Maths Anxiety: Theory to Practice

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Abstract

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Literature Review (/1100 words)

Prevalence

Maths anxiety is hugely prevalent, and consequently the literature describing research around it is extensive. The Organisation for Economic Co-operation and Development (OECD) (2013) 2012 Programme for International Student Assessment (PISA) report states that across OECD countries, over 30% of 15 year old students "get very nervous doing mathematics problems", and over 60% of students "worry about getting poor grades in mathematics".

Why is Maths Anxiety Important?

It is my view that as teachers our foremost concern should be for the wellbeing of our students. Lyons and Beilock (2012b) used functional magnetic resonance imaging (fMRI) to demonstrate that students categorised as having a high level of maths anxiety will often experience the anticipation of a maths task as viceral pain. Moral imperative (and ethical duty of care) requires us to take every step possible to protect our students from such an experience.

Beyond the clear and overwhelming wellbeing concerns, it is also important to recognise the connection between maths anxiety and performance, and the complex web of stakeholders surrounding a students academic success in maths. Foley et al. (2017) discuss the negative correlation between maths anxiety and performance shown in the 2012 PISA (OECD, 2013) report, and also note the rising demand for Science, Technology, Engineering and Mathematics (STEM) professionals worldwide. It has been shown that when a student has low self-concept (correlated with high maths anxiety), they will tend not to enroll in maths beyond the minimum requirements for graduation (Ashcraft, Krause, & Hopko, 2007). Beyond highschool graduation, it has been shown that students affect towards maths can predict their university major (LeFevre, Kulak, & Heymans, 1992). So although many governments and industries around the world are recognising their

need for more mathematics-qualified graduates, addressing maths anxiety may be a key peice to the puzzle of filling this demand.

Maths performance, and hence the maths anxiety-performance link is important to many other stakeholders as well. Parents who want their children to acheive academic success in maths, students themselves feeding back into their own self-concept and self-efficacy, and schools which are often ranked and funded based on their students academic acheivement, with maths being a recurring problem subject for many schools. In an Australian context one important way in which schools and ranked and funded is through National Assessment Program — Literacy and Numeracy (NAPLAN). Ultimately it is difficult to seperate any maths anxiety research from the concept of maths performance, for better or for worse.

So although I think students wellbeing should be reason enough for maths anxiety to be important, there are many reasons beyond their wellbeing alone that make it a critical area to address.

Milestones in our Understanding of Maths Anxiety

The history of maths anxiety research is nicely summarised in the review by (Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016).

The existance of maths anxiety as "emotional disurbances in the presence of mathematics" has been noted as early as the 1950's, Dreger and Aiken Jr (1957) even postulated that what he tentatively designated "Number Anxiety" and later became to be known as Maths Anxiety could be a distinct syndrome from general anxiety. Later the landmark meta-study of Hembree (1990) supported this hypothesis, showing a correlation of only 0.38 between maths anxiety and general anxiety. In more recent times, this hypothesis has also been confirmed by Young, Wu, and Menon (2012) using fMRI to show that the brain activity in a person experiencing maths anxiety is measurably distinct from that in a person suffering general anxiety. These later studies inlcuding the meta-analysis of Hembree (1990) but also later the work of Kazelskis et al. (2000) and others further delineated maths anxiety from test anxiety, and this work continued until today it

is quite well accepted that these anxieties although they share some overlap, are meaningfully distinct constructs.

Significant work has been done over the years to develop psychometrics to measure maths anxiety, almost exclusively consisting of self-reporting surveys (with the exception of some more modern fMRI work, such as that of Lyons and Beilock (2012a)). One of the earliest instruments for measuring maths anxiety was the Maths Anxiety Rating Scale (MARS) 98-item 5-point Likert scale of Richardson and Suinn (1972). Since then, many different groups have split off and created various revised versions of a number of offshoots of this original idea, but all rely on a self-reporting survey. An example of one of the more recently developed scales is the Maths Anxiety Scale — Revised (MAS-R) of Bai, Wang, Pan, and Frey (2009), which they later did some work to demonstrate was very reproducible (Bai, 2011).

Causes, Models, Interventions, and Gaps in the Literature

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Causes of maths anxiety are nicely explored in the review by (Ramirez, Shaw, & Maloney, 2018).

(Faust, 1996) show a anxiety-complexity effect in which low and high maths anxiety groups perform similarly on low complexity problems, but in high complexity problems the high anxiety groups performance is impacted. The possible mechanisms for this are also discussed, but one of the important implications is that experiencing success and self-competance can potentially combat the negative effects of maths anxiety on performance. However, the results of (Jansen et al., 2013) imply that the causal effects here may be confounded. Specifically, (Jansen et al., 2013) showed that although if students are given more successful experiences in maths they will perform better, this effect actually largely seems to be confounded by number of practice problems attempted: if given more experi-

ence of success, students attempt more problems, and perform better, but their improved performance is almost completely predicted by the number of problems they attempted, not their experience of success. Furthermore, although this intervention had a significant impact on maths performance, it did not appear to have any effect on maths anxiety.

This raises an important question as to our goal when implementing interventions: are we trying to raise students maths performance, or to influence them to have a more positive affect in the classroom? These are certainly not equivalent, although there may be specific areas where they might overlap, and this coulld be a good place to aim for due to the complex community of stakeholders involved in the classroom. The work of (Wang et al., 2015) shows the role of intrinsic motivation in mediating the relationshop between maths anxiety and performance — specifically that although in students with low intrinsic motivation a direct negative correlation was observed between math anxiety and performance, in high intrinsic motivation students this was not the case, instead a inverted U-shape association was observed, implying that a moderate amount of anxiety was correlated to improved performance for these students. The proposed interpretation for this more or less lies int he area of 'productive struggle'.

Key items implied by the literature to be the most promising avenues to pursue as far as interventions to address maths anxiety are concerned':

- Modelling the process of struggling with maths, and overcoming that. Not claiming that maths can always be fun but that sometimes it is difficult, and that that is ok.

- Providing oppurtunities for students to express their naratives and hence process their feelings about maths through expressive writing.

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Proposed research design/ methodology/ budget outline (/700 words)

Ethics Issues (/100 words)

Executive Summary (/100-150 words)

Glossary

fMRI functional magnetic resonance imaging. 2–4

MARS Maths Anxiety Rating Scale. 4

MAS-R Maths Anxiety Scale — Revised. 4

NAPLAN National Assessment Program — Literacy and Numeracy. 3

OECD Organisation for Economic Co-operation and Development. 2, 9

PISA Programme for International Student Assessment. 2, 9

STEM Science, Technology, Engineering and Mathematics. 2

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