathematics). Seven of these (8.8 %) stated that they were not confident when their children asked for help (Item 19). The open-ended answers from two of these respondents suggest that they struggle with mathematics anxiety. One of the two respondents, when asked how they felt when they hear the word mathematics stated, "I cringe". The other stated, "Intimidated, immediately feel stupid". Both reported that they were not confident in helping their children with mathematics. There were five other respondents who also stated that they were not confident in helping their children with mathematics. Two stated that they had liked mathematics at school, one said that maths was "not easy", and the other two did not answer the questions about their own experiences.

The respondents were asked to describe experiences when they felt confident, and when they did not feel confident, in assisting their children in mathematics. For the respondents

who had more than one child homeschooling, the responses between children were very similar, therefore, only the responses for the first child are described here. There were 74 responses to the question asking about situations when they felt confident; 11 of the responses described using real-life applications such as cooking, shopping and budgeting. Eleven participants stated that they felt confident all or most of the time and 12 participants stated they were confident when working with their children. The mathematical topics that were included in the positive experiences varied from early years learning, such as place value to more advanced mathematics such as calculus, whereas other responses were more general, for example, when "they knew the work". There were 74 responses to the question asking about experiences when they did not feel confident; 14 of the participants said they were never not confident, and 14 stated that they were not confident when they either did not understand the material themselves, had forgotten the topic or when their child became frustrated. A small number of parents, however, stated that not knowing the content was an opportunity to research a topic with their child.

Innate ability

The mean for *Beliefs* (2.18) suggests that, overall, the participants did not believe that the ability to learn mathematics is innate. There was a small but significant positive correlation between *Tradition* and *Beliefs* ($r = 0.303$, $P = 0.006$), suggesting that parents who believed that there is a best way to learn mathematics were more likely to believe that mathematics ability was innate. There was also a small but significant negative correlation between *Tradition* and *Beliefs* ($r = -0.262$, $p = 0.019$). This suggests that parents who were engaged with their children's mathematics were less likely to believe that mathematics ability is innate. None of the factors were significantly correlated with the length of time the parents had homeschooled or with the number of children they had homeschooled.

On examining some individual items it was found that ten participants (12.5%) agreed to the statement "people who are good at maths are born like that", 23 (28.5%) were neutral, and 47 (67.5%) disagreed (mean score = 3.7). Whereas the number of respondents who disagreed with the statement "you either have a maths mind or you don't" was equal to the question about being "born like that" (47), twenty participants (25%) agreed that you either have a maths brain or you don't, and 13 (16.3%) were neutral.

Gender

In answer to the statement "men are better at maths than women" only two (2.5%) of the respondents agreed. Fourteen (17.5%) were neutral and 64 (80%) disagreed.

Beliefs about mathematics and its learning

Sixty-one (76.3%) of the respondents agreed that mathematics is creative. Only 5 (6.0%) disagreed with this statement and 14 (17.5%) were neutral. Out of the five respondents who disagreed with this statement, four stated that they were not confident in assisting their children. Respondents showed a mixture of what can be considered traditional and not-so traditional beliefs about the teaching of mathematics. For example, 48 (60.0%) stated that learning times tables by heart was important, 50 (62.5%) stated that learning the correct procedures was important, and 44 (55.0%) said worksheets and textbooks were a good way to learn mathematics. However, only 27 (33.8%) stated that practising set

procedures was good, and 13 (16.3%) stated that it was important that their children do things the way the parents showed them or were in their books.

Table 6: Additional help parents would like for each child homeschooled

Help required	Child			
	1st	2nd	3rd	4th
None	15	16	9	1
Not sure	5	1		
Tutoring	7		1	
Time	3	1		1
Free or low-cost resources	4			
Hands on resources	1		1	
Games/ hands-on activities that increase interest/ interactive resources from the Internet/ less procedural	7	8	5	1
Others to share classes with	2			
Advice	2		1	
Worked examples	2			
Australian resources	2			
Multiplication tables		1	1	
(Other family members help out)	3	1		

What additional help do these parents need?

Table 6 shows the distribution of answers given by the parents when asked what other help would assist them in their homeschooling experiences in mathematics. This may be attributed to the parent becoming more experienced and/or the child being younger where the work is seen to be easier. It is also possible that the older children are helping their younger siblings. There were intimations by the parents that while they were confident in homeschooling their children in mathematics now, they believed they would need additional help, such as a tutor, as their children became older and advanced to more difficult topics. Of interest was the number of parents who stated that they would like to find more interesting sources for their children to use – resources that were "fun", "interesting", "interactive" and "less procedural".

Summary and conclusion

Similar to many studies in the homeschooling area, this study relied on volunteers, which limits the generalisability of the findings (see Kunzman & Gaither, 2013; 2020). It is still believed, however, that the study contributes to the literature on parents who are involved with homeschooling children in mathematics.

The results indicate that, overall, the respondents in this survey were highly involved in their children's mathematics learning and believed they had a good understanding of how their children were performing in this area.

Although the parents overall reported high confidence when it came to homeschooling their children in mathematics, there were also indications in the responses to the open-

ended questions that the parents experienced times of difficulty. Table 6 indicates that some parents wanted tutors, others needed more time, and others felt they needed advice. Others were concerned when their children's work developed beyond their own knowledge or were concerned that this might happen in the future. In addition, there were also several comments about being unsure of what to do when their children became frustrated in their mathematics learning. The written responses indicate that parents were more confident when they used real-life applications and understood the content themselves. The same experience, however, did not always lead to the same response. Some parents found lack of knowledge frustrating, whereas others saw this lack of knowledge as a joint learning opportunity with their child. It was apparent that many of the parents found the Internet a source of assistance that assisted them in their role as homeschooling parents.

Over half of the respondents agreed that learning procedures is important, and that worksheets and textbooks are a good way to learn mathematics. This latter belief has also been found in some mathematics teachers as they simplify preparation (Ünal, 2017) and may reflect the parents' and teachers' own school experience. However, the proportion of the respondents who also agreed that games and activities were a good way to learn mathematics (85%) and the number of respondents who wished to find more games and activities that were fun and interesting indicates that many were also using, or looking for, less traditional ways for their children to learn. Most of the respondents also agreed that mathematics is creative. Even though the numbers were too small to be generalisable, it is of interest that those who did not think that mathematics was creative were more likely to be those who were not confident in mathematics themselves; a finding that corresponds with the beliefs and confidence with teachers (Stipek et al., 2001).

This study has added to the sparse literature on parents who homeschool their children in mathematics. It indicates that, whilst the parents were generally confident in their role, they also experienced difficulty. The combined role of parent and teacher is complex, and more research in this area could result in more successful outcomes for these children. This is now increasingly important since the start of the recent Covid-19 pandemic, when schools in many countries were closed.

Ethics

This research was approved by the Human Ethics Research Committee at the University of Tasmania: H0016103.

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Appendix

Names and email addresses of homeschooling organisations contacted
(email addresses were correct at the time of the data collection)

	Name of organisation	Email address
1	Home education network	help@home-ed.vic.edu.au
2	Home education SA	home-education-sa@yahoo.groups.com
3	Connecting Queensland Homeschoolers	cqhs@protonmail.com
4	Aussie educator	contactaussie.educator@gmail.com
5	Australian Christian Homeschooling	info@achs.edu.au
6	The educating parent	beverleypaine@theeducatingparent.com
7	Homeschool Christian Academy	info@homeschoolwa.com.au
8	Sydney home education network	shen@sheb.org.au
9	Home Education Association	admin@hea.edu.au
10	Home Education WA	coordinator@hbn.org.au

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