

CAUSES UNDERLYING PRE-SERVICE TEACHERS' NEGATIVE BELIEFS AND ANXIETIES ABOUT MATHEMATICS

Liisa Uusimaki & Rod Nason

Queensland University of Technology

This article reports on a study that investigated the causes underlying a sample of eighteen third-year Australian pre-service primary teachers' negative beliefs and anxiety about mathematics. It was found that most of the participants' maths-anxiety could be attributed to their primary school experiences in learning mathematics. Situations such as teaching mathematics or being evaluated in mathematics were noted as particularly stressful and mathematical topics such as algebra, space and number sense were specifically identified to cause maths-anxiety. The paper concludes with a brief discussion about the implications of these findings for an ensuing program whose purpose is to help these pre-service teachers address their negative beliefs and anxieties about mathematics.

INTRODUCTION AND BACKGROUND

Teachers' beliefs about mathematics have a powerful impact on the practice of teaching (Charalambos, Philippou & Kyriakides, 2002; Ernest, 2000). It has been suggested that teachers with negative beliefs about mathematics influence a learned helplessness response from students, whereas the students of teachers with positive beliefs about mathematics enjoy successful mathematical experiences that result in them seeing mathematics as a discourse worthwhile of study (Karp, 1991). Thus, what goes on in the mathematics classroom may be directly related to the beliefs teachers hold about mathematics. Hence, it has been argued that teacher beliefs play a major role in their students' achievement and in their formation of beliefs and attitudes towards mathematics (Emenaker, 1996). Addressing the causes of negative beliefs held by pre-service primary teacher education students about mathematics therefore is crucial for improving their teaching skills and the mathematical learning of their students.

Negative beliefs about mathematics are often manifested in the phenomenon known as maths-anxiety. Although early research suggests that the term 'maths-anxiety' was rather an expression of general anxiety and not a distinct phenomenon (Olson & Gillingham, 1980), more recent research into maths-anxiety has recognized it not only to be more complex than general anxiety but also more common than earlier suggested (Ingleton & O'Regan, 1998). Thus, to understand maths-anxiety it must be recognized for its complexity. Maths-anxiety is not a discrete condition but rather it is a "construct with multiple causes and multiple effects interacting in a tangle that defies simple diagnosis and simplistic remedies" (Martinez & Martinez, 1996, p.2; Bessant, 1995). A definition by Smith and Smith (1998) takes into consideration this intricacy by encompassing both the affective and the cognitive domain of learning.

They state that maths-anxiety is a feeling of intense frustration or helplessness about one's ability to do mathematics, and can be described as a learned emotional response to participating in a math class, listening to a lecture, working through problems, and /or discussing mathematics to name but a few examples (Hembree, 1990; Le Moyne College, 1999).

The origins of negative beliefs and anxiety about mathematics can be classified into three categories: a) environmental, b) intellectual, and c) personality factors (Trujillo & Hadfield, 1999). Environmental factors include negative experiences in the classroom, parental pressure, insensitive teachers, mathematics being taught in a traditional manner as rigid sets of rules and non-participatory classrooms (Trujillo & Hadfield, 1999; Stuart, 2000). Intellectual factors include being taught with mismatched learning styles, student attitude and lack of persistence, self-doubt, lack of confidence in mathematical ability and lack of perceived usefulness of mathematics (Trujillo & Hadfield, 1999). Personality factors include unwillingness to ask questions due to shyness, low self-esteem and for females viewing mathematics as a male domain (Trujillo & Hadfield, 1999; Levine, 1996). From this it can then be seen that the origins of negative beliefs and anxiety about mathematics are as diverse as are the individuals experiencing maths-anxiety. For some people maths-anxiety is related to poor teaching, or humiliation and/ or belittlement whilst others may have learnt maths-anxiety from the maths-anxious teachers, parents, siblings or peers, or who may link their anxiety to numbers or only to some operations (Stuart, 2000). Research studies have found that maths-anxiety surfaces most dramatically when the subject either is or is perceived to be under evaluation (Tooke & Lindstrom, 1998).

In the case of many pre-service teachers, negative beliefs and anxiety about mathematics have their origins in prior school experiences such as their experiences as a mathematics student, the influence of prior teachers and of teacher preparation programs, as well as prior teaching experience (Raymond, 1997). For example, many negative beliefs held by teachers can be traced back to the frustration and failure in learning mathematics caused by unsympathetic teachers who incorrectly assumed that computational processes were simple and self-explanatory (Cornell, 1999). Research (e.g., Brown, McNamara, Hanley, & Jones, 1999; Nicol, Gooya & Martin, 2002; Trujillo, & Hadfield, 1999) suggests that a teacher's personal school experiences, especially at secondary level, influence the development of negative beliefs and anxiety about mathematics. This results in a considerable proportion of students entering primary teacher education programs with negative beliefs and attitudes towards mathematics (Carroll, 1998; Levine, 1996).

To help pre-service teachers to overcome their negative beliefs and anxiety about mathematics requires interventions that facilitate fundamental shifts in pre-service teachers' system of beliefs and conceptions about the nature and discourse of mathematics (Levine, 1996). This requires direct conscious action on the part of the

maths-anxious person. It also requires a clear definition of and reflection on the person's part about what particular kinds of mathematics causes negative feelings and anxiety (Martinez & Martinez, 1996). A person who says that he or she 'hates' mathematics may find on further reflection, that he or she 'hates' specific types of mathematics. For instance there may be a strong dislike for algebra whilst mental computation activities are seen as fun and challenging. Teacher educators can do much to facilitate this process by identifying: (a) the origins of pre-service teachers' negative beliefs and anxieties about mathematics, (b) situations causing negative beliefs and anxieties about mathematics, and (c) types of mathematics causing negative beliefs and anxieties about mathematics and then utilizing this information to inform the design of intervention programs that facilitate change in non-threatening ways to the pre-service teachers' beliefs and conceptions about the nature and discourse of mathematics.

Therefore, the aims of the research study were to: 1) identify the causes underlying our sample of pre-service teachers' negative beliefs and anxieties about mathematics, and 2) determine the implications of these causes for the design of an intervention program for these pre-service teachers.

METHODOLOGY

Participants

The eighteen participants in this study came from a cohort of approximately 300 third-year pre-service primary student teachers enrolled in a mathematics education curriculum unit at a major metropolitan university in Eastern Australia. The eighteen participants (17 female and 1 male) were selected from a pool of forty-five self-identified maths-anxious students who volunteered for the study. The criteria for selection were degree of maths-anxiety, access to internet, and availability to attend workshops.

Procedure

The study proceeded in three stages: 1) Development of semi-structured interview, 2) Administration of semi-structured interview, and 3) Analysis of interview data.

Development of semi-structured interview

The following four questions were designed for the semi-structured interview: 1) When did you learn to dislike mathematics? 2) Why did you learn to dislike mathematics? 3) What causes your maths-anxiety? and 4) What mathematical concepts cause your maths-anxiety? Questions 1 and 2 focused on the identification of the origins of the participants' maths-anxiety. Question 3 focused on the identification of situations causing maths-anxiety. Question 4 focused on identifying types of mathematics that caused them maths-anxiety. As was noted earlier in this paper, information about the origins of pre-service teachers' negative beliefs and

anxieties towards mathematics, and situations and types of mathematics causing maths-anxiety is needed for the planning of intervention programs aimed at helping pre-service teachers address their negative beliefs and anxieties about mathematics. The design of these questions was informed by the research literature on maths-anxiety (e.g., Martinez and Martinez, 1996; Smith & Smith, 1998), the formation of beliefs and attitudes towards mathematics (e.g., Cornell, 1999; Emenaker, 1996), and means of overcoming maths-anxiety (Carroll, 1999; Raymond, 1997).

Administration of semi-structured interview

The eighteen participants were invited to attend a 20 minute semi-structured interview. Prior to the interview that was conducted by the researcher the purpose of the research study was explained to each participant. During the course of the interview, follow-up questions that enabled the researcher to delve deeper into the thoughts that underlay their responses to questions were administered. The interviews were audio-recorded for later transcription.

Analysis of interview data

After the initial familiarisation reading of the transcripts, the transcripts then were read more closely. From this reading an initial set of emerging themes were identified and listed for each of the three issues being investigated (namely the origins of maths-anxiety, situations causing maths-anxiety, and types of mathematics causing maths-anxiety). The initial themes were then entered into a table. The transcripts were iteratively revisited in order to find data to support or refute the themes. This led to the modifications to the list of themes for each of the issues investigated. The process of analysis was completed by going back to the interview transcripts and ascertaining the number of participants per theme. The totals for each theme were then converted to percentage scores.

RESULTS

Issue 1: Origins of negative beliefs and anxiety about mathematics

The analysis of data revealed that 66% of the participants (n = 12) perceived that their negative beliefs and anxiety towards mathematics emerged in primary school. Linda for example, remembers “exactly” what year in primary school she learnt to dislike mathematics.

When I was in Grade 5 and we started doing division and I was away the very first day they introduced division and I came back the next day and I had no clues what everyone else in the class seemed to know really well. And my teacher never took the time to actually sit down and go through it with me so I was trying to play catch up and I feel like I've been playing catch up every since...

Out of 12 participants who traced their negative beliefs and anxieties back to negative mathematical experiences in primary school, two of the participants identified specific mathematics content, such as learning the multiplication table in grade 2 and abacus, as the cause for their maths-anxiety. One of the participants traced her negative beliefs about mathematics back to her mother. Significantly, the remaining 9 participants specifically identified primary school teachers for their learnt dislike and fear of mathematics. Tina, for example, remembers the time in primary school as a time when,

I used to make lots of mistakes and I was always frightened... I vividly remember, actually in Grade 1, getting into huge trouble because I couldn't fit a puzzle together. I vividly remember that. Just absolutely getting caned by this teacher.

The analysis also revealed that 22% of the participants ($n = 4$) identified secondary school as a time when they learnt to dislike mathematics. Like the 12 participants who identified primary school experiences as where their negative beliefs and anxiety towards mathematics originated, all four of these participants specifically identified secondary school teachers as the major contributing factor for their learnt dislike of mathematics. Petra's comment about one of her secondary school mathematics teachers exemplified the type of comments made by these four participants about some of their secondary mathematics teachers.

I had a teacher called Mr O, a bit of a Hitler looking fellow but I just have visions of him throwing dusters at students you know to get their attentions and he just never explained anything... just wrote it on the board and then you just copied it and then you just had to really go home and try and work it out so I was pretty stressed about that 'cause I kept thinking you need to talk about it, you need to go through it together and ask whether you understand it.

Only 11% of the participants ($n = 2$) identified tertiary education as the time when their negative beliefs and anxieties towards mathematics emerged. An important aspect of the comments made by these two participants was that their negative beliefs about mathematics was not traced back to how mathematics was taught but back to specific content of mathematics.

Issue 2: Situations causing most maths-anxiety

The participants felt most anxious about mathematics when they had to communicate their mathematical knowledge in some way (48%), for example, in test situations or verbal explanations. Also, causing a lot of anxiety was the teaching of mathematics in practicum situations (33%) due to insecure feelings of making mistakes or not being able to solve it correctly. For example, Rose explains that her most anxious moments are:

When I'm being called on to answer questions... and I don't know the right language and I try to answer the question as best I can but you don't really get your meaning across because you don't understand the language and you don't know what language to use.

Testing... Just when somebody tests my knowledge... It does and it makes me feel as if I don't know what I am talking about.

Issue 3: Types of mathematics causing maths-anxiety

Two strands from the Queensland Studies Authority (2003) syllabus caused most anxiety: 'algebra and patterns' (33%) and 'space' (31%). Number operations especially division, was also a concern (21%). The anxiety caused by these strands was well exemplified by Ann's response to Question 4.

Long division! Couldn't ever do that. Dividing. Can't do that. Times tables. You know how they used to learn the times tables. I still can't do them because they sing that song. One, ones are one and all that and I never had a very good memory so I could never learn them. I'm making myself sound really bad... And with addition and subtraction, I still use my fingers to count up things... I used to do it under my desk so the teacher couldn't see 'cos you're supposed to know just what 6 plus 6 is without counting it on your fingers sort of thing.

SUMMARY AND CONCLUSIONS

Most of the findings from this study regarding the causes of negative beliefs and anxieties about mathematics were consistent with the findings reported in the research literature. (e.g., Brown, McNamara, Hanley, & Jones, 1999; Carroll, 1998; Cornell, 1999; Nicol, Gooya, & Martin, 2002; Trujillo, & Hadfield, 1999). For example, this study found that the origin of maths-anxiety in most of these participants could be attributed to prior school experiences (cf., Levine, 1996; Martinez & Martinez, 1996). Whilst the literature suggests that negativity toward mathematics originates predominantly in secondary school (e.g., Brown, McNamara, Hanley, & Jones, 1999; Nicol, Gooya & Martin, 2002), data from this study suggests that negative experiences of the participants in this study most commonly originated in the early and middle primary school. The perceived reasons for these negative experiences are attributed to the teacher, particularly to primary school teachers (72%) rather than to specific mathematical content or to social factors such as family and peers.

Situations which caused most anxiety for the participants included communicating one's mathematical knowledge, whether in a test situation or in the teaching of mathematics such as that required on practicum. This is consistent with findings in the literature that suggests that maths-anxiety surface most dramatically when the subject is seen to be under evaluation (e.g., Tooke & Lindstrom, 1998). Specific

mathematical concepts, such as algebra, followed by space and number sense, caused most concern amongst the participants.

Many of these findings have clear implications for the intervention program to follow this study. For example, the findings that many of the participants' maths-anxiety was teacher-caused indicate the need for the facilitator in the ensuing workshops to be warm, non-intimidating and supportive in nature. The findings also imply that the participants need to be provided with learning environments where they are able to: 1) freely explore and communicate about mathematics in a supportive group environment 2) explore and relearn basic mathematical concepts, and 3), apply this re-learned knowledge in real-life and authentic situations. As evidenced by the latent themes in the participants' responses, it is also clear that isolation and evaluation anxieties will not be allayed via merely arming pre-service teachers with content knowledge. This would act to further problematise the individual and dismiss the fundamental importance of the individual feeling part of an emerging mathematics community in which they perceive themselves to be supported.

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