

CENTRE FOR NEUROSCIENCE IN EDUCATION, UNIVERSITY OF CAMBRIDGE

Understanding Mathematics Anxiety

Investigating the experiences of UK primary and
secondary school students

Executive Summary

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Executive Summary

Background

The project investigated individuals' attitudes towards mathematics because of what could be referred to as a "mathematics crisis" in the UK. Evidence suggests that functional literacy skills amongst working-age adults are steadily increasing but the proportion of adults with functional maths skills equivalent to a GCSE grade C has dropped from 26% in 2003 to only 22% in 2011 (National Numeracy, 2014). This number is strikingly low compared with the 57% who achieved the equivalent in functional literacy skills (National Numeracy, 2014).

While mathematics is often considered a difficult subject, not all mathematics difficulties result from cognitive difficulties. Many children and adults experience feelings of anxiety, apprehension, tension or discomfort when they are confronted by mathematics. This may be contributing to a relatively low level of numeracy amongst UK adults. In this project we investigate primary and secondary school students' experiences in the mathematics classroom and beyond, in order to learn more about the prevalence, nature and resolution of mathematics anxiety

Mathematics anxiety describes feelings of apprehension, tension or discomfort experienced by many individuals when performing mathematics or in a mathematical context (Richardson & Suinn, 1972). It has been associated with cognitive difficulties performing mathematical tasks, potentially because anxiety interferes with our ability to hold and manipulate information in mind (working memory), but is predominantly an emotional problem (Ashcraft & Krause, 2007). Developmental dyscalculia, on the other hand, is a cognitive difficulty in acquiring mathematical skills (Devine, Hill, Carey, & Szűcs, 2017).

Aims

This project had multiple goals. Firstly, we wished to provide estimates of mathematics anxiety prevalence amongst UK primary and secondary school students. Secondly, we wished to validate an instrument for measuring mathematics anxiety in this group. Thirdly, we wanted to see how mathematics anxiety is related to other individual factors, such as maths performance, gender and individual cognitive differences. Additionally, we used interviews to gain a richer understanding of students' experiences with and feelings towards mathematics.

Methodology

Our study had two main phases. In the first of these, we worked with more than 1700 primary and secondary students to screen for mathematics anxiety, test anxiety and general anxiety, and gain a measure of mathematics and reading performance. In the second phase, we worked one-to-one with the children to gain a deeper understanding of their cognitive abilities and feelings towards mathematics, using a series of sessions administering cognitive tasks, questionnaires and interviews (Carey, Devine, et al., 2017; Carey, Hill, Devine, & Szűcs, 2017; Devine et al., 2017). Throughout, we

worked on two further sub-projects looking at the relationship between maths anxiety and performance and cross-cultural comparisons (Carey, Hill, Devine, & Szucs, 2015; Hill et al., 2016).

Summary of Key Findings

- We have validated, in our large sample of British children, that the modified Abbreviated Math Anxiety Scale is **reliable** (it appears to measure one construct) and **valid** (this construct seems to really be maths anxiety, rather than another form of anxiety or other feelings towards maths (Carey, Hill, et al., 2017). See *Validating the modified Abbreviated Math Anxiety Scale (mAMAS)* for more details.
- We conducted a **literature review** into the long-established relationship between maths anxiety and performance (those with higher maths anxiety tend to have poorer maths performance). We conclude that this is likely because anxiety interferes with performance *and* poorer performance increases anxiety, acting as a **vicious circle** (Carey et al., 2015). See *Exploring the relationship between mathematics anxiety and performance* for more details.
- In our large sample of British children, we investigated the relationship between maths anxiety and **developmental dyscalculia**. We found that whilst more dyscalculics than typical children met criteria for maths anxiety, the majority of those with maths anxiety had normal performance (Devine et al., 2017). See *The relationship between mathematics anxiety and developmental dyscalculia* for more details.
- In a separate group of Italian children, we participated in research looking at **developmental change, gender differences** and **specificity** of maths anxiety. We found that unlike general anxiety, maths anxiety increases with age. The relationship between maths anxiety and performance becomes more specific with age – in younger, but not older, children, this relationship disappears after accounting for general anxiety. See *Maths anxiety: Gender differences, developmental change and anxiety specificity* for more details.
- We have identified, in our large British sample, **anxiety subgroups**. These may increase in complexity with age. In our secondary school students, we found that those with anxiety specific to academia (high maths and test anxiety) had poorer performance than those with higher, but less specific, anxiety. We conclude that this may reflect a dual path in anxiety development and maintenance (Carey, Devine, et al., 2017). See *Anxiety profiles and their relationship with performance* for more details.
- In our smaller subsample of British students, with whom we conducted further testing, we looked at the relationship between various **cognitive variables** and maths performance. It seems that a myriad of factors are associated with maths performance, but that basic numerical processing is not (unpublished data). See *Cognitive factors in mathematics performance* for more details.
- In another Italian sample, we investigated specific **memory subtypes** and their relationship with maths anxiety and dyscalculia. Whereas maths anxiety appears to be associated with a deficit in **verbal working memory** and perhaps also **visuospatial working memory**, dyscalculia is associated with deficits in **visuospatial memory**; both short-term and working memory are affected (Mammarella, Hill, Devine, Caviola, & Szűcs, 2015). See *Working memory, dyscalculia and maths anxiety in Italian students* for more details.
- Our qualitative research has shown that children of 9-10 years are able to discuss their experiences and origins of mathematics anxiety. Mathematically anxious children seemed to describe negative events with less contextualisation. They were also more likely to discuss

physical sensations in their maths classes and clearly articulated some of the negative consequences of maths anxiety. See *Qualitative research: Experiences and origins of mathematics anxiety* for more details.

Conclusions

Each of the completed projects within our study further reveals the complex, multifaceted nature of mathematics anxiety. It is likely that mathematics anxiety is not a simple construct with only one cause – rather, it can emerge as a result of multiple predisposing factors including gender, cognitive abilities and general predisposition towards anxiety, rumination or panicking under pressure. This helps to explain why mathematics anxiety is robustly correlated to a small degree with many constructs (e.g. test anxiety, general anxiety and mathematics ability). We have clearly shown that emotional and cognitive mathematics problems dissociate and therefore require different intervention strategies. Our qualitative analysis of structured interviews suggests that children as young as 9 are experts in their own experiences in mathematics and this can be harnessed to further understand the thought processes underlying maths anxiety. This brings us closer to design effective prevention and remediation programs for mathematics anxiety.

Recommendations

- The 9-item modified Abbreviated Mathematics Anxiety (mAMAS) scale developed by this project proved to be a reliable tool for investigating math anxiety in school context.
- Teachers need to be conscious that individuals' maths anxiety likely affects their mathematics performance.
- Teachers and parents need to be conscious of the fact that their own mathematics anxiety might influence student mathematics anxiety and that gendered stereotypes about mathematics suitability and ability might drive to some degree the gender gap in maths performance.
- Hence, for parents and teachers, tackling their own anxieties and belief systems in mathematics might be the first step to helping their children or students.
- With our research showing that maths anxiety is present from a young age and goes through significant developmental change, we suggest focusing further research on how maths anxiety can be best remediated *before* any strong link with performance begins to emerge.
- The qualitative part of our research shows that children are able to verbalise the suffering that mathematics anxiety causes them. Our qualitative research also points to several potential causes of maths anxiety that could be focused upon by further research.
- Teacher training should clearly highlight the role of both cognitive and affective factors behind maths learning in schools.
- Policy makers should be conscious that emotional blocks can have substantial impact on learning potential.
- Emotional and cognitive problems require completely different interventions.

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