ACER’s Mathematics Anxiety and Engagement Strategy (MAES): A framework
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1. Acronyms and Abbreviations

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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ACER</td>
<td>Australian Council for Education Research</td>
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<tr>
<td>MAES</td>
<td>Mathematics Anxiety and Engagement Strategy</td>
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<tr>
<td>CVT</td>
<td>Control-Value Theory of Achievement Emotions</td>
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<td>EVT</td>
<td>Expectancy Value Theory</td>
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<td>AMSI</td>
<td>Australian Mathematical Sciences Institute</td>
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2. Introduction

ACER’s Mathematics Anxiety and Engagement Strategy (MAES)

The Mathematics Anxiety and Engagement Strategy (MAES) was established by the Australian Council for Educational Research (ACER) in 2018 in response to declining mathematics achievement and participation among Australian students. Findings from the 2022 cycle of the Programme for International Student Assessment (PISA) show that 15-year-old students in Australia had significantly lower levels of mathematical literacy than students in 2003 (De Bortoli et al, 2023). The 2022 results also showed that male students outperformed female students and only 30 percent of students from more disadvantaged backgrounds achieved the National Proficient Standard\(^1\) in mathematics compared to 72 percent of students from more advantaged backgrounds. In 2022, the Australian Mathematical Sciences Institute (AMSI) reported that the number of Australian students enrolling in one or more mathematics subjects in Year 12 was continuing to decline (Wienk, 2022). There was also an increasing gender gap, with AMSI noting that only 38 percent of students enrolled in more-advanced mathematics subjects were female. Other research suggests that belief in mathematical ability may be a key factor influencing female students’ decision to enrol in upper secondary STEM subjects (Watt et al, 2017). These findings highlight that improving mathematics engagement could be a key lever to addressing gender equity in STEM and to addressing socioeconomic disadvantage.

The aim in developing MAES was to help counter declining mathematics achievement and participation by identifying and removing significant barriers to students’ positive engagement with mathematics. MAES uses an innovative, multidisciplinary approach that is informed by research in education, psychology, and neuroscience. Namely, MAES offers key research findings in a format that is useable for educators and policymakers. To guide the direction of MAES, an Advisory Board was established that includes academics and education stakeholders from around Australia.

Barriers to mathematics engagement and persistence

In MAES, two key barriers to mathematics engagement and persistence are identified: \textbf{mathematics anxiety} and \textbf{low valuing of mathematics}. These barriers must be addressed to improve mathematics achievement and participation nationally.

From 2013-2018, ACER conducted research in the Science of Learning Research Centre and developed an evidence-based and multidisciplinary approach to addressing \textbf{mathematics anxiety} (Buckley et al., 2016). ACER’s developments in this area have been refined in MAES through work with universities, preservice and practising teachers, schools, government education departments and education stakeholders.

\[^1\] The National Proficient Standard is a benchmark set by ACARA that represents a standard of achievement. At this standard, students are expected to use their mathematical skills to complete tasks that are “challenging but reasonable” for students at that year level (ACARA, 2022, p.6).
ACER’s research using Australian longitudinal data showed that one of the strongest factor predicting whether students persisted with STEM studies from secondary school into tertiary studies was how much they valued mathematics at age 15 (Edwards et al., 2023). Low valuing of mathematics has therefore been identified in MAES as the second key barrier to students’ positive engagement with mathematics and has been addressed through resource development and partnership with education stakeholders.

The MAES framework

In this document we provide a brief overview of important research findings about mathematics anxiety and low valuing of mathematics. We also describe how the MAES approach addresses these barriers to mathematical learning.

The MAES framework has been used in partnership with education stakeholders to develop new resources for schools, universities, and education systems. These resources provide school leaders, educators (preservice and practising) and students with the knowledge and skills to reduce mathematics anxiety, to encourage students to value mathematics, and to increase students’ mathematics confidence.

In developing the MAES framework we aimed to:

- Present research findings across the three fields of education, psychology, and neuroscience in a useful form for educators, school leaders and policymakers.
- Clearly identify how using a multidisciplinary approach to address mathematics anxiety and improve the valuing of mathematics can complement current practices used in schools and universities.
- Illustrate that the approaches described all contribute to developing student and teacher mathematical resilience, ensuring students persist in the face of mathematical challenge and continue to pursue mathematics opportunities.

For more in-depth discussion of the educational, psychological and neuroscience research and theory underpinning MAES, please see Buckley et al. (2016) and Buckley et al. (2020).
3. Mathematics anxiety

Mathematics anxiety is defined as the worry, nervousness and/or tension linked to performing mathematical tasks (Richardson & Suinn, 1972; Cipora et al., 2022). Neuroscience research has shown that there is more activity in areas of the brain associated with the experience of physical pain when people feel anxious about mathematics (Lyons & Beilock, 2012a). While research has illustrated that feeling anxious about mathematics is often linked with other types of academic anxiety (e.g. test anxiety) and general anxiety, studies have also shown that mathematics anxiety is a distinct phenomenon that should be considered and addressed as such (Cipora et al., 2022; Dowker et al., 2016; Kazelkis, et al., 2000).

Mathematics anxiety is widely studied because it can affect learning. A recent meta-analysis including research completed between 1972 and 2018 found higher levels of mathematics anxiety were, on average, associated with lower levels of mathematics achievement (Barroso et al, 2021). These analyses showed that the strength of the relationship varied across different grade levels (from Grade 1 to adult non-student samples) with the strongest association in secondary school. This finding supports previous research that suggests mathematics anxiety peaks in early adolescence (Ma, 1999; Meece et al, 1990).

Research has shown that mathematics anxiety interrupts learning by overloading working memory and preventing individuals from demonstrating their mathematics potential (Ashcraft & Kirk, 2001; Hembree, 1990; Ho et al., 2000; Ramirez et al., 2018). The long-term consequence of mathematics anxiety is avoidance, with mathematically anxious students deliberately choosing career pathways that do not involve mathematics (Daker et al., 2021; Devine et al., 2012).

Research also shows that:

- Females, on average, report higher levels of mathematics anxiety than males (Geary et al., 2023; DeBortoli et al., 2023)
- Children as young as 6 years old report feeling anxious about mathematics (Tomasetto et al., 2021)
- High levels of mathematics anxiety are reported by some primary teachers (Hembree, 1990; Philipp, 2007). Longitudinal research shows that teachers with higher levels of mathematics anxiety tend to have students with lower levels of mathematics knowledge after a school year compared to peers with non-anxious teachers (Schaeffer et al, 2021).
The MAES approach for understanding anxiety

A key foundation of the MAES approach is acknowledging that mathematics anxiety is more than just the experience of struggling with poor mathematical skills (Beilock & Willingham, 2014; Buckley et al., 2016). In MAES, anxiety is separated into two components: symptoms and causes. Each of these components affects learning/teaching differently (as illustrated in Figure 1). This understanding of anxiety uses the state/trait anxiety dichotomy from psychology, labelling these as symptoms (state mathematics anxiety) and causes (trait mathematics anxiety) (see Buckley et al., 2016; Buckley et al., 2020 for more details).

**Figure 1: Components of mathematics anxiety**

- **Symptoms**
  - Felt during participation or when anticipating doing mathematics
  - Physiological and cognitive
  - Similar to symptoms of any anxiety (e.g. anxiety about public speaking, spiders)
  - Impact on the ability to learn and/or teach in the moment

- **Causes**
  - Negative beliefs and thinking about mathematics potential
  - Long-standing and often held unconsciously
  - Shaped by factors in the home and school, experiences and culture
  - Impact on mathematics-related choices and development

Figure 1 describes the symptoms of mathematics anxiety as:

- Physiological (increased physiological response, e.g. increased breathing and heart rate), and
- Cognitive (intrusive negative thoughts or worries)

Mathematics anxiety symptoms interfere with working memory, reducing an individual’s potential to learn and/or teach at their best. In contrast, the causes of mathematics anxiety are more enduring, like attitudes that have been shaped over time through experiences and the environment.

One theory in educational research – the Control-Value Theory of Achievement Emotions (CVT; Pekrun, 2006) – proposes that anxiety in mathematics is experienced when an individual values mathematics but also feels they have little or no control over their learning in the classroom (Schukajlow et al., 2023). MAES uses this theory to better understand the relationship between the learner and mathematics, especially for understanding the causes of mathematics anxiety. This theory implies that low perceptions or beliefs about control in mathematics should be targeted to address the primary cause of anxiety. Low-control beliefs are influenced by a range of factors including experiences and attitudes about mathematics in the home, relationships with teachers and peers, and peer and broader cultural norms (Good et al., 2012; Maloney & Beilock, 2012; Maloney et al., 2015; Tomasetto et al., 2011).
These factors can contribute to an individual thinking that their mathematics potential is fixed and unchangeable, irrespective of any effort they might apply to change it.

**The MAES approach to addressing anxiety**

Building on the ideas emphasised above, the MAES approach to addressing mathematics anxiety focuses on providing individuals with the tools to improve their feelings and attitudes related to control in mathematics (Buckley et al., 2020). This approach is unique and differs from current approaches to addressing mathematics anxiety in many classrooms. Educators often attempt to target mathematics anxiety indirectly by trying to improve content knowledge and skills, believing that this will improve mathematics confidence and thereby reduce anxiety (Rayner, Pitsolantis, & Osana, 2009). This approach is used in preservice primary teacher education; however, research suggests that it may not be effective in the long-term as many practising primary teachers report high levels of mathematics anxiety (e.g., Beilock et al., 2010). The indirect approach is also problematic for highly mathematics-anxious individuals who find it difficult to engage in any mathematics.

**A student with high levels of mathematics anxiety**

A teacher attempts to build the student's skills, knowledge and confidence by exposing them to more maths tasks, however, anxiety operates like a barrier and the student is not able to engage effectively. A teacher provides the student with strategies to reduce and regulate their fearful response to maths in the moment, removing the barrier that is anxiety. The teacher’s efforts to build skills, knowledge and confidence are then more effective.

In MAES, mathematics anxiety is addressed directly as an emotion using emotion-regulation techniques and strategies designed to help identify, challenge and change the negative beliefs and thinking that individuals hold about their mathematics potential (Buckley et al., 2020; Buckley & Sullivan, 2023).
In MAES, different strategies are applied to address the symptoms versus the causes of mathematics anxiety. The strategies described are based in psychology and are designed to complement the efforts of educators in the classroom to reduce mathematics anxiety through building confidence, skills and knowledge.

**Strategies to address the symptoms**

Table 1 briefly describes several emotion regulation strategies that are used in MAES, and that are targeted towards schools, universities and education systems. These strategies do not involve doing any mathematics but help to reduce and regulate the heightened physiological and cognitive sensations of the symptoms of mathematics anxiety. This reduction and regulation of sensations allows individuals to think, learn and/or teach more effectively. Some of these strategies are already used in schools, often to enhance students’ wellbeing rather than as techniques to address negative emotions.

<table>
<thead>
<tr>
<th>Emotion regulation strategy</th>
<th>Brief description</th>
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<tbody>
<tr>
<td>Deep breathing exercises</td>
<td>Focusing on slow and deep breathing from the diaphragm, rather than rapid, shallow chest breathing.</td>
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<tr>
<td>Progressive muscle relaxation</td>
<td>Learning to ease stress and physical tension by tensing and relaxing muscle groups.</td>
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<tr>
<td>Positive reframing/cognitive reappraisal</td>
<td>Reorienting thinking to deliberately reframe something first seen as negative to a positive experience.</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>Being present in the moment to what is going on internally and externally and acknowledging these things free of judgement.</td>
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<tr>
<td>Expressive writing</td>
<td>Writing, without restriction, about negative thoughts and feelings for events that provoke anxiety.</td>
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Research shows that these strategies can reduce the symptoms of mathematics anxiety and its negative impact on learning (e.g., for deep breathing exercises, Larson et al, 2010; for progressive muscle relaxation, Flor et al, 2013; for cognitive reappraisal, Jamieson et al., 2010, and Pizzie & Kraemer, 2021; for mindfulness, Brunyé et al, 2013, and Samuel & Warner, 2021; for expressive writing, Park et al, 2014).

For the strategies outlined in Table 1, it is important to note that:

- These strategies can be used by both students and teachers who experience mathematics anxiety.
- These strategies should be introduced/practised when students/teachers are not anxious so that they are easier to access and use during anxious moments.
• Multiple strategies are provided so that individuals have different tools to use, according to their preferences.
• Expressive writing depends on the use of literacy skills. Some evidence suggests it may be more effective for older individuals (e.g. upper primary/early secondary onwards) (Mesghina & Richland, 2020). In an educational setting, it is also important to emphasise that the writing is for personal use by the individual (e.g., a teacher should not expect to collect the writing that a student produces. It is up to the individual on whether they want to share what they have written).
• Care needs to be exercised when introducing students to these strategies so as not to prime non-anxious students that anxiety is something they should be experiencing in mathematics. For instance, breathing exercises could be introduced in a class setting to help all students focus for an upcoming mathematics lesson rather than highlighting their use for anxious students. A teacher could speak individually to an anxious student to also suggest they use the technique when they are anxious in class.

**Strategies to address the causes**

Given the causes of mathematics anxiety arise from poor mathematics control beliefs, addressing these causes focuses on helping individuals identify and change negative beliefs and thinking about mathematics. These beliefs and patterns of thinking are often held unconsciously; identifying such beliefs is the first step, followed by efforts to challenge and change the beliefs. Although educators often challenge students’ negative beliefs and thinking about mathematics in the classroom, Table 2 presents additional strategies that can be used to help mathematically anxious students and teachers address the basis of their anxiety. Expressive writing can be effective for targeting both the symptoms and causes of mathematics anxiety.

**Table 2. Strategies that can be used to address the causes of mathematics anxiety**

<table>
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<th>Strategy</th>
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<tr>
<td>Maths metaphors</td>
<td>Identifying the types of belief and patterns of thinking an individual holds towards mathematics by asking them to create a metaphor of what mathematics means to them.</td>
</tr>
<tr>
<td>Expressive writing</td>
<td>Writing freely about negative thoughts and feelings for events that provoke anxiety.</td>
</tr>
<tr>
<td>Bibliotherapy</td>
<td>Reading about and identifying with situations and characters experiencing similar challenges to normalise emotions and gain insight into ways of moving forward in a positive direction.</td>
</tr>
<tr>
<td>Cognitive behavioural approaches</td>
<td>Learning how thoughts, feeling and behaviours are linked, and identifying, challenging, and changing unhelpful thinking and behaviour.</td>
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</table>
Research evidence supports the use of these strategies to deal with mathematics anxiety and/or test anxiety, or for helping to identify beliefs and thinking about mathematics (e.g., for maths metaphors, Brady & Winn, 2014; for expressive writing, Park et al, 2014; for bibliotherapy, Wilson & Thornton, 2008; for cognitive behavioural approaches, Krispenz et al., 2019). Growth-mindset interventions can also be a way to challenge and change low-control beliefs by teaching students that effort can lead to improvement (Paunesku et al., 2015; Yeager & Dweck, 2020).

The strategies discussed in Tables 1 and 2 are evidence-based tools that have the potential to support individuals to reduce and regulate their mathematics anxiety and improve their feelings and attitudes related to control in mathematics. The tools should be used in combination with other strategies designed to target mathematics anxiety indirectly, for example, building student/teacher confidence, skills, knowledge and enjoyment in mathematics.

Using these techniques in combination is particularly important for the causes of mathematics anxiety. The MAES framework aims to support individuals to change negative control beliefs about their mathematics potential. For this to be effective, the individual must test out their new positive control beliefs and experience success in their mathematical learning.

Reducing and regulating, not eliminating

None of the MAES strategies discussed are designed to eliminate anxiety entirely. Anxiety has a biological and evolutionary function and can also be important in education. In fact, moderate levels of mathematics anxiety can facilitate an individual’s best learning and/or teaching. Students who are told about the positive effects of increased physiological arousal (as occurs in the symptoms of mathematics anxiety), or anxious students who are told to try and harness that arousal and think of it as “excitement” rather than “anxiety”, tend to perform better on mathematics tasks than students who are not provided with any instructions or those who are told to “stay calm” (Brooks, 2014; Jamieson et al., 2010; Jamieson et al., 2016).

Thinking about mathematics anxiety as an emotional and attitudinal experience that can be regulated is also important for dispelling any labelling traps – for example, “I/they have mathematics anxiety, so mathematics just isn’t for me/them.” In fact, neuroscience research suggests that how individuals respond to mathematics anxiety – for example, by recruiting emotion regulation strategies versus being stuck in a rumination cycle of negative thoughts – determines whether it will negatively affect their learning (Lyons & Beilock, 2012b). Longitudinal research also suggests that some students can have high levels of mathematics anxiety in upper primary school, but this can gradually decrease during secondary school with a resilient mindset (Wang et al., 2020).

The importance of targeting the symptoms and causes together

Finally, the MAES approach to addressing mathematics anxiety emphasises that both the symptoms and causes should be addressed together to effectively reduce and regulate anxiety in the long-term. Some educators might find this challenging because some of the tools described – particularly the
emotion regulation techniques – are not traditionally found in mathematics classrooms. Figure 2 provides a rationale for why it is necessary to focus on both components of mathematics anxiety, showing the learning profiles that may arise when neither, each, or both components are addressed.
Working with parents

Effectively addressing mathematics anxiety, particularly its causes, also depends on recognising the impact of the home environment on students’ beliefs about mathematics and their mathematics potential. Recent research findings on the impact of parents’ mathematics anxiety on their children are mixed. Some US studies suggest that mathematically anxious parents may help their children with mathematics homework in ways that increase children's mathematics anxiety and negatively impact their children’s mathematics learning (Kiss & Vukovic, 2021; Maloney et al, 2015). In contrast, a recent study in Chile showed that when mathematically anxious parents engaged in more frequent mathematics activities at home, their children’s mathematics anxiety did not negatively impact learning (Guzmán et al., 2023). These researchers concluded that parents with higher levels of mathematics anxiety may manage their children’s anxiety better, given their own experiences, whereas parents with low mathematics anxiety may be less able to empathise with their children’s anxiety or help them as effectively. While findings across these studies vary, they all emphasise that parents, regardless of their level of mathematics anxiety, may require support in this context.

For parents that are mathematically anxious, support may include:

• Asking parents to consider how they discuss mathematics at home and showing parents what positive ‘maths talk’ looks like.
• Educating parents that mathematics anxiety can lead to avoiding mathematics in the long-term, which can limit educational and professional choices in the future.
• Demonstrating how mathematical beliefs that align with a growth mindset can be encouraged, and the importance of parents modelling a growth mindset to their children (e.g. that making mistakes in mathematics, asking for help, and struggling is OK).
• Emphasising that parents do not need to be able to successfully complete the mathematics problems their children bring home to have a positive impact on their children’s attitudes towards mathematics.
• Identifying some simple emotion regulation techniques that parents and children can practise together to address the symptoms of mathematics anxiety.

For parents that are not mathematically anxious, support may include:

• Providing parents with information about the impact of mathematics anxiety for those that are anxious and helping parents understand the fear that can be experienced when anticipating mathematical tasks.
• Educating parents that mathematics anxiety can lead to avoiding mathematics in the long-term, which can limit educational and professional choices in the future.
• Identifying some simple emotion regulation techniques that parents and children can practise together to reduce the symptoms of mathematics anxiety.
4. Mathematics value

ACER longitudinal research (Edwards et al., 2023) and other longitudinal studies (e.g., Jiang et al., 2020; Musu-Gillette et al., 2015; Toh & Watt, 2022; Watt et al., 2012) have demonstrated that students’ valuing of mathematics plays an important role in guiding them towards or away from mathematics career pathways. ACER’s analyses showed that the level of value endorsed at age 15 was a key predictor of whether students persisted with STEM study, particularly for students from disadvantaged backgrounds. There are several important implications of this research:

• the pathway to tertiary STEM study may be decided by early adolescence,
• mathematics may be the ‘gatekeeper’ subject for persisting with STEM pathways, and
• improving students’ valuing of mathematics could be an important lever for increasing Australia’s future STEM workforce capacity.

A key theory on academic motivation, the Expectancy-Value Theory, (Eccles-Parsons et al., 1983; Eccles & Wigfield, 2020) outlines four different types of value that are important parts of academic motivation. These include:

• utility value: Valuing mathematics because you consider it useful for future or present goals and plans,
• intrinsic or interest value: Valuing mathematics because you find it interesting and/or enjoyable,
• attainment value: Valuing mathematics because it is important to your sense of self (e.g. mathematics is important in my family).

The fourth type of value in EVT is called perceived cost and relates to the costs an individual considers are associated with a task or subject area. For example, a cost could be the amount of effort required, the emotional cost, or whether other opportunities might be missed if this task/subject is prioritised.

In ACER’s research, utility value was identified as the value type that predicts persistence with the STEM pathway (Edwards et al., 2023). Some researchers suggest that utility value may be important for initial choices along the STEM pathway (e.g., whether to persist with mathematics study through secondary school and enrol in tertiary courses that involve mathematics) while other types of value may become more influential later when completing tertiary degrees and entering the workforce (Toh & Watt, 2022). Some evidence also suggests that mathematics utility value must be high for female students in early secondary school to have an impact on their choice to continue studying mathematics, whereas for male students the same effects can be found for only moderate-high levels of value (Watt, 2006). Australian results for the 2012 cycle of PISA showed that 80 percent of male students agreed with the statement, Mathematics is an important subject for me because I need it for what I want to study later on, compared with 67 percent of 15-year-old female students (Thomson et al., 2013). On average, levels of utility value tend to decline for all students during secondary school (Chouinard & Roy, 2008; Petersen & Hyde, 2017).
Utility value interventions

Improving students’ utility value has been widely studied, in particular through a technique known as a utility value intervention (Hulleman, & Harackiewicz, 2009; Hulleman et al., 2010). This intervention involves student agency and makes the value of mathematics visible to students by asking them to self-generate ways that mathematics connects to their lives. Research has shown that:

- when teachers inform students why mathematics is important for their lives and future, this can negatively affect students’ interest and achievement in mathematics.
- when students generate their own reasons for why mathematics is important for their lives it can positively impact on students’ achievement, value, and interest in mathematics (Canning & Harackiewicz, 2015).

Canning & Harackiewicz’s (2015) research found that some teacher scaffolding or guidance in the intervention process is helpful, particularly for individuals who were not confident about mathematics. However, self-persuasion and students using personal agency in the process are the critical elements. For the interventions to be effective, students need to discover themselves why mathematics is meaningful and relevant for their lives.

Two specific psychological mechanisms may explain why utility value interventions improve students’ motivation. Firstly, they can help students see new opportunities to engage with mathematics in personally enjoyable ways. Secondly, they can help students create new links between mathematics and their own identities (Silverman et al., 2023).

Evidence also suggests that parents can be part of successful utility value interventions for adolescents. In two studies, parents were sent information on the usefulness of mathematics and science for future career pathways and for daily life, and were instructed on how to talk to their children about these topics (Harackiewicz et al., 2012; Rozek et al., 2015). Researchers reported an increase in the number of students choosing to enrol in STEM courses at school for children whose parents were involved in this intervention versus children of parents who were not involved.

Utility value interventions can come in different forms (Hulleman, & Harackiewicz, 2022). For instance, they can include:

- Asking students to write about how a mathematics topic they are learning relates to their daily lives,
- Asking students to write a letter to a friend/family member explaining the relevance of a specific mathematics topic,
- Asking students to list their interests, goals and hobbies, asking them to list the mathematics topics they have recently studied, and then asking them to brainstorm connections between the two lists.
While the form of the intervention can vary, there are three principles that should be upheld in all utility value interventions:

1. The connections students make must be personally meaningful,
2. The connections students make must be specifically linked to a mathematics topic area,
3. The connections students make must be relevant to the mathematics content they are currently learning (Hulleman, & Harackiewicz, 2022).

Promoting utility value research in MAES

ACER’s work with educators and policymakers in the utility value space is a more recent development within the MAES initiative. This work has contributed by translating research on utility value and utility value interventions so that they can be applied in classrooms. For example, MAES includes prompts for a task that allows students to develop their own personally meaningful connections to mathematics, while also being true to the intervention's principles (i.e. that connections made must be personal, specific, and topic-related). This task would be adapted to be appropriate and engaging to educators’ specific educational contexts. The task prompts also ensure that educators understand the important role of student agency in making meaningful mathematics connections, and to ensure these connections have a positive impact on students’ valuing of mathematics and their mathematical learning and persistence.
The MAES framework describes approaches to addressing two key barriers to students’ positive engagement and persistence with mathematics. The approaches emphasise strategies, tools and tasks that help individuals develop agency over their thoughts, feelings and beliefs regarding mathematics and mathematical learning (for anxiety) and for the role of mathematics in their lives (for utility value).

The MAES framework offers ways to practise being mathematically resilient and encourage persistence in the future. For example, the MAES approach to addressing mathematics anxiety presents students and teachers with emotion regulation strategies to reduce and regulate their mathematics anxiety. By providing an opportunity to master that emotion, they can remember the experience and build on it for the next time that anxiety arises. Given mathematics tends to evoke more anxiety than other subject areas, the mathematics classroom is an important context for practising emotional resilience, which can be useful for dealing with any academic anxiety and for managing stressors in daily life (Buckley & Sullivan, 2021). In relation to the valuing of mathematics, approaches emphasised in the MAES framework focus on the importance of student agency for increasing value so that the value developed will encourage students to persist with mathematics in the long-term.

An emphasis on mathematical resilience is also illustrated in the MAES framework through our key message that the focus should not be eliminating mathematics anxiety but learning to gain control over its effects on learning. We highlight that some anxiety in learning can be associated with our best performance, which encourages greater acceptance of the emotion in the classroom and hopefully also fosters greater persistence and participation in mathematics. This approach complements growth-mindset interventions that seek to highlight the role of effort and agency in learning. As holding a growth mindset in mathematics means believing that internal factors like effort and perseverance lead to improvement and success, a growth mindset is also protective against low-control beliefs that are the foundation of mathematics anxiety.

ACER has collaborated with a range of stakeholders to translate the MAES approaches described in this framework document into curriculum content (for preservice teachers), information seminars, professional development workshops, resource materials, a podcast series and curriculum content. It is hoped that this content can add to the existing strategies and resources published in this space. Future partnering opportunities with educators, policy makers and other education stakeholders are vital to the ongoing development of MAES and to the success of efforts to improve student engagement and participation with mathematics.
6. References


