

# Students' Perceptions of the Impacts of Parents, Teachers and Teaching upon their Anxiety about the Learning of Fractions

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This paper reports on three of ten themes that emerged from a study of the impacts of a fraction teaching intervention on the mathematics anxiety and fraction competence of eight Year 8 students. Two of the themes that arose from the multiple data sources related to teachers and teaching and a third related to parental support. The students identified practical, hands-on activities and group work as impacting positively on their learning and their confidence in relation to fractions. The influence of parents, either positive or negative was also mentioned by several of the students. The study highlights the connections between mathematics anxiety among middle school students and the nature and extent of support that they perceive from teachers and parents.

Mathematics anxiety has been a recognised construct since the early 1970s. It was defined by Richardson and Suinn (1972) as, “feelings of tension and anxiety that interfere with the manipulation of mathematical problems in a wide variety of ordinary life and academic situations” (p. 551). Cemen (1987) extended this definition to include the perceived threat one may feel to one’s self esteem. Mathematics anxiety includes aspects that are cognitive (e.g., worry), attitudinal (e.g., dislike), and emotional (e.g., fear) (Ma, 1999) and is considered to be one dimension of the broader construct, attitude to mathematics (Ma & Kishor, 1997). In this context it can be considered as one end of a confidence – anxiety spectrum. It has also been recognised that attitude to mathematics and hence mathematics anxiety can more usefully be studied in relation to specific aspects of mathematics. For example, Beswick, Brown and Watson (2006) reported varying levels of confidence among middle school mathematics teachers in relation to different aspects of the mathematics curriculum. Interestingly, teachers reported least confidence in relation to fractions.

The majority of research on mathematics anxiety has involved adult students, often primary pre-service teachers. The study reported here sought to address the gap in relation to school students and focussed on year 8 students because middle school, and middle school mathematics in particular, has been recognised as a critical gateway to high school course taking and future enrolment (Siemon, Virgona, & Cornielle, 2001). The first years of secondary school have also been identified as a key period in the development of mathematics anxiety (Hembree, 1990). The current study heeded McLeod’s (1992) suggestion that all research on teaching and students’ learning would profit from the integration of affective factors.

The relationship between mathematics anxiety and mathematical performance was described by Ashcraft and Kirk (2001) who asserted that positive attitudes and low mathematics anxiety allow an individual to enjoy and seek out mathematical experiences which inevitably lead to increased mathematical competence. Conversely, poor attitudes and high anxiety support avoidance behaviours which lead to decreased mathematical competence. In addition, they described how “higher levels of mathematics anxiety are related to lower available working memory capacity” (p. 236). Their research has indicated that even though this effect of the mathematics anxiety is temporary, whilst the anxiety exists the student may find it difficult to focus their attention on the task at hand or may have distracting thoughts which disallow their engagement with the task.

In addition to the influence of students' attitudes and consequent behaviours, the influence of parental and teacher support in a child's learning has been highlighted as relevant to the development of mathematics anxiety (Ma, 1999; Trujillo & Hadfield, 1999; Goldstein, 1999; Turner et al., 2002). Goldstein (1999) illustrated how the "emotional tone" of the engagement between the learner and the teacher, has power to effect learning and achievement. For instance, a teacher who is pleasant, warm and responsive demonstrates care and is more able to affect a learner's motivation to understand and achieve (p. 655). Trujillo & Hadfield (1999) reported parental pressure and insensitive teachers as perceived causes of mathematics anxiety among primary pre-service teachers.

Interventions aimed at reducing mathematics anxiety have included those focussed on improving of students' basic mathematical skills (e.g., Tooke & Lindstrom, 1998), training in study skills (e.g., Seon & King, 1997), and combinations of cognitive and behavioural approaches (e.g., Turner et al., 2002). Turner et al. (2002) showed that an "holistic" approach to providing for student engagement in mathematics (Turner et al., 2002), can be achieved by emphasising conceptual understanding rather than final answers, in conjunction with the support and encouragement of teachers who value humour and allow for peer support. When the emphasis is on understanding rather than on competition and ability, students are less likely to avoid seeking help (Turner et al., 2002). Journal writing is a specific tool that has been used in efforts to reduce mathematics anxiety and has also been shown to increase student learning (Connor-Greene, 2000).

Rational number concepts (and particularly fractions) are complex. Many studies have shown that most middle school students have difficulty in learning about these concepts and about fractions in particular (Mullis, Martin, Gonzalez, & Chrostowski, 2004; Siemon et al., 2001) and that their teachers lack confidence in teaching them (Beswick et al., 2006). Studies such as *The Middle Years Numeracy Research Project* (Siemon et al., 2001) have highlighted the fact that students in the middle years are not competent with fractions, and have identified such competence as a major factor affecting the overall performance of students in these years. Since mathematical performance has been linked to mathematics anxiety (Ashcraft & Kirk, 2001) it seems likely that difficulties with fractions might be a specific underlying cause of mathematics anxiety among middle school students. This study examined the effects of a fraction teaching intervention upon the anxiety levels of Year 8 students who had been identified as having high levels of mathematics anxiety relative to their peers in the same school.

## The Study

The study was designed to monitor in detail the impacts upon mathematics anxiety of a fraction teaching intervention. In so doing it employed a range of instruments and rich data about the factors that influenced the participant's levels of mathematics anxiety were collected. The research question of particular relevance to this paper was:

- In what ways do students perceive teaching, teachers' attitudes and behaviours, and parental support to impact upon their levels of mathematics anxiety and their ability to learn about fractions?

### *Instruments*

*Mathematics Anxiety Questionnaire (MAQ)*. The questionnaire was adapted from that developed by Wigfield and Meece (1988) to include items about mathematics anxiety in relation to the topic of fractions as well as in relation to mathematics generally. The

questionnaire comprised 17 questions to which responses were sought on a 5-point Likert scale ranging from “Not at all” to “Very much”.

*Fractions Tests.* A test on fractions (FT1) was developed by the first author in conjunction with the students’ usual Year 8 mathematics teacher. It was designed to cover the understanding of fractions that is required at Year 8 level for all students in Tasmanian schools. The test allowed the researcher to gain an understanding of the students’ levels of competence with fractions and to identify appropriate intervention material to target the specific needs of the participants. A second test (FT2) that covered the same material as FT1 and of equal difficulty was similarly developed in conjunction with classroom teacher for use at the conclusion of the intervention.

*Interviews.* An individual interview was conducted with each participant prior to the commencement of the intervention to provide insights into the students’ prior experiences of learning mathematics, their knowledge of fractions, and attitudes to mathematics generally and fractions in particular. Some questions asked participants to expand upon some of their responses to the MAQ. Others asked about their feelings while completing FT1. A second individual interview was conducted with each participant at the conclusion of the intervention. The purpose of this was to determine whether mathematics anxiety levels had changed and/or the participants could identify reasons for this occurring or not occurring. Questions included, “Has how you feel about fractions changed over the six lessons?” and “What, if anything, have you learned that you might be able to use in the regular maths lesson?”

Informal group and individual interviews were also conducted throughout the intervention and were aimed at exploring the students’ thinking about and developing understandings of fractions as well as their feelings about the topic. For example, some of the questions included, “How did you feel about the lesson on fractions today?” and “Which part of the lesson did you enjoy most? Why?” and “Which aspect of the lesson did you enjoy the least? Why?”

*Student journals.* Participants each kept a journal throughout the intervention and were encouraged to reflect upon their feelings and ideas at the end of each lesson. In the early weeks of the study students were given prompts to expand upon. For instance, “Today I learnt.” And “This made me feel ...”, and “I felt like this because ...”. The students were encouraged to let their feelings about the lesson flow without worrying about spelling or expression.

*Video-taped lesson observation.* Each of the interventions lessons was video-taped in order to record behaviour as it occurred.

### *Participants*

Based on the results of the MAQ, eight students experienced the highest levels of mathematics anxiety, compared with the other Year 8 students at their school were selected to participate in the intervention. FT1 suggested that, of the eight students, five were reasonably competent with fractions, while three experienced difficulty with most questions.

## Procedure

FT1 and the MAQ were administered to 40 students in two Year 8 mathematics classes in an independent boys' school, in the students' usual mathematics classrooms in the same mathematics lesson, and under the supervision of the class' mathematics teacher. The six intervention lessons commenced after initial individual interviews with each participant had been conducted. The lessons made use of McIntosh and Dole's (2004) mental computation materials, and emphasised the development of conceptual understanding. Hands-on learning materials were used in order to assist students in visualising fraction sizes and locations on the number line, and efforts were made to meet the individual learning needs of the students involved. The lessons involved manipulating cut-out shapes from paper, drawing shapes, working with fraction cards, rolling dice and playing fraction games. Collaborative work was an important feature of each of the lessons and was facilitated by seating all students around a central table. The topics of the six lessons are provided in Table 1.

Table 1

### *Lesson topics*

Lesson	Topic
1	Basic concepts and representations of fractions
2 & 3	Equivalent fractions
4	Ordering of fractions
5	Addition and subtraction of fractions
6	Multiplication and division

FT2 and the MAQ were administered to the eight participants 1 week after the conclusion of the intervention. Final individual interviews were conducted after this.

All of the interview data, video recordings of lessons, and student journal entries were coded to identify themes (Burns, 2000, p. 441) using a constructivist grounded theory approach applied in two phases (Charmaz, 2006). The first part of the analysis involved open coding in a line-by-line fashion to identify initial emergent codes in each of the three data types. The data were then analysed again according to these codes to ensure they accurately reflected the data in regards to mathematics anxiety.

Following open coding, axial coding was applied to make a more coherent and accessible interpretation of what was occurring. To this end, themes or categories were developed. The construction of categories involved the examination of codes from each of the three data types. The codes assisted in providing a framework with which to work in an attempt to understand the implications of what was revealed.

## Results

Data relevant to the research question that is the focus of this paper emerged from interviews and student journal entries. The 10 themes that emerged from open-coding of the interview data were *High confidence and positive attitude*, *Enjoyment*, *Improved understanding*, *Low confidence and self-doubt*, *Previous Experience*, *Lack of understanding*, *Memory*, *Factors affecting learning*, *Teaching methods*, and *Teacher and parental influence*. The seven themes from the journal entries were, *High confidence and positive attitude*, *Improved understanding*, *Enjoyment*, *Lack of confidence*, *Lack of understanding*, *Memory*, *Teaching methods*, and *Teacher and parental influence*.

The axial coding phase resulted in a total of 10 categories that reflected the themes from each of the three data types. The three categories that are relevant here arose from the interview and journal data and are shown in Table 2 along with codes from phase 1 of the coding that relate to them. The numbers of participants who had at least one instance of each code in their interview or journal data are also shown.

Table 2  
*Categories related to teachers and teaching*

Category	Related codes	No. of students in interviews (n=8)	No. of students in journal entries (n=8)
Teaching methods	Finding the hands-on activities helpful to learning	1	6
	Finding the hands-on activities not helpful to learning	1	1
	Learning in small groups more helpful and enjoyable than learning alone	7	4
Teacher attitude / behaviour	Recognising teachers' influence upon effective learning	2	0
Parental influence	Having positive parental influence	3	0
	Having negative parental influence	2	0

The *Teaching methods* category focused on the merits of hand-on activities and small group learning. According to six of the eight students in the intervention, the hands-on activities in the intervention lessons had been helpful to their learning. In journal entries, these students described the usefulness of the hands-on approach. Fergus, made the following comment, "It was easy because we did it hands-on and could see the actual fraction." Chris commented, "I think that doing the maths in a hands-on way made it easier to do, because I got more involved." Eric commented, "I felt that I was quite comfortable with maths today. It was easy with the cut-outs." Students F and C were reasonably capable as assessed by FT1 and FT2 while students E struggled, however, it seems that the hands-on approach was of some benefit to most students. Eric commented in the post-intervention interview, that he liked how the intervention involved "using stuff to show fractions ... it was funner (sic) and less boring." Harry, who achieved highly in FT1 and FT2, wrote the following in his journal, "From the six lessons, I learned a lot. I could even say every lesson I understood something better or things got clearer for me. All the explanations and activities we did made it much clearer." Fergus made a similar remark in the final one-to-one interview with the researcher. He said, "... what you have taught me in fractions is an easier way". Gresham (2007, p. 186) reported similar results with pre-service early childhood and elementary education students, many of whom commented that they finally "understood concepts such as fractions, decimals, percents, probability and statistics, and algebra when the topics were presented in a concrete and practical format".

Evidence suggesting that learning in a small group was helpful and more enjoyable than learning alone was provided by seven of the eight students in their post-intervention interviews. For example, Chris who had reported feeling quite alone and disconnected from his peers in his usual mathematics classes, commented in the post-intervention interview that, "I can be sort of more confident when I'm talking in front of a group about my answers and stuff, I usually hate that, but it doesn't seem like a big deal anymore."

When he was asked by the researcher to explain what he would like to happen in his usual mathematics lessons, he commented,

working in groups and probably doing more sort of, hands-on work, more involved ... before it's just like sit there and go through the exercises ... you don't really focus or need to focus or anything, you just have to get these done by a certain time.

When asked to explain what he enjoyed most about the intervention lessons, he said,

I liked the fact that we worked in a small group, I sort of like the way that um, I don't know if this is related, but like I liked to be with people I was friends with and then people I didn't really know ... that was nice I guess.

Fergus commented in the post-intervention interview that what he enjoyed most was that in the small group, "everyone got to have a say". George wrote in his journal, "I think the small group helps a lot and it makes it a lot more enjoyable" and Chris commented in his journal that, "today's lesson was strangely fun; I think from being in a small group and not just crunching through a bunch of questions from the textbook." Later he wrote that, "working in a smaller group was more relaxing and the involvement in the work made it easier to understand and bag attention than usual."

The category, *Teacher Attitude/Behaviour*, became evident from the pre-intervention and post-intervention interviews. The category name acknowledges the intimate relationship between teachers' affect and their actions: relevant data comprised student reports of teacher behaviours from which one could infer attitudes or beliefs. Two students, Fergus and Harry, acknowledged the importance of a teacher's influence upon learning in the pre-intervention interviews making explicit reference to the impact of the teacher's approach upon the student experience with mathematics. Fergus stated that his least favourite part of the mathematics lesson is "when the teacher talks for too long and you've got to listen to it." He admitted that this made him feel that the more the teacher talked, the more he worried that "you might not get it right and you might get it wrong." In the post-intervention interview Fergus commented that he would rather that the teacher did not "talk too long." Without the researcher making any reference to teacher approach and attitude, when asked about the part of the mathematics lesson he least enjoyed, Harry said, "When the teacher is explaining what to do and I already know it ... because you get bored and you start talking to your neighbour." For Fergus, too much teacher talk created for him a fear that he would not remember what had been said and hence would not be able to do the mathematics. It affected his self confidence. For Harry, the teacher's inability to assess and extend his current level of understanding created boredom and disinterest in the subject.

The teacher's attitude, which affects the choices they make for their students and the behaviours they exhibit in their classes, was important enough for students to mention without prompting. Chris, a high achieving student, made reference to the boredom he experienced in his usual mathematics lessons in connection with the structure of the lessons and the activities they were assigned. He said,

the teacher ... we have a text book, um it's a really thick one, it's very boring, which has a list of exercises and it has like, 1A and 1B and 1C and the teacher will just tell us like, a couple of lists of exercises we have to do, we've just got to crunch through all of them or we do a sheet from start to finish.

David stated that his favourite part of the lesson was "like not being in a classroom doing text book work." This evidence, that teacher attitude influences student behaviours, concurs with the findings of Gresham (2007) that the enthusiasm and provision of an

inviting environment were amongst the reasons provided by the early childhood education preservice teachers in her study, for the reduction in their mathematics anxiety levels.

For some students, their parents' ability to provide support (reflected in the category, *Parental influence*) appeared to influence the students' own attitude towards mathematics. For instance, Eric, when asked to whom he would go to for help with his mathematics homework if he needed it, replied, "Ah, I wouldn't go to my parents because they haven't a clue." Interestingly, in his post-intervention interview, when asked whether he could see himself following a career in mathematics, Eric answered, "... I don't want to be a pen pusher ... behind a desk doing stuff with maths." Ben, who was also low achieving (based on FT1 and FT2) commented that, "Mum is not that good at understanding maths." He also mentioned in his post-intervention interview that he was not interested in a career in mathematics because he had already decided he would join the Police Academy when he left school. Unlike Students E and B, Allan's parents had paid for extra mathematics tuition for him since he was in Grade 5 in Primary School. He also commented that he would ask his mother or "my Mum's friend who works at uni, sometimes she helps me" if he needed extra help with mathematics.

## Discussion and Conclusions

The participants in this study were positive, in terms of both their learning and their affective reactions, about the use of hands-on activities and group work in learning about fractions, and several contrasted this with their usual experience of mathematics lessons. Students described the intervention lessons as "providing an easier way" (Fergus) and improving existing understandings (Harry). Several students linked cognitive and affective aspects of their experiences, connecting ease of learning with feelings of comfort (Eric) and enjoyment (Eric, Greg), and attributing improved understandings to increased involvement with the lessons (Chris, Greg), and the ability the activities afforded to visualise fractions (Fergus).

Two of the three students who were identified by FT1 as having particular difficulty with fractions (Eric and Ben) reported little parental support for their mathematics learning and little interest in pursuing its study. In contrast to their situation, Allan, a relatively high achiever, had several adults who could provide mathematical support when it was required. This finding highlights that for many students the teacher and the mathematics teaching they receive in class is the only source of help. The fact that two of the eight students in this study (Chris and Fergus) described their usual mathematics lessons as places in which they did not feel confident to talk about their solutions but rather, worried about being "right", suggests that the support received in that context can be inadequate. For students like Eric and Ben, with no alternative sources of help, the effectiveness of mathematics teaching and the 'emotional tone' of the mathematics classroom environment (Goldstein, 1999) are especially crucial.

The findings illustrate the wisdom of McLeod's (1992) advice to study cognitive and affective aspects of learning and teaching together since for many of these students the two were inseparable. They also confirm the value, in terms of both understanding and affect, of a holistic approach to engaging students with mathematics (Turner et al., 2002). Further analysis of the data collected will allow a more comprehensive assessment of the effectiveness of the intervention lessons in particular and a detailed analysis of the aspects thereof that appear to be most effective.

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