Deconstructing maths anxiety: Helping students to develop a positive attitude towards learning maths

Sarah Buckley
Australian Council for Educational Research

Higher maths ability is often believed to go hand-in-hand with greater levels of general intelligence. At the same time, many students have a negative attitude towards maths. Maths anxiety is defined in the research literature as feelings of concern, tension or nervousness that are experienced in combination with maths.[i] In 2005, researchers in the United States estimated that approximately 20 per cent of the US population were highly maths anxious[ii]. Given the cultural similarities between the US and Australia, we can assume that the percentage would be comparable here.

Research in education, cognitive psychology and neuroscience shows that anxiety can lead to a drop in maths performance. Some people refer to this as the 'online effect' of anxiety.[iii] A series of experiments completed by a US researcher provide a picture of how this happens. They show that high levels of maths anxiety compromise the amount of resources an individual can draw on to complete a mathematical task.[iv] In particular, high levels of anxiety can affect an individual's ability to run working memory, the type of memory that allows us to hold information in our head as we complete tasks like mental calculations. The other long-term impact of maths anxiety is the development of a negative attitude towards the subject. Anxious individuals will avoid subjects, courses and careers that involve maths. Such avoidance can limit students' opportunities and career pathways.

More and more research is showing that emotions like maths anxiety are a fundamental part of the learning process because they can influence a student's behaviour. For instance, if a student is enjoying a lesson they will be motivated to invest more effort in that class, and perhaps future classes, and they will learn more effectively. High levels of anxiety in the classroom have the opposite effect and can lead to students avoiding work and learning things only at a surface level. Pekrun, a leading researcher in the area of emotions in the classroom, points out that anxiety is an anticipatory emotion that focuses on the uncertainty of achieving a particular outcome.[v] Recent neuroscience findings support this notion. A study using functional magnetic resonance imaging (fMRI) of the brain found neurological evidence of anxiety negatively impacting on maths performance prior to completion of a maths task, when students were anticipating the maths task ahead of them.[vi] Researchers from this study concluded that it is not the skill level of the maths anxious individual that leads to performance drops but rather their ability to manage their anxiety at this anticipatory stage and devote their attention to a task.

Pekrun's theory on emotions in the classroom proposes that emotions have two underlying components – how much a student *values* what they are doing and how much *control* the student believes that he or she has over a task. For instance, an emotion like enjoyment is the product of a student highly valuing what they are doing in conjunction with feeling a high level of control over the task. On the other hand, anxiety is experienced when a student highly values a task but feels that he or she has no control and it is the incongruence of these two things that causes discomfort. Since we know that many in the community experience maths anxiety, it follows that environmental factors are likely to contribute, firstly, to people valuing maths and, secondly, to how much control they feel in relation to the subject. We could think of high value being reflected in the idea that ability in maths and general intelligence are linked. Maths is valued because it is considered an indicator of intelligence and therefore, showing poor mathematical ability has implications for how 'smart' you will be perceived to be. Feelings of lack of control could stem from the idea that maths is 'difficult' or the notion that you have to have a 'maths brain' in order to succeed in the subject. These two types of myths fuel the experience of maths anxiety for students and the community.

In addition to these ideas, other beliefs also promote a negative culture around maths. Perhaps

one of the reasons that maths anxiety is such a common feeling in the community is that it is acceptable to show anxiety in this area. Even though the link between maths ability and general intelligence is widely endorsed, admitting to personal difficulties with maths, a lack of interest in maths or worry over maths is socially acceptable and considered the norm. On the other hand, if a student admits that they like maths and are good at it that student will often be labelled a 'nerd'. This contradiction reflects a culture that facilitates the development of maths anxiety in students.

Negative community beliefs about maths are often heavily endorsed in adolescence through high school peer culture. Indeed, the high school classroom seems to be one of the places where negative attitudes towards maths are the most prevalent. While adolescence in general is a developmental stage associated with a decline in academic motivation[vii], maths seems to be the subject that is hardest hit. Researchers in the US found that maths anxiety increased most sharply in early adolescence, in particular in the early years of high school.[viii] Findings from the 2003 Programme for International Student Assessment (PISA) demonstrated that anxiety and negative attitudes are also more typically reported by girls in adolescence.

The issue of gender and maths has been researched for decades. A discussion paper commissioned by the ACT Schools Authority in 1985[ix] noted that it was written to 'arouse awareness and offer practical assistance to all levels within the school community'. The paper suggested that there were common myths permeating Australian culture related to girls' ability in maths. Some of these included the myth that 'girls, physiologically, are incapable of comprehending and manipulating symbols or of thinking in an abstract way'; 'mathematicians are logical, girls are illogical'; and 'educating women in maths/science is a waste of time when they are going to get married'. Luckily, these myths are no longer accepted as truths almost 30 years on; however, the paper lists other misconceptions that educators continue to challenge – 'maths/science is only required by those students who choose to follow a scientific career'; 'maths is only for bright kids'; and 'societal and/or peer pressures prevent girls admitting they like and enjoy maths, whatever the level of difficulty of the study'. The latter myth relates to a phenomenon known as stereotype threat, which has been widely researched in order to understand girls' higher levels of maths anxiety, poorer achievement and lower representation in maths-related careers.[x] Application of this theory suggests that girls are exposed to negative stereotypes about gender and maths, and the threat of this stereotype makes them more vulnerable to feeling anxious.

Myths in relation to gender and maths are not the only ones that have the potential to negatively impact students' learning in maths. There is a common misconception that maths is only important for people with career interests in fields like engineering, business and science when, in fact, it is a subject that provides thinking skills invaluable to everyday life. In his report to the Prime Minister last year, the Chief Scientist emphasised that, 'mathematics, engineering and science are pervasive. They are with us and used by us every day'.[xi] Unfortunately, and perhaps because avoidance is the ultimate consequence of mathematics anxiety, the numbers of students enrolling in advanced subjects and in any mathematics subject in upper secondary school are declining, with girls in particular choosing not to pursue maths into their senior years.[xii] The Chief Scientist commented that in order to address this downward trend, 'the understanding of the pervasiveness in and importance of mathematics, engineering and science to Australia's future needs to be promoted and nurtured across the community'.

Recommendations like this one from the Chief Scientist are commonly made with the hope of increasing the number of graduates with tertiary maths degrees so that Australia can be an international competitor in the mathematics field and have a workforce that will help to promote the economy. However, this recommendation is also important for students struggling with anxiety in the classroom and could be addressed at this level. Teachers have the opportunity to dispel negative stereotypes and myths about maths, and to help create a positive classroom environment that encourages students to have a go without fear. In order to do this, students should feel that maths is just like any other subject and hard work will bring about improvement. Teachers also have the opportunity to encourage their students to believe that things like gender stereotypes and negative

peer culture should not limit their mathematical choices. Students should also be made aware of the many applications of maths in many careers and life pathways. Armed with this outlook, they will be able to fulfil their maths potential and make choices based on factors other than anxiety.

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