

Understanding mathematics anxiety

Introduction and background

The UK is currently undergoing what could be referred to as a ‘mathematics crisis’. Whereas functional literacy skills amongst working-age adults are increasing, the proportion of adults with functional maths skills equivalent to a GCSE grade C has fallen from 26 per cent in 2003 to just 22 per cent in 2011. This is markedly lower than the equivalent figure for functional literacy skills (57%).

Not all maths difficulties result from cognitive difficulties. A large number of children and adults experience anxiety, apprehension, tension and discomfort when confronted with maths and this may well be a factor in the relatively low levels of numeracy amongst UK adults.

This project was funded by the Nuffield Foundation and carried out by researchers at the Centre for Neuroscience in Education at the University of Cambridge. It had 3 aims: to provide estimates of mathematics anxiety prevalence amongst UK primary and secondary school students; to validate an instrument for measuring mathematics anxiety in this group; and to explore links between maths anxiety and other factors such as maths performance, gender and individual cognitive differences. Researchers also conducted interviews to gain a better understanding of students’ feelings about maths. In the first phase of the study, researchers worked with 1,700 primary and secondary students to screen for maths anxiety, test anxiety and general anxiety and to gain a measure of maths and reading performance. In the second phase they worked with individual children through interviews, questionnaires and cognitive tasks to gain a better understanding of their cognitive abilities and feelings towards maths.

Key findings

Qualitative research

- The modified Abbreviated Math Anxiety Scale was developed in response to the need for a brief and appropriate scale to assess maths anxiety in British children and adolescents. Working with a large sample of British children, the researchers were able to conclude that the scale is reliable, i.e. it measures just one construct. They also found it to be valid, i.e. it specifically measures maths anxiety rather than other forms of anxiety or feelings towards maths.
- The researchers carried out a literature review into the relationship between maths anxiety and performance which clearly established that those with maths anxiety tend to have poorer maths performance. They concluded that this is probably because anxiety interferes with performance and poorer performance increases anxiety so that a vicious circle is created.
- Separate research was conducted with a group of 1,000 Italian children; 639 were in primary school and 342 in secondary school. Researchers looked at developmental change, gender differences and the specificity of maths anxiety. Researchers found that unlike other forms of anxiety, maths anxiety increases with age. The negative correlation between maths anxiety and performance appears later in the educational timeline; there are clear links in the secondary, but not in the primary phase. They also found that girls had higher levels of both maths and general anxiety across both school phases.
- In another Italian sample, researchers investigated memory subtypes and their relationship with maths anxiety and dyscalculia (a specific learning difficulty affecting the normal acquisition of maths skills). Findings from this study suggest that dyscalculic children struggle more with visuospatial memory (memory of visual and spatial features such as colour, size and position in space) than verbal memory (memory of words). On the other hand, children with maths anxiety showed a specific deficit in verbal working memory. Working memory is a limited capacity system in which information can be stored and manipulated for short periods.
- In the sample of British children, researchers investigated the relationship between maths anxiety and developmental dyscalculia. They found that while more dyscalculics than typical children met the criteria for maths anxiety, the majority of those with maths anxiety had normal performance.
- Work with the large British sample revealed a number of anxiety subgroups which may increase in complexity with age. In secondary school pupils, it was found that those with anxiety specific to academia (high maths and test anxiety) had poorer performance than those with higher, but less specific anxiety. This may reflect a dual pathway in the development of anxiety.
- Younger students tend to have homogenous scores on each type of anxiety. For example, if a younger child has relatively high levels of maths anxiety, they are likely to have high levels of test anxiety and general anxiety. By contrast, older students have more variable levels of the different types of anxiety. The research identified a group



of secondary students who had low general anxiety levels but higher test and maths anxiety, and another cluster where students had high general anxiety levels but low maths and test anxiety.

Qualitative research with primary pupils

- Primary school children were generally articulate and clear in their discussions of mathematics anxiety. One important finding from the research was how profoundly affected certain students were by mathematics anxiety. Some students described behavioural manifestations which may or may not have been driven by anxiety. Others were clearly able to articulate the emotional and behavioural effect of their anxiety levels. For example, one pupil described it like this: 'Once, I think it was the first day and he picked on me, and I just kind of burst into tears because everyone was staring at me and I didn't know the answer'.
- Of the 32 primary age children identified as mathematically anxious, only 5 expressed broadly positive feelings towards maths, 15 falling in the intermediate category and 12 expressing uniformly negative feelings.
- More than half of mathematically anxious children reported feeling that the work in general was too difficult for them or beyond their capabilities. Those with maths anxiety were more likely to report a number of physical responses such as stomach aches, feeling sick, having butterflies or feeling tearful. Some mathematically anxious students further reported feeling hot and sweaty, wanting to run from the classroom, experiencing headaches or a sense of their head spinning.
- Most mathematically anxious children (28 of 32) were able to clearly articulate reasons for their anxiety about mathematics. This involved describing particular incidents or experiences which lead to anxiety or nerves some of the time in mathematics lessons. Most (18) of the children reported that they began to lose confidence in their ability to complete work successfully when the work became more challenging or when they felt they were receiving poor marks in classwork or tests.
- Five children (all with high mathematics anxiety) discussed how being mocked by peers had made them feel anxious. Three (all with high mathematics anxiety) discussed anxiety elicited by comparisons with their siblings, and one (with high mathematics anxiety) discussed parental pressure.

Qualitative research with secondary pupils

- For the group of secondary students reporting maths anxiety at the time of the interviews, feeling anxious about learning maths was a common experience.
- Most of the secondary students with maths anxiety indicated it was the nature of the subject, and in particular the fact that it was seen as 'hard' compared to other subjects that made them feel anxious. In one case a student talked of fear of getting an answer wrong: 'it's like everyone else is putting their hand up and then I can't do it because I'm scared of getting it wrong'.
- The secondary students were able to account for changes in their feelings in maths lessons over time. These changes often related to a specific event, although some mentioned multiple issues. For those who indicated they were feeling more worried about maths now compared to in the past, the most common trigger, mentioned by 7 students, appeared to be transfer from primary to secondary school. Many of their comments indicated that they felt under more pressure because of a perception that the work in secondary school seemed more important and mattered more. As one student said: 'I think it's just like secondary

school's kind of more important and like all the tests are put towards something in secondary school but in primary school it didn't really matter as much'.

- After primary to secondary transition, the most common trigger of anxiety, mentioned by 6 students, was a change of teacher. It was generally the interpersonal relationships rather than the actual way the subject content was taught that triggered anxiety.
- In addition to specific triggers, individual students reported they were feeling more anxious due to decreasing confidence, a sense they were not making progress and concerns about what others thought of them.
- For the students who indicated an improving situation, multiple reasons were given, with the teacher mentioned by the majority. Comments on the whole related to the teacher's approach and interpersonal style, as well as clarity of explanation. As one student said: 'it's because they (the teacher) explain stuff better, and he doesn't really treat anyone like they're better than someone if that makes sense. Like that's what I felt was happening in primary school. A lot of people were smarter than me because I was in like a lower group'.
- Changes in grouping arrangements were also mentioned by some students as having helped. As one student said: 'But the new teacher is nice, and she doesn't seem to rush me. She puts me with groups of people who do the same kind of work as me'.

Recommendations

- Interventions such as reducing classroom pressure and assessing children without time pressure, might be effective in alleviating the interfering effect of anxiety and thereby improving performance. For example, using methods like free writing about emotions prior to a test could help to stop these thoughts from interfering with the memory required to complete mathematical tasks.
- Some research has shown that mathematics anxiety in teachers and parents might influence student mathematics anxiety. This means that for parents and teachers, tackling their own anxieties and belief systems in mathematics might be the first step to helping their children or students.
- Since this research shows that maths anxiety is present from a young age and goes through significant developmental change, it may be worth testing younger children to attempt to remediate anxiety before any strong link with performance begins to emerge.
- There should be funding for future research on how academic anxieties and mental health impact the cognitive aspects of learning and learning outcomes. Teacher training should clearly highlight the role of both cognitive and affective factors in schools. Policy makers should be conscious that emotional blocks can have substantial impact on learning potential.
- During this project a 'maths diary' was used to look at how younger students perceived their experiences in maths lessons. Whilst this was always intended to be a research tool, some of the individuals we worked with suggested that expressing their feelings in such a format helped them to engage with and discuss them. Whilst this will not on its own remediate mathematics anxiety, filling in a structured form which can provide a discussion point with parents or teachers might be useful to some of those experiencing maths anxiety.

The full document can be downloaded from:

<http://www.nuffieldfoundation.org/understanding-mathematics-anxiety>