A Mathematical Resilience Intervention for Upper Primary Students: A Design to Address Mathematics Anxiety

Ashley McAvoy
Edith Cowan University
amcavoy@our.ecu.edu.au

Eibhlish O'Hara
Edith Cowan University
e.ohara@ecu.edu.au

Paula Mildenhall
Edith Cowan University
p.mildenhall@ecu.edu.au

This paper is part of a broader mixed-methods study exploring how a literature-informed mathematical resilience intervention impacts mathematical resilience and mathematics anxiety in Year 5 and 6 Australian students. This paper details the creation of a five session, whole-class mathematical resilience intervention for upper primary students. The intervention was developed through a synthesis of mathematical resilience literature, focusing on building students' knowledge and skills related to the four constructs of mathematical resilience described by Johnston-Wilder and Lee (2024): growth mindset, struggle, value and support.

Mathematics anxiety negatively impacts mathematics performance, learning behaviours and academic and vocational choices (Luttenberger et al., 2018). It is an international concern; results from the 2022 Program for International Student Assessment (PISA) show a negative relation between mathematics anxiety and student mathematics achievement across all countries (OECD, 2023). Consequently, there has been renewed interest into how to decrease mathematics anxiety and one way may be to increase mathematical resilience. This paper describes a research-informed mathematical resilience intervention for Year 5 and 6 students.

Literature Review

Mathematics Anxiety

Mathematics anxiety has been defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems" (Richardson and Suinn, 1972, p.551). Research suggests that mathematics anxiety is a distinct form of anxiety, separate from test anxiety and general anxiety (Devine et al., 2012; Williams et al., 2025). It is typically assessed via self-report questionnaires, where participants rate their anxiety in various mathematics scenarios. PISA 2022 results found 35% of Australian 15-year-old students reported that they get very nervous doing mathematics problems and 61% feel anxious about failing in mathematics, with female students reporting significantly higher mathematics anxiety than male students (De Bortoli & Underwood, 2025). This gender discrepancy is reflected in the literature (Devine et al., 2012; Gokhool et al., 2022; Williams et al., 2025). While some studies have found no gender differences in mathematics anxiety in primary and secondary students (Erturan & Jansen, 2015; Mitchell & George, 2022), no studies report mathematics anxiety to be higher in males.

Evidence suggests that mathematics anxiety develops in primary school and increases with age (Dowker et al., 2016). In Hembree's (1990) seminal meta-analysis, mathematics anxiety was found to peak in Grades 9-10, but studies suggest that mathematics anxiety can appear as early as Year 1, with young children reporting high levels of mathematics anxiety (Erturan & Jansen, 2015; Ramirez et al., 2016).

Many factors impact on the development of mathematics anxiety, including environmental factors (such as parents, teachers, socio-economic status and poor mathematics experiences),

(2026). In N. Berger, M. Thompson, J. Ley & C. Wilsmore (Eds.), *Beyond boundaries: Strengthening futures in mathematics education. Proceedings of the 48th annual conference of the Mathematics Education Research Group of Australasia, Sydney* (pp. 258–265). MERGA.

personal factors (such as general anxiety, genetic predispositions, gender and appraisal), and reciprocal variables, such as mathematics self-concept and self-efficacy, prior mathematics knowledge and motivation (Luttenberger et al., 2018; Ramirez et al., 2018). Mathematical resilience is a powerful construct that could potentially address several factors that shape mathematics anxiety.

Mathematical Resilience

Johnston-Wilder and Lee (2010) coined the term 'mathematical resilience' as "a positive approach to mathematics that allows people to overcome any affective barriers presented when learning mathematics" (p. 2). They advocate that it is an antidote to mathematics anxiety, supported by their early work with adult apprentices (Johnston-Wilder et al., 2014). They describe four aspects of mathematical resilience: having a growth mindset, recognising the personal and societal value of mathematics, understanding that mathematics involves struggle and knowing how to find support (Johnston-Wilder & Lee, 2024).

Evidence that supports the link between mathematics anxiety and mathematical resilience is still emerging and relatively recent, but mathematical resilience is increasingly viewed as both a preventative and interventional approach to reducing mathematics anxiety. Studies with secondary and tertiary students have consistently found a negative relationship between mathematics anxiety and mathematical resilience, with varying effect sizes (Gokhool et al., 2022; Hadji-Sonni, 2023; Lovelace, 2022; Trigueros et al., 2020).

Research on this relationship in primary school children is limited. A systematic review conducted by Akkan and Horzum (2024) examined thirty-one studies on increasing mathematical resilience published from 2000 to 2021 and found that 38.7% of studies used high school students and none of the studies in their review had primary school aged participants.

Intervention studies that have attempted to decrease mathematics anxiety by increasing mathematical resilience in school-aged students show promising results, however many are limited by small sample sizes and generally focus on high school students. Kirkland (2020) examined how a one-on-one expressive writing and mathematical resilience intervention affected mathematics anxiety in three UK primary students. While the intervention reduced mathematics anxiety, mathematical resilience was not measured. A case-study in a Brazilian high school conducted a mathematical resilience intervention with 32 high school students, utilizing the three tools discussed later in this paper, and found that mathematics anxiety appeared to decrease, however, due to the small sample size, they were unable to obtain a p-value lower than 0.05 (Para & Johnston-Wilder, 2023). Their qualitative results, however, showed increases in mathematically resilient thinking. Hadji-Sonni (2023) conducted a study with 125 French high school learners from Year 6 to 10 and found that the mathematical resilience intervention, also using these tools, reduced mathematics anxiety and increased mathematical resilience. A study with seventeen Year 12 UK students found that mathematical resilience increased and mathematics anxiety decreased after the intervention (Johnston-Wilder et al., 2015). With the exception of Hadji-Sonni (2023), these studies are limited by small sample sizes, restricting generalisability.

One aspect of being mathematically resilient involves having a growth mindset (Johnston-Wilder & Lee, 2024). In the PISA 2022 results, growth mindsets were related to lower levels of mathematics anxiety (OECD, 2023). Although studies are limited, interventions aimed at building growth mindsets in mathematics have also demonstrated positive effects on mathematics anxiety. For instance, Clark (2021) conducted mathematics growth mindset lessons with fourteen fourth grade children using an online course and found that an increase in growth mindset scores was linked with a decrease in mathematics anxiety scores.

Building Mathematical Resilience

This paper focuses on building mathematical resilience by targeting all four factors of mathematical resilience and using mathematical resilience tools in dedicated instructional sessions, but this is only one possible approach. Alternative approaches involve teachers providing students with challenging mathematical tasks to normalise uncertainty and support productive engagement with challenge (Buckley & Sullivan, 2023). These approaches also address key aspects of resilience, particularly Struggle and Support.

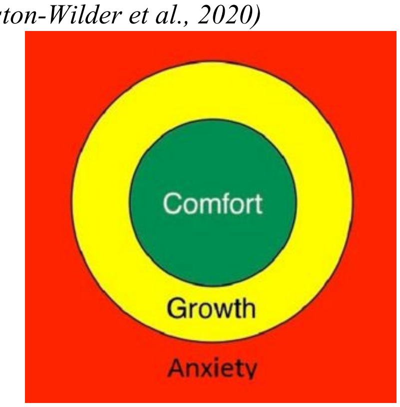
One aspect of mathematical resilience includes having a growth mindset, which can be developed through teaching students about what a growth mindset is and how it is beneficial, conveying information about the neuroplasticity of the brain and supporting learners to try mathematics problems that challenge them (Johnston-Wilder & Lee, 2024).

Mindset interventions largely have three objectives, according to Jiang and colleagues' (2024) meta-analysis. The first is to explain the scientific basis behind how human brains change and learn (Jiang et al., 2024). This is supported by a meta-analysis of ten studies by Sarrasin and colleagues (2018), that found that teaching students about neuroplasticity had an overall positive effect on motivation, achievement and brain activity. The second objective is to give credibility to mindset theory, often through sharing stories of people overcoming challenges with growth mindsets (Jiang et al., 2024; Yeager & Dweck, 2020). The third objective is to enable students to internalise the message, often through writing activities, role play or experiential learning (Jiang et al., 2024).

Mathematical resilience tools have been used successfully with adults and high school students, however, the effectiveness of these tools for increasing mathematical resilience in primary school students has not yet been studied. The Growth Zone Model (GZM; see Figure 1), adapted by Johnston Wilder and colleagues (2020) from Vygotsky's (1978) Zone of Proximal Development, aims to help students recognise the difference between productive nervousness and debilitating anxiety.

Figure 1

Growth zone model (GZM; Johnston-Wilder et al., 2020)



Note. From "A toolkit for teachers and learners, parents, carers and support staff: Improving mathematical safeguarding and building resilience to increase effectiveness of teaching and learning mathematics," by S. Johnston-Wilder, C. Lee, S. Pardoe, and S. Richards, 2020, *Creative Education, 11,* Figure 2 (10.4236/ce.2020.118104). CC BY 4.0.

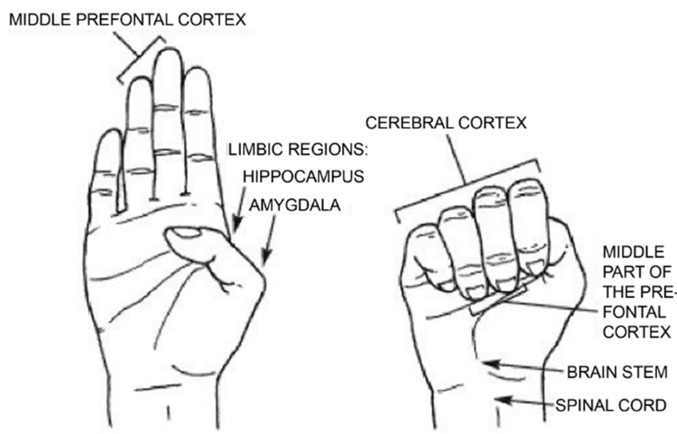
The green circle of the GZM is the comfort zone, where learners feel confident and safe. The yellow ring, the growth zone, is where learners experience challenge, make mistakes and may require support. The red zone is the anxiety zone, where learners feel threatened and their cognition decreases.

Using the GZM, along with the Hand Model of the Brain (Siegel, 2011; Figure 2) and the relaxation response (Benson, 2000), Johnston-Wilder and colleagues (2021) found the tools helped an adult learner focus on their emotional responses and manage their mathematics anxiety. Similarly, a one-on-one intervention with thirteen Year 7 students in England found that the GZM increased students' emotional awareness and supported students to reengage with their learning (Baker, 2021).

The Hand Model of the Brain (HMB) describes how the brain reacts when threatened, shutting off higher-order thinking skills. Johnston-Wilder and colleagues (2020) describe how it can be used when explaining about mathematics anxiety and how the brain works. The closed fist represents a regulated brain ready to learn, while the open hand represents a dysregulated brain and corresponds to the anxiety zone in the GZM. Johnston-Wilder and colleagues (2020) argue that teaching the HMB explains how the brain reacts to stress and reframes stress responses as the brain trying to protect the individual. It can also be used by learners to show what state they are in using the hand signals and gives a name to mathematics anxiety that is simpler- learners can say "I've flipped".

Figure 2

Hand Model of the Brain (Siegel, 2010)



Note. From *Mindsight: Transform your brain with the new science of kindness* (p.15), D. Siegel, 2010, Oneworld Publications. Copyright 2010 by Siegel.

The relaxation response (Benson, 2000) is a mindfulness strategy that learners can use to calm their body when they feel they have 'flipped', engaging their parasympathetic nervous system (Johnston-Wilder et al., 2020). Recommended techniques include 7-11 breathing, 3-3-3 grounding (naming three things they can hear, see and feel) and going for a walk (Johnston-Wilder et al., 2020). Focused deep breathing exercises have been found to decrease mathematics anxiety in adult and child samples (Brunyé et al., 2013; Khng, 2017).

Rationale

While studies have found a negative relationship between mathematics anxiety and mathematical resilience, few studies have actually tested how one variable impacts on the other. Additionally, most research on mathematical resilience has been conducted with secondary students and adult populations, with few studies investigating its application in primary school contexts (Akkan & Horzum, 2024). This lack of mathematical resilience research at the primary level is concerning, given that primary school seems to be when mathematics anxiety develops, and where preventative interventions could be most effective (Barroso et al., 2021; Namkung et al., 2019). If mathematical resilience interventions were found to be effective in decreasing primary school students' mathematics anxiety, they could be used in schools to support struggling students and combat the negative effects of mathematics anxiety.

To the best of the authors' knowledge, no mathematical resilience programs exist in primary schools currently. This paper describes the creation of a five-session mathematical resilience intervention for Year 5/6 students, based on the interventions published in the literature conducted with adolescent samples and other recommendations. This intervention is part of a larger mixed-methods research project which seeks to investigate the relationship between mathematical resilience and mathematics anxiety across year level and gender, before and after the intervention. Results will follow later in the year.

The Intervention

The intervention goals are based on the constructs of mathematical resilience: Growth, Struggle, Value and Support (Johnston-Wilder & Lee, 2024). Table 1 shows an overview of the learning goals for each session of the intervention and the mathematical resilience focus.

Across the five sessions, students will:

- Develop a growth mindset about mathematics
- Understand that mathematics involves struggle and making mistakes are part of the process of learning mathematics
- Learn strategies they can use when they get stuck
- Understand the personal and societal value of mathematics

Session 1 introduces group expectations, emphasising a respectful environment in which students feel safe to make mistakes and seek challenges, an important condition for developing mathematical resilience (Johnston-Wilder & Lee, 2024). Students learn about neuroplasticity and how the brain learns, which has been recommended when teaching for a growth mindset (Jiang et al., 2024; Johnston-Wilder & Lee, 2024; Sarrasin et al., 2018). Students watch a video illustrating how repeated effort strengthens neural connections and then explain the concept to a partner and create their own analogy. They are introduced to the Hand Model of the Brain and play a game identifying different brain parts and functions. Finally, the definition of a growth mindset is explicitly introduced and students label fixed or growth mindset thoughts before writing about a time they demonstrated a growth mindset.

Table 1

Learning Goals and Focus of the Mathematical Resilience Intervention Sessions

	Learning Goals	**Mathematical Resilience Focus**
1	I can explain how our brain learns. I can point to parts of the brain using the Hand Model of the Brain. I can differentiate between growth and fixed mindset thoughts and describe a time I used a growth mindset.	Growth Mindset
2	I can describe and explain which zone of the GZM others are in. I can explain why it is important to struggle in maths. I can write about how I can use a growth mindset in my maths learning.	Growth Mindset Struggle
3	I can write about when I have been in each zone of the GZM. I can describe relaxation strategies I can use to regulate myself when anxious.	Struggle Support
4	I can list ways to get 'unstuck'.	Support
5	I can identify the value that maths has for me and in society. I can apply mathematical resilience tools and strategies that I have learnt to overcome struggles when problem-solving maths questions.	Value Support Struggle

Session 2 introduces the GZM to students and has students performing short skits in small groups, where the rest of the class tries to figure out which zone of the GZM the 'main character' is in. Role play can be used to enable students to internalise the messages of mindset theory (Jiang et al., 2024), specifically that we want to be working in the growth zone, and that struggle is part of learning. The skits were created to be relatable and recognisable scenarios, e.g. struggling with completing homework. The session finishes with a free-write answering two questions: Why is it important to struggle in maths? and How will I use a growth mindset in maths? Mathematically resilient learners recognise that mathematics challenges involve struggle, and can regulate the associated negative emotions (Johnston-Wilder & Lee, 2024).

Session 3 has students relating the GZM to themselves by writing and sharing about when they have been in each zone, to consolidate their understanding of the model. Students are introduced to three relaxation strategies: Hand breathing, 3-3-3 grounding and muscle relaxation. These techniques were selected for their suitability in primary classrooms, with hand breathing chosen as an alternative to the 7-11 breathing recommended by Johnston-Wilder and colleagues (2020), deemed too difficult for this age group. Hand breathing has students tracing their hand, breathing in when tracing up a finger and breathing out when tracing down for five slow breaths. Research on progressive muscle relaxation has found it reduces stress and anxiety among children (Ayed et al., 2021; Köse Kabakcıoğlu & Ayaz-Alkaya, 2024). The session finishes with a video and discussion about Hellen Keller, providing credibility to mindset theory by showing someone who overcame challenges (Jiang et al., 2024; Yeager & Dweck, 2020).

Session 4 focuses on finding support. When students are in the Growth zone of the GZM, they should be getting stuck and making mistakes, but they need to be taught strategies for how to get 'unstuck'. Students brainstorm ways they can get unstuck and then are shown different strategies. They then make their own poster with at least 5 strategies.

In Session 5, students brainstorm all the ways we use mathematics, for themselves and in society, which focuses on the mathematical resilience construct of Value. When children do not understand the practical uses of mathematics, this can be linked to decreased motivation and negative mathematics attitudes (Ashby, 2009). Students then apply what they have learnt throughout the sessions while tackling a challenging mathematics problem.

Conclusion

This mathematical resilience intervention will be conducted in four Year 5 classes and three Year 6 classes, and work samples and observational notes will be collected. Before and after the intervention, students will fill out a mathematical resilience survey and mathematics anxiety survey. After the intervention, students will also complete a qualitative written survey of thoughts and opinions on the intervention. These data will allow further exploration of the extent to which mathematical resilience interventions can enhance mathematical resilience and reduce mathematics anxiety in upper primary students, as well as whether the impact of such interventions varies by gender or year level. Additionally, qualitative data will be used to identify what aspects of the intervention students found most and least helpful to build mathematical resilience and why, offering valuable insight for refining future interventions.

More broadly, this work contributes a practical approach to supporting students who struggle with low mathematical resilience, by explicitly targeting the four aspects of mathematical resilience. Although the effectiveness of the intervention will be explored in subsequent research, it offers a research-informed and classroom-based approach that has the potential to improve students' mathematics experiences and attitudes towards mathematics and guides efforts to foster resilience and potentially reduce anxiety in the primary classroom.

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