# Mathematics anxiety in student teachers

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## Abstract

This study was undertaken in a British initial teacher education institution by a lecturer working with students on a primary teacher training course. Its aim was to explore the existence of mathematics anxiety in students and how such anxiety may affect their learning for primary teaching. Investigation was carried out through review of literature and consideration of questions subsequently arising, linked to collection and analysis of questionnaire data from a sample of primary teaching students.

### Introduction

This study took place in an initial teacher education institution where some students presented with negative attitudes towards mathematics, potentially affecting their learning for primary teaching. Quantitative research was undertaken to investigate this, using questions generated from a review of literature. The intention was to elicit students' attitudes towards mathematics and explore how their learning for primary teaching might be affected.

### Theoretical review

Mathematics anxiety exists in some adults (Perry, 2004), including teachers (Haylock, 2003), and is influenced by people's beliefs (Tobias, 1978). It has been described both as an irrational phobia (Hodges, 1983), and a rational fear rooted in real experience of failure and inadequacy (Perry, 2004). Associated emotional factors include 'anger' (Cherkas, 1992), 'tension' (Richardson and Suinn, 1972), 'guilt' (Cockcroft, 1982) and 'panic, dislike, anxiety, bewilderment, fear, fright, terror, stupidity, frustration, and a fear of looking stupid' (Buxton, 1981).

Mathematics anxiety can influence students' mathematical performance physically by affecting memory (Kogelman and Warren, 1978) and creating nervousness and an inability to concentrate (Tobias, 1978). Cockcroft (1982) found people developing coping strategies for everyday life, and Brady and Bowd (2005) describe people avoiding mathematics where possible.

Being 'no good' at mathematics is often admitted (Haylock, 2003), and may be passed on to students by their parents (Furner and Duffy, 2002). Beliefs leading to mathematics anxiety include that a 'mathematical mind' is needed (Furner and Duffy, 2002); that the left/right brain is dominant (Austin and Wadlington, 1992); that to be good at the arts means one cannot be good at mathematics (Tobias, 1991); that one must be logical as opposed to intuitive (Frank, 1990) and that there is a set right or wrong way to do mathematics (Cherkas, 1992) with an exact answer (Buxton, 1981).

The abstract nature of mathematics could be a cause of anxiety according to Orton and Frobisher (1996). A common belief appears to exist that rules must be applied in a set way that must be remembered, dependent on previous understanding (Cornell, 1999), with a lack of creativity in reaching answers (Austin and Wadlington, 1992). Students can be prevented from understanding by being taught mathematics without an investigative, open-ended approach (Oxford and Anderson, 1995). If mathematics is portrayed as putting procedure into practice, then students may believe it involves following rules to find the right answer and such learning by rote can lead to mathematics anxiety (Cornell, 1999).

Brady and Bowd (2005) provide evidence of students being expected to understand after brief explanations of concepts, and even teachers embarrassing students. Haylock (2003) provides evidence of:

> *...the negative effect …of the teacher's response to …failure to understand...*
>
> (Haylock, 2003:4)

on the part of the learner. Another identified concern is the feeling of 'being found out' by someone judgemental and 'in authority' (Buxton, 1981), with teachers always seen as correct and students accepting blame for not understanding. Brady and Bowd (2005) describe hostility, impatience and insensitivity in mathematics teachers that added to mathematics anxiety.

Teachers following objectives that do not match students' needs can cause anxiety (Oberlin, 1982). Buxton (1981) questions whether there are specific areas of mathematics that cause particular problems, such as long division. Mathematics done at speed is revealed as a negative past school experience (Buxton, 1981) alongside the need for accuracy and showing neat working out (Cockcroft, 1982).

Key factors identified as leading to anxiety in mathematics are its link to real life (Cornell, 1999) and its usefulness (McLeod, 1992), whereas Buxton (1981) argues for the 'power, enjoyment' and 'pleasure' of engaging in mathematical activity for its own purpose. However, Suggate, Davis and Goulding (1998:X) suggest a lack of enjoyment in students of mathematics who are:

> *mentally scarred by past experiences of failure...*

with teachers' expectations set too high (Haylock, 2003). According to Cockcroft (1982:101):

> *Once attitudes have been formed, they can be very persistent and difficult to change.*

Students told by teachers that they cannot do mathematics may believe this, and it need take only one teacher to create lasting mathematics anxiety in a learner (Perry, 2004).

Concern about doing well in mathematics (McLeod, 1992) and associated methods of assessment are an identified source of anxiety (Perry, 2004). Difficulties also lie in the exclusivity of mathematical symbols and notation (Schwartz, 2000). Gender has been identified as a possible cause of mathematics anxiety with the notion that males are better at mathematics than females (Furner and Duffy, 2002). Brady and Bowd (2005) suggest that girls receive less help and more ridicule when experiencing difficulties, and Tobias (1978) purports the notion that girls believed they would invite social unpopularity if they were seen to be good at mathematics.

According to DfES (2002:2), while:

> *...teachers can and do make huge differences to children's lives …indirectly through their …attitudes...,*

Winteridge (1989) claims that:

> *...many primary school teachers lack confidence in their mathematical abilities.*

Winteridge (1989:5) and Tishler (1980) state that teachers may be prevented by mathematics anxiety from learning what is needed to become effective teachers of mathematics themselves. Williams (1988) suggests that teachers pass on their negative attitudes to students, and Wood (1988) that their own teaching may be affected. Tobias (1978) finds some choosing to teach younger children assuming that the mathematics required is easier. In order to teach, mathematical understanding is needed and Tobias (1991) claims that self-belief in the ability to do mathematics is needed alongside a resolve to do something about being afraid of it.

The purpose of this review of literature was to establish the existence and manifestation of mathematics anxiety, together with possible causes, to generate questions for use in research with primary teaching students, the intention being to carry out quantitative research to find out whether the issues arising from theory are substantiated in current practice.

**Methodology**

An initial focus on two groups of primary teaching students experiencing negative attitudes towards mathematics led to a review of literature in order to understand this context, resulting in the following specific research questions. Do primary teaching students:

- consider it acceptable to admit to difficulties with mathematics
- have negative perceptions of mathematics
- experience negative physical and/or emotional feelings about mathematics
- think there is a link between mathematics anxiety and concerns for their own practice
- identify potential causes of mathematics anxiety
- recognise the implications of mathematics anxiety for their learning for primary teaching?

The intention was to use contemporary literature to explore the attitudes towards mathematics for some students embarking on an initial teacher education course and consider the implications for their learning. The use of independent critical thought to develop the concepts derived from literature is recognised by Silverman (2005). There is relevance to the researcher (Denscombe, 2002) through a personal interest in why people feel anxious about mathematics, and how this may have an impact on practice.

Four factors were identified from the literature review:

- beliefs associated with learning mathematics
- the existence of mathematics anxiety, including emotional and physical manifestations of this
- possible causes of mathematics anxiety
- implications for practice.

These factors were incorporated into a questionnaire designed to collect data to ascertain whether practice matched theory. It was recognised that in order to generate new theory there would need to be data collected on a wider scale with more in-depth analysis.

The questionnaire was carefully prepared, as advocated by Cohen, Manion and Morrison (2000) with sub-sections used for clarity and the use of non-threatening questions. A criticism of the design is that the nature of the topic could lead participants to assume a position on mathematics anxiety that affects their responses, but in an attempt to avoid this, and in the interests of objectivity, wording of the questionnaire was made consistent with that used in literature.

The sample consisted of two groups of mixed gender and a range of ages, all new to initial teacher education and therefore with reduced likelihood of bias related to prior experience within the course.

The purpose of the study was shared with participants at the outset (Cohen et al., 2000:259). Ethical implications of student responses potentially being influenced by their lecturer conducting the research were considered and the ethical guidelines of the institution adhered to. Assurance of confidentiality was given, with the right to decline to participate. Students' completed questionnaires were anonymous.

Small-scale quantitative study is limited in terms of reliability and it was recognised that to increase this, questionnaires could be given to the same group of people on different occasions. However, it was felt that subsequent teaching and learning could affect responses regarding students' attitudes and thus affect results.

Potentially, this work could form a pilot study for further research, and hence reliability could be improved. In an attempt at accountability for this project, however, the data collection was consistent and clear techniques were used to analyse findings and present conclusions. Authenticity was assured in that the research took place and the data is verifiable. It was therefore reasonable to draw the conclusions, while recognising the limitations of such a small-scale study preventing a more rigorous approach to analysis.

The choice of questions might be seen as biased in that these involved a prior indication of mathematics being of concern to some students. It could also be argued that a personal interest in mathematics anxiety on behalf of the researcher led to a search for the negative response and hence a potential distortion of findings. However, construct validity is defensible as questions asked were derived from theory; criterion validity defensible, as the responses to those questions were analysed simply and openly, with the data depicting the

reality of the situation as studied, and resulting conclusions are made from corresponding findings; although content validity can be questioned due to the small sample used (Denscombe, 2002). However, the aim was to provide a snapshot of links between theory and practice and – with limitations recognised –this was achieved. The method of analysis involved quantitative representations of findings from data, with links identified between findings and literature. Due to the small-scale nature of the study, in-depth quantitative statistical analysis was not possible, the expectation being that an indication of the strengths of those links could be raised for future research.

The focus of the study was open to subjectivity since responses were based on participants' attitudes towards mathematics. Responses were limited to discrete and closed answers, in an attempt to avoid ambiguity. When processing data, checks were made of completeness and accuracy of answers and non-responses were accounted for in analysis.

A criticism was that answers were limited to matches, or not, to given criteria rather than allowing for participants' individual responses concerning their attitudes towards mathematics for which an interpretive approach might be needed. The sample size and the simplicity of the questionnaire design allow measurement matching the required purpose, but could be expanded to include further sub-groups for more in-depth study to ascertain distribution of variables such as gender and age, and carried out over time.

The limitations of the scale of this study mean that conclusions are not generalisable, triangulation would be needed through more detailed evaluation of methodological approaches used in research. However, within the confines of the institution, the links between theory and practice are supportable for the purpose of the study.

**Data analysis and discussion of findings**

From the 50 questionnaires distributed, 31 were returned, giving a 62% sample response sufficient to take forward in analysis. Reasons for non-responses were not explored.

***Beliefs associated with learning mathematics***

In consideration of whether it is acceptable to admit to being 'no good' at mathematics, 94% of respondents agreed, supporting Haylock (2003). However, this is contradictory to the feelings of shame reported by Buxton (1981) and Cockcroft (1982). It is evident that the majority of these students think it acceptable to admit difficulties with mathematics.

At least one respondent shared the beliefs raised from theory, hence giving support to the theoretical findings of Furner and Duffy (2002); Austin and Wadlington (1992); Tobias (1991) and Frank (1990). Analysis of students' beliefs about mathematics showed the most frequent response to be the belief that mathematics is either right or wrong, with high frequency agreement that to do mathematics one must be logical and that mathematics always has an exact answer, confirming the findings of Buxton (1981). This suggests a belief about the subject that supports Oxford and Anderson's (1995) notion that these students of mathematics have not been encouraged to be creative and to think mathematically, but rather to follow logical methods leading to set answers, as identified in students by Cornell (1999) that does not allow for innovative, independent mathematical thinking encouraged by Buxton (1981). However, there is some contradiction in that fewer respondents believed there to be a set way to do mathematics and that indicates a more innovative approach to finding answers. The findings are conclusive that these students have, to some degree, negative perceptions of mathematics.

***Existence of anxiety - including emotional and physical manifestations of this***

Only 19% of respondents did not experience negative emotional or physical factors when engaged in mathematics. 61% experienced both emotional and physical factors together and 81% experienced either emotional, or physical, or both factors. These students indicated the whole range of emotional factors identified from literature by Richardson and Suinn (1972). All the physical factors were identified in accordance with theory (Kogelman and Warren, 1978; Tobias, 1978 and Brady and Bowd, 2005). The findings show that the majority of these students experience negative physical and/or emotional feelings about mathematics.

In exploration of links between potential mathematics anxiety and students' own practice being affected (Wood, 1988), 68% of respondents indicated a lack of confidence in teaching mathematics themselves, which links to the work of Haylock (2003) with over half of respondents indicating concern over having to teach older or more able children as identified by Tobias (1978). Almost a quarter were concerned about passing on negative attitudes to children, an issue shared by Williams (1988).

This study does not allow analysis of the underlying reasons for these concerns, but students' attitudes towards mathematics potentially has an impact on their practice in terms of their ability in the subject, since 70% of those who responded agreed that feeling anxious about mathematics affects their learning, which concurs with Tishler (1980). This constitutes 52% of the whole sample of participants and is therefore less indicative, but the findings demonstrate that overall there appears to be a link between mathematics anxiety and students' concerns for their own practice

***Potential causes of mathematics anxiety***

To identify possible causes of mathematics anxiety, responses were ranked according to frequency of response. Of the 41 possible causes of mathematics anxiety identified from literature, all but eight were chosen by respondents as applicable to them, indicating that a wide range of factors is involved. A significant issue is that the latter included zero response to the suggestion that mathematics anxiety has:

> *...nothing to do with the way I was taught – it's the subject itself.*

This suggests that it is not the nature of mathematics that is problematic, but the learning of the subject, which is supported in that learning particular aspects of mathematics ranked most high, followed by discouragement from learning in an interactive, creative and relevant way, with negative experiences from school including a lack of enjoyment, and encouragement alongside judgemental attitudes, as found by Buxton (1981). Relevance to real life was ranked highly, linking with findings from Cornell (1999) and McLeod (1992).

Also significant were teaching approaches suggested in theory by Oberlin (1982), Cornell (1999), Buxton (1981), Furner and Duffy (2002) and Perry (2004), including the notion of finding a set answer, with a lack of explanation and understanding of students' needs, a reliance on memory, previous understanding and rule following and methods of assessment. Attitudes of teachers were also indicated as a potential cause of mathematics anxiety. Respondents agreed with issues raised by Brady and Bowd (2005). In accordance with findings from Schwartz (2000), Buxton (1981) and Haylock (2003), some felt blame for their lack of understanding and some found mathematical language a barrier. Some respondents were not encouraged to use an investigative approach and some felt mathematics was done too quickly, supporting notions from Buxton (1981) and McLeod (1992).

Few respondents identified as potential causes of mathematics anxiety the expectations of teachers (Haylock, 2003; Brady and Bowd, 2005) or being taught by rote (Cornell, 1999). Only one felt their attitude was affected by that of their parents (Furner and Duffy, 2002), one by a single teacher (Perry, 2004), one the need for neat working out (Cockcroft, 1982) and one that mathematics is abstract (Orton and Frobisher, 1996). No students gave reasons connected to gender as had been suggested in literature by Furner and Duffy (2002), Brady and Bowd (2005) and Tobias (1978).

Using suggestions raised from theory, potential causes of mathematics anxiety can be identified for these students, but further research would be needed to explore the extent to which these are significant, as this ranking gives only a general picture.

***Implications for practice***

The purpose of the study was to determine implications for students' learning for primary teaching. The findings indicate that a degree of mathematics anxiety, identified in theory by Perry (2004), exists for these students with their fears influenced by their beliefs and past experiences, as suggested by Tobias (1978) and Suggate et al. (1998), as opposed to an irrational phobia implied by Hodges (1983). Such anxieties appear to have an effect on the students' attitudes and abilities, as Winteridge (1989) claims, and this is an important issue for practice according to the DfES (2002). I support Tobias' (1991) notion that students' self-belief is key and intend to engage in further research into this area.

Claims to generalisation are not made by this study, but findings suggest implications for primary teaching students' learning. Students in this sample generally expressed negative attitudes towards mathematics that potentially link directly to their learning and hence practice (Tishler, 1980). If these were found to be indicative of a general population, there would be widespread implications for initial teacher education.

**Conclusion**

Following my personal professional experience of primary teaching students expressing anxiety about mathematics, a review of literature revealed that mathematics anxiety exists and is manifested in a range of ways with a variety of potential causes. Research carried out with a sample of primary teaching students shows that mathematics anxiety exists in some, potentially affecting their associated learning. Mathematics anxiety appears to be a real fear, the root of which can be affective and cognitive, with people's beliefs influencing the way they think about mathematics and subsequently affecting their learning. Evidence suggests that the ability to do mathematics is strongly influenced by people's attitudes rather than any cognitive skill. Students' mathematics anxiety has implications for initial teacher education provision and further research is needed to find out its extent and how such anxiety might be prevented.

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