THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 1/24

BEING EMOTIONALLY READY

INSIDE

Wee Tiong Seah and Julia L Hill, Faculty of Education, University of Melbourne

BEING EMOTIONALLY READY TO LEARN MATHEMATICS. WHY BOTHER WITH EMOTIONAL READINESS?

As mathematics teachers, we draw on our knowledge of mathematics learning theories, of learning psychology, and of individual students, to design our mathematics lessons. We have done very well in this aspect, no doubt supported by decades of (mathematics) educational research, the findings of which have been efficiently translated for us through teacher workshops and teacher journals such as this one.

However, we also know that a major hurdle to effective mathematics teaching in schools is that of students' emotional readiness to learn mathematics.

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THE COMMON DENOMINATOR
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The Mathematical Association of Victoria, 61 Blyth Street, Brunswick VIC 3056

ABN: 34 004 892 755
Tel: 03 9380 2399
office@mav.vic.edu.au

President: Kerryn Sandford
CEO: Jennifer Bowden

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FROM THE PRESIDENT

Kerryn Sandford

Welcome to 2024 and another full year of mathematics learning here with MAV.

In December, our annual conferences saw 940 delegates, 5 keynotes, 190 presenters and 100 sessions on each of the two days. I was able to catch Matt Sexton's keynote which emphasised the importance of Middle Leaders in the improvement of mathematics teaching and learning through 'aiming high' which he argued was about 'challenge for all'. In his keynote he discussed the need to create psychologically safe environments in the mathematics classroom that encourage challenge and support students to aim high without fear, linking well with the article later in this edition by Wee Tiong Seah and Julia Hill about being emotionally ready and the importance of mathematical wellbeing.

I enjoyed the session by the USA's Robert Kaplinsky, who is well known for his Open Middle problems and other approaches to teaching mathematics that invite students to think and to be creative as well as provide the teacher with excellent information about the misconceptions that students carry about key ideas in mathematics.

On the final day, I attended the keynote by Professor Chris Matthews from ATSIMA (Aboriginal and Torres Strait Islander Mathematics Alliance) on the importance of aiming high for all students and, especially, ensuring that we teach in ways that provide all students with a chance to see themselves and their culture valued and represented. Chris' work with ATSIMA to address the current inequity that exists in educational outcomes for Aboriginal and Torres Strait Islander young people across this country is well known. He is a passionate advocate for greater inclusion and visibility of First Nations culture, knowledge and perspectives within the mathematics curriculum. Chris outlined the Goompi model that he has developed to support this work and demonstrated several ways in which it has been applied to enhance the learning of all students and First Nations students. He called for greater support to progress this work at the system level and challenged his audience to consider their role in helping to address these inequities. Chris made many strong points about the opportunities that are there that we may not be taking advantage of as well as we could. With the recent release of both the new Australian and Victorian curriculums and the many elaborations that encourage educators to consider ways to enhance their teaching of mathematics through incorporating First Nations history, culture and knowledge, I can't help but agree with him on this point.

For those of you who attended MAVCON 2023, I hope that you heard messages that resonated with you and will support your work to improve mathematics teaching and learning for all students. I encourage you to reach out to MAV, perhaps through the new communication platform, to learn more about what you can do to support psychological safety and mathematical wellbeing, find creative ways to engage and assess your students' learning and ensure that all students in our classrooms feel culturally safe and supported so that they too, can learn at their best.

LIFE LONG LEARNING

The Term 1 edition of MAV's primary journal, *Prime Number* has several thought provoking articles including: practical ways to incorporate Polya's problem solving steps to scaffold thinking, assessing reasoning in the classroom and introducing Daily Reviews to the maths classroom. MAV's secondary journal *Vinculum* has information on planning an effective Vocational Major Numeracy course and developing mathematical argumentation skills in students.

YOUR MEMBER BENEFIT

MAV's journals are a benefit of your MAV membership. Journals are sent to all member schools and individual members. Check with your maths leaders for a hard copy and pass it around to all mathematics educators at your school. You can access electronic copies via MAV's website, www.mav.vic.edu.au.

UPCOMING MAV EVENTS

For more information and to reserve your place at any of the events below, visit www.mav.vic.edu.au.

EVENT	DATE	YEARS	PRESENTERS
The anticipate phase: unpacking this crucial step of the Launch, Explore, Summarise instructional model	8/2/24 Virtual	F–6	Jessica Kurzman
MAV VCE Conference	9/2/24	VCE	Various
The anticipate phase: unpacking this crucial step of the Launch, Explore, Summarise instructional model	12/2/24 Virtual	7–10	Jessica Kurzman
The rules and foundations of pseudocode (Part 1 of 3)	20/2/24 Virtual	VCE	Toan Huynh
Analysing pseudocode (Part 2 of 3)	27/2/24 Virtual	VCE	Toan Huynh
Designing and writing pseudocode (Part 3 of 3)	5/3/24 Virtual	VCE	Toan Huynh
Launch, Explore, Summarise instruction model - but how?	6/3/24 Virtual	F–6	Renee Ladner
Launch, Explore, Summarise instruction model - but how?	7/3/24 Virtual	7–10	Renee Ladner
Bass Coast regional tour - Innovative approaches to engaging maths pedagogy	8/3/24	F–6	Various
Learner agency	TBC	F–10	Larissa Raymond
MAVMEG24 Transformations: An opportunity to reflect and transform our practice (for Leader's)	20/6/24	F-12	Various
MAVMEG24 Transformations: An opportunity to reflect and transform our practice (for Teacher's)	21/6/24	F-6	Various

FIRST NATIONS PERSPECTIVE

Kerryn Sandford, Principal, Heathmont College and MAV President

As I stated in my *From the President* column, my learnings from the 2023 ATSIMA conference were deep and profound. Much of the conference revolved around sharing and challenging practice.

I enjoyed Rachel Whitney-Smith's workshop on changes to the new Australian Curriculum to include the elaborations around key themes derived from the mathematical thinking, understandings and processes of Australian First Nations Peoples with the aim of engaging all learners in rich experiences that further all student's knowledge of the history, and cultures of First Nations peoples.

Here are some helpful places to start if you are looking to incorporate learning about First Nations culture, history or perspectives into your mathematics programs:

VAEAI - Victorian Aboriginal Education Association Incorporated
www.vaeai.org.au

Maths Monographs – Teaching mathematics from a cultural perspective
www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/Pages/research_culturalperspective.aspx

Narragunnawali resources
www.narragunnawali.org.au/mathematics-resource-guide

The University of Melbourne have developed excellent mathematics resources
https://indigenousknowledge.unimelb.edu.au/curriculum

Australians Together
https://australianstogether.org.au/curriculum-resources/#Year10

The Queensland Department of Education page has great resources and ideas
www.qcaa.qld.edu.au/about/k-12-policies/aboriginal-torres-strait-islander-perspectives/resources/cross-curriculum-priority/maths-sample-resources

The Make it Count (AAMT) resources
https://mic.aamt.edu.au/Resources/Units-of-learning/Middle-years

ATSIMA (Aboriginal and Torres Strait Islander Mathematics Alliance) resources – are excellent and cover many of the elaborations in the new curriculum
https://atsima.com/resources

Chris Matthews on maths as story telling
https://strongersmarter.com.au/wp-content/uploads/2020/08/REV_Maths-as-Storytelling.pdf

BEING EMOTIONALLY READY

Wee Tiong Seah and Julia L Hill, Faculty of Education, University of Melbourne

CONT. FROM PAGE 1.

These manifest in the form of students' negative attitudes, disengagement, and mathematics anxiety, to name but a few. Each of these not only threatens to undo teachers' professional planning and delivery, but also signals that effective mathematics learning cannot take place when students are not prepared to want to learn. Indeed, this may contribute some insights to why our students' mathematics performance in international and local assessment exercises does not reflect their potential and our investment into improving mathematics education in Australia.

To be certain, there are successful intervention programs which had been designed to improve attitudes, strengthen engagement and alleviate anxiety. However, intervention programs can be disruptive to students' learning schedules in school, not to mention that by the time they are given, students' mathematics learning might already have been affected. What if we can foster students' emotional readiness for mathematics learning ahead of time, so that teachers can better deliver their intended lessons to the entire class?

MATHEMATICAL WELLBEING

It is against this context that we had chosen to research and develop mathematical wellbeing (MWB). Here we regard MWB as being associated with feeling good about learning mathematics and functioning well with regards to doing mathematics. Thus, there are both cognitive and affective aspects to MWB. We tried to identify what this looks like, and we came across the philosopher Valerie Tiberius' value fulfilment theory. This theory posits that wellbeing is a function of the extent to which relevant values are pursued and fulfilled. So, wellbeing might be enhanced when our valuing of relationships (for instance) is fulfilled through catching up with friends or advising a friend. On the other hand, if for some reasons we are unable to experience or deepen relationships with others, our sense of wellbeing may suffer during this period.

We collected and analysed data from some 14,000 students across Australia, China and New Zealand, to identify seven 'ultimate values' that are associated with positive MWB.

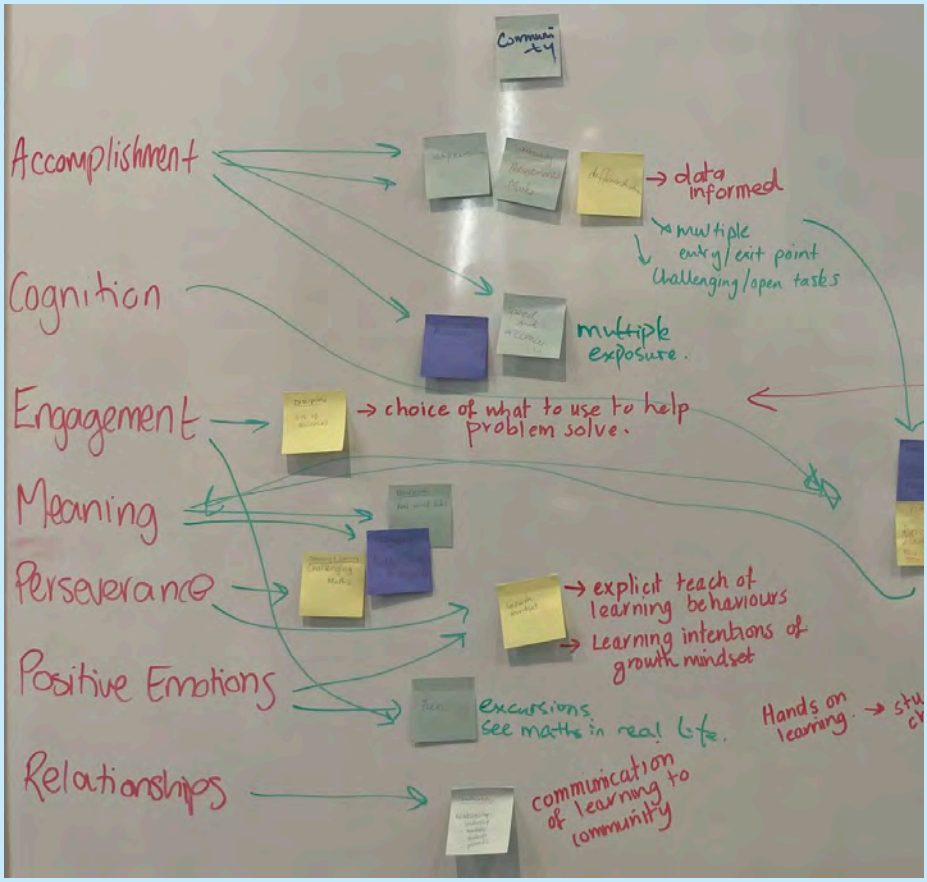

Figure 1. Teacher suggestions of how UVs might be fulfilled for students.

That is, our data suggests that across diverse ethnic and socio-economic settings, students' MWB is associated with the embracing and experiencing of the values of accomplishment, cognitions, engagement, meaning, perseverance, positive emotions, and relationships. Being at the highest level and most impactful on MWB, they are called 'ultimate values' (UVs), and each is served by 'instrumental values' (IVs) which can be culturally distinct. For example, accomplishment might be associated in some cultures with the fulfilment of the IV of performance (i.e. high scores), yet in some other cultures, students who value and experience understanding or deep learning would feel accomplished. Table 1 provides a description for each of the seven UVs, together with some examples of the IVs.

FACILITATING MATHEMATICAL WELLBEING

If we believe in the empowering role played by MWB in facilitating students' mathematics learning, then, it follows that we should design and deliver our mathematics lessons in such a way that there are opportunities for students to experience and fulfil their valuing of each of the seven UVs. The list of IVs in Table 1 can serve as a useful guide.

What might this look like? Let's take accomplishment as an example again. A student in Chengdu, China had told us that for her, she would feel accomplished when her work and effort were being acknowledged by adults around her. So, in fact, her mathematics teacher had been aware of this for her and her peers in class, and the teacher would purposefully select different students to help her out with chores during mathematics lessons. For this student and her peers, being selected to be the student helper for the day's lesson made them feel accomplished, that their mathematics learning must have been progressing well.

It should be noted, however, that teachers' actions which facilitate values fulfilment – such as nominating student helpers – are culturally-meaningful. For example, might the same teacher action be interpreted by students in other countries in the same

manner? To this end, teacher understanding of their own students would also play a constructive role in incorporating lesson features and/or learning tasks which allow for values fulfilment.

TRYING IT OUT

Perhaps, a good way to start would be for us to reflect on our own teaching practice, asking ourselves what we are already doing in our teaching which facilitate students' fulfilment of the seven UVs needed for the promotion of student MWB, thereby revealing those UVs which are not as well fostered yet. That way, we can then challenge ourselves to strengthen other aspects of our practice, so that our students have opportunities to experience all seven UVs, thereby nurturing their sense of MWB and positioning them in optimal readiness to want to learn mathematics with us.

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Figure 2. Teacher suggestions of how UVs might be fulfilled for students.

ULTIMATE VALUES	DESCRIPTION	EXAMPLES OF INSTRUMENTAL VALUES
Accomplishment	Valuing achievement, reaching goals, confidence or mastery completing mathematical tasks and tests	Accuracy, high marks, goals, confidence, understanding, deep learning
Cognitions	Valuing knowledge, skills, and/or understanding required to do mathematics at school	Efficiency, recall, prior knowledge, understanding
Engagement	Valuing concentration, absorption, deep intertest, or focus when learning/doing mathematics	Attention, interesting work, novel learning, autonomy
Meaning	Valuing direction in mathematics; feeling mathematics is valuable, useful, worthwhile or has a purpose	Maths agency, real world links, utility, task value
Perseverance	Valuing drive, grit, or working hard towards completing a mathematical task or goal	Challenging maths, practice and hard work
Positive emotions	Valuing positive emotions when learning/doing mathematics e.g., enjoyment, happiness, or pride	Minimal anxiety, fun, safe climate, pride
Relationships	Valuing supportive relationships; feeling valued, respected and cared for; connected with others; or supporting peers in mathematics	Belonging, group work, family support, teacher explanations, teacher warmth and care, peer support

Table 1.

FAMILY MATHS NIGHT FUN

Jessica Kurzman – Maths leader, St Patrick's Primary School and MAV consultant

As part of my consulting work with MAV, I was invited to facilitate a series of Family Maths Nights at Mernda Primary School. The school was keen to foster home-school partnerships in mathematics in a fun and engaging way.

Family Maths Nights have been used to help improve attitudes to mathematics and can have an ongoing effect on mathematical game playing at home (Nantais & Skyhar, 2020). Maths games are often used in classrooms (Russo et al., 2021) to increase engagement and learning (Bragg, 2012). The sessions were aimed at helping families connect with their children's learning and seeing how maths games could easily become part of their home routine to promote positive attitudes to learning at both home and school.

PLANNING THE SESSIONS

The sessions were run over a series of three afternoons, each focussing on different levels i.e., junior, middle and senior school. The sessions were conducted for an hour after school to allow as many interested parents to attend as possible. Families were asked to pre-register their attendance, to support with planning and the preparation of resources required for each session.

Four games per session were planned to provide families with a 'taste' of the games. Families rotated through the games, spending 8 - 10 minutes playing each game. Each of the games was tailored to meet the needs of the group. As there were families with children of different age groups attending different sessions, it was important to have four different games for each session - this ensured that even if a family attended multiple sessions, they would see four new games each time.

THE INSTRUCTION SHEETS

Each game had an instruction sheet with the same key elements on each:

1. Title

2. Aim

3. How to play: step by step, clear and concise to make them quick to read and understand

4. Questions to ask while playing: 5 - 10 questions aimed to promote discussion around mathematics while playing the game - questions were specifically designed around the mathematical content and skills in each game.

5. Too easy / Too hard prompts: these prompts allowed the games to be adapted to meet the needs of individual learners so the game would be appropriate to any level.

SETTING UP THE SESSIONS

A central space with chairs and a large screen was the gathering point for the start of the session. Each game was set up in a different classroom (four games = four classrooms). The resources were laid out so when families entered, they could go to a table and find an instruction sheet and the resources they needed. The activities were self-directed and didn't need anyone to provide a whole group instruction (which would have taken more time), and could be quickly read and interpreted, allowing the families to play the games at their own pace.

I found the best way to set these spaces up quickly was to have each activity and the resources prepared in its own box prior to the event. This meant all I needed to do was take one box into each classroom and set everything out on the tables quickly and easily, there was no last-minute running around looking for resources! It did take preparation, but it made the setting up fast and seamless for each of the sessions.

STRUCTURE OF THE SESSIONS

Each session began with all attendees in a central area for a short welcome and introduction. I shared some of the reasons maths might look different to when the parents were at school. I highlighted and showed images of other things that have changed over the same period of time (such as telephones, televisions and cars), to emphasise that change occurs to make improvements, as well as to adapt better to the needs of society.

I shared some insights about learners in the 21st century, and the types of skills they need to be successful (such as communication, collaboration and problem solving) to again emphasise why we focus on these skills more and more in today's mathematics classrooms.

I spoke of the importance of maths being fun and engaging - stressing that we want our students to continue to want to learn maths and also see it as a positive and valuable experience. This linked in beautifully with the Family Maths Night, as we were then able to show the families just how fun maths can be, as well as how the games could be used to promote valuable learning in many different areas of maths.

After this introduction, families were allocated a starting room. We spread families across the rooms, to ensure the spaces were not too crowded or noisy. As families entered the rooms, they made their way to a table, where they found everything they needed, and began playing the games together! There was a staff member in each room to help if families needed further instruction. We roamed during game play time assisting as needed, as well as modelling questions that could be asked while playing to help with learning.

After about eight minutes, a timer went off and we asked families to pack up their game and leave it ready for the next family. The groups would then move into the next classroom and repeat the sequence with the next game. This repeated until families had the opportunity to play all four games.

TRANSLATING THE LEARNING

At the conclusion of the final game, families were invited to return to the central space, where I concluded the session by providing tips for helping children with maths at home.

Examples included:

- promote a positive attitude towards maths
- encourage learning from mistakes
- talk about maths regularly in real life contexts
- play maths games.

We had a guess the lucky number competition to finish the session, and those children who guessed the lucky numbers won a maths game or picture story book to take home, which was a fun way to end.

As families left, they were invited to take home a printed pack of the games they had played on the night. The pack included copies of each of the instruction sheets, and any printable resources they would need to play the games at home. I also included a copy of the ACU MTLC Parent Guide which provided additional ideas to help at home. Families were very pleased to be given copies of the games.

REFLECTION AND FEEDBACK

Feedback from families who attended the evenings was very positive. They enjoyed playing the games together in a fun and non-threatening way. Some parents had commented that they had been a bit nervous to take part in a maths session, due to their own negative experiences of maths at school or their self-perceived low abilities around mathematics. They were pleasantly surprised how the games had allowed them to feel far more comfortable. This in turn made it clear how playing games could help their children feel far less self-conscious or threatened by maths when having fun through playing games. Moving forward, Mernda Primary has indicated they are keen to hold Family Maths Nights annually.

I found the experience of facilitating the evening fun and extremely rewarding. It was wonderful to see families enjoying time together, with maths games being central to the fun! Seeing parents walk away feeling more confident with ways they can support their children, along with seeing children who were proud to show their parents what they could do really emphasised the value in hosting and celebrating a Family Maths Night.

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While the preparation of events like these can be time consuming, seeing the enjoyment on the faces of families makes it worthwhile!

Alternatively, schools can engage a consultant from MAV to take the hard work out of it, and reap the benefits for your school community!

UNPACKING CHATGPT

Antje Leigh-Lancaster – Leigh-Lancaster Consulting

It's hard to miss the recent hype around ChatGPT and AI in general. This article provides a brief overview of some of ChatGPT's features most relevant to mathematics educators. Both ChatGPT and AI are moving rapidly, please bear in mind that his article was written in late 2023.

HOW DOES CHATGPT WORK?

Before diving in, let's take a look at how ChatGPT works. ChatGPT is a large language model (LLM), which means that it is trained on a massive dataset of text and code. It learns the patterns and relationships between the words and phrases in the dataset, so when you ask a question or prompt, it uses this knowledge to generate a *response based on the likelihood of the next word or phrase* being correct, given the context of the previous words or phrases.

This is why any current LLM can also generate responses that are 'creative' or unexpected. It's important to remember ChatGPT *does not have the ability to think* for itself or to evaluate options in a nuanced way, carry out mathematical computations directly or understand concepts.

WHAT MIGHT MATHEMATICS EDUCATORS USE CHATGPT FOR?

There are two versions of ChatGPT available, ChatGPT3 is free and ChatGPT4 currently costs USD$20 a month. The paid version is trained on a much larger dataset and can run in three different modes: Default, Advanced Data Analysis (previously called Code Interpreter) and Plugins.

The following list outlines some of the things mathematics educators could use either version for:

- Brainstorming and ideas: real-life examples of particular mathematics topics, starter activity to introduce a topic, topic prompts for students to discuss.
- Explaining a mathematics concept, formula etc suitable for a 12 year old to understand.
- Listing key concepts, skills and processes for a particular topic.
- Developing a lesson sequence, including a key learning focus for each.

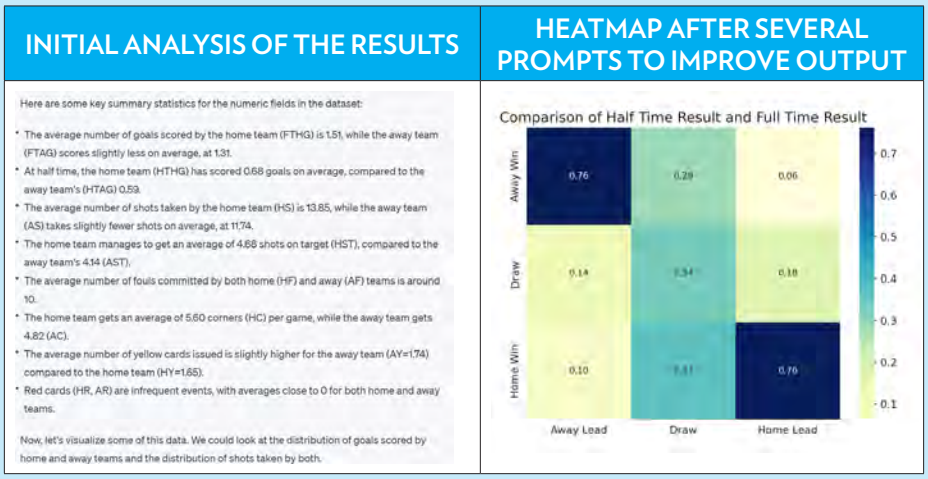


Figure 1. Files can be uploaded to ChatGPT4.

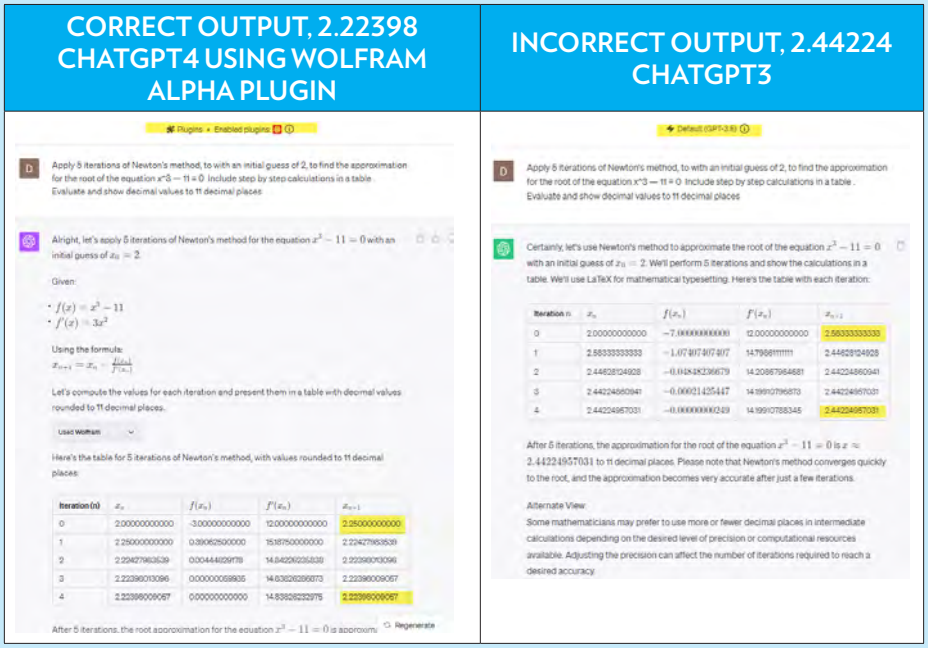


Figure 2. Computational accuracy can be challenging.

- Highlighting common errors and misconceptions to be mindful of.
- Creating multiple choice questions, short answer test or an investigation.
- Writing an assessment rubric for a whole topic or given task.
- Solving a mathematics problem, including working and an explanation, may require ChatGPT4 depending on complexity.

Keep in mind, the responses are only as good as the dataset its trained on and can reflect any biases from within the training dataset. It's important to always evaluate and verify outputs, for now I'm still finding quite a range of inaccuracies in responses.

WHAT CAN ONLY BE DONE USING CHATGPT4?

ChatGPT4 opens up a wide range of possibilities, here are three examples:

- Upload files (Word, PDF, Excel, jpg ...) to summarise, analyse, manipulate, add to etc (See Figure 1.)
  For example, it can anaylse an Excel spreadsheet, provide key insights, summary statistics and data displays.
- Use plugins and the Advanced Data Analysis modes to work with mathematics of increased complexity and increased correctness of results.
  For example, this prompt was inputted into ChatGPT3 and ChatGPT4:

'Apply 5 iterations of Newton's method, with an initial guess of 2, to find the approximation for the root of the equation x^3 − 11 = 0. Include step by step calculations in a table. Evaluate and show decimal values to 11 decimal places.'
Expected result is cube root of 11, which is 2.22398 ...
(See Figure 2.)

- Write, adapt and error-check code
For example, as a non-coder I was able to create this 2-dice rolling simulation by telling ChatGPT I was new to this and needed step-by-step instructions along the way. (See Figure 3.)

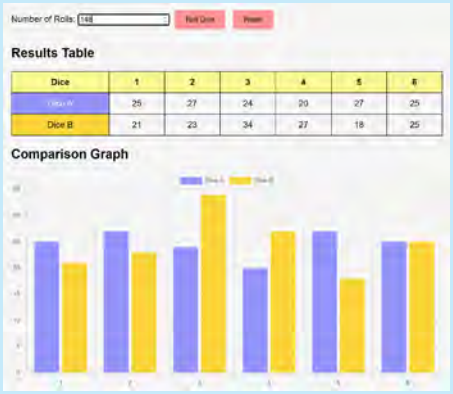


Figure 3. 2-dice simulation.

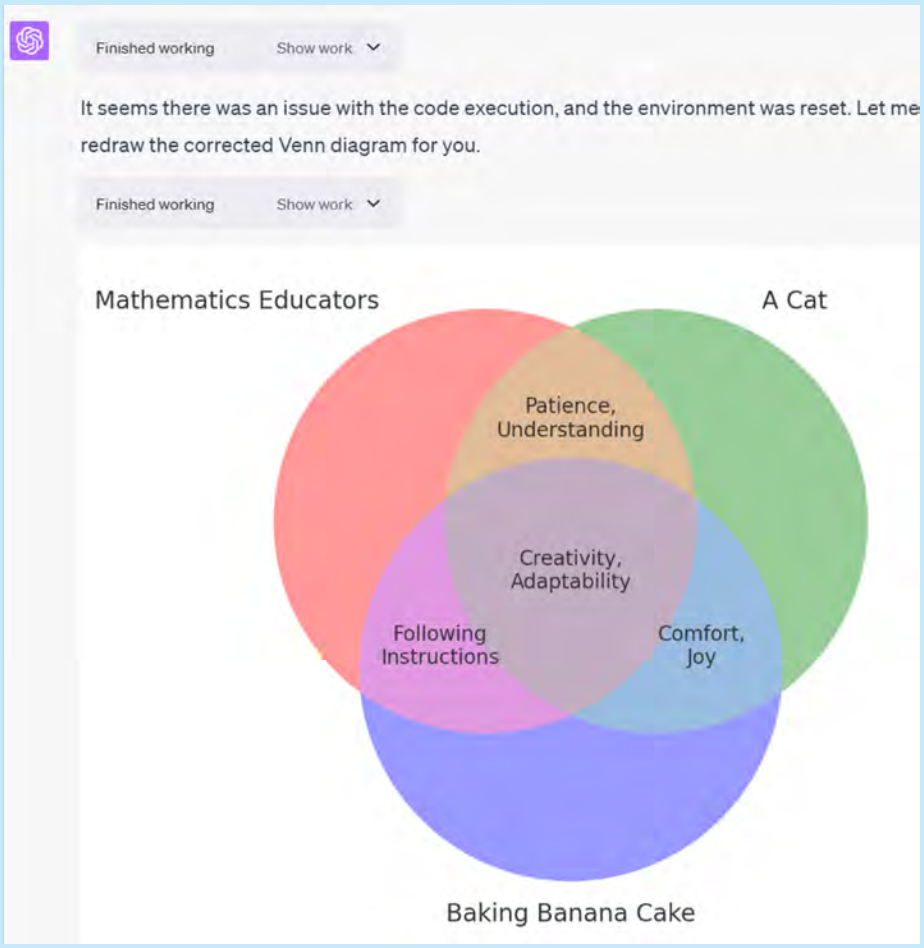


Figure 4. Experimenting.

WHAT INFORMATION SHOULD A PROMPT INCLUDE?

There are many suggestions on the internet in relation to what an effective prompt should include, however as is often the case, it depends on the context.

Here are some useful tips to get started:

- Start with an action: create, develop, outline, summarise, ...
- Provide context: I am a mathematics teacher in Australia, teaching students aged 9 years about [insert]
- Include details/examples eg an open task is [insert definition], create 5 open tasks focused on developing understanding about [insert].
- Use double quotes "..." to channel focus .
- Be specific: how long, tone (casual, semi-formal, professional).
- Explain the [insert concept/process/ ...] to a 14 year old.

When wanting to tackle a larger piece of work, evolve ideas gradually. Make sure you are happy with the high-level information provided before getting granular. For example, if you want to develop a series of lessons on linear functions for Year 8, a possible approach is:

- Set the scene (content to be covered, number and length of lessons).
- Ask it to provide a key focus for each lesson (refine until you're comfortable with the output).
- Expand to lesson ideas, activities, contexts (refine as needed).
- Develop some assessment questions/ exit tickets.
- Provide answers and worked solutions, if multi-choice, explain common errors used in distractors.

When it comes to inputting mathematical expressions into ChatGPT, either type them in directly eg (3+x^2)/5 or enter them in LaTeX form (MS equation editor can help with this). Despite being able to upload images and Word docs into ChatGPT4, I find it struggles to correctly decipher mathematics that's been typeset or created using an equation editor.

EXPERIMENT AND HAVE FUN

Depending on what exactly you want ChatGPT to do, it can take some time to refine your prompts to get the results you're looking for. Start simple, explore and have some fun.

Figure 4 shows the end result of a series of prompts that started with:

'Create a 3 circle Venn diagram showing the connections between mathematics educators, a cat and baking banana cake'

One aspect of ChatGPT I value is its patience. You can ask as many 'dumb' questions as you like, without needing to worry about anything ... except whether the output it gives is correct!

REVISED CURRICULUM PLANNING

Renee Ladner - Primary education consultant, MAV

USING VICTORIAN CURRICULUM V 2.0 DURING PLANNING AT ALBANVALE PRIMARY SCHOOL

'The new curriculum ... now we're going to have to change everything!' and 'I feel like I just got my head around this curriculum!' are phrases that have been echoed whilst I have been visiting schools recently.

The revised introduction provides a clearer and more contemporary context for learning in mathematics, computational and algorithmic thinking and the use of digital tools, including Artificial Intelligence. The improved contextualisation of the Learning in Mathematics section is most supportive for teachers who are new to the curriculum area (VCAA).

It is important to note that this curriculum is revised, not completely new. There are now six strands, moving away from the original three, including:

- Number
- Algebra
- Measurement
- Space (in line with the Australian Curriculum Version 9.0)
- Statistics
- Probability (commencing at Level 3)

This makes it clearer for teachers to follow the progression of mathematical concepts through the curriculum and structure their teaching and learning programs. The model also provides greater flexibility to link ideas across different curriculum learning areas and scaffold the mathematical ideas under each strand (VCAA). The mathematics has not changed, but many outcomes have been combined and refined seeing a reduction from 286 content descriptors to 257 from Foundation to Year 10. This also sees a stronger alignment with the Australian Curriculum V9.

An expectation of mathematical proficiency has been embedded into curriculum content across all strands to ensure that students develop mastery in mathematics through the development and application of increasingly sophisticated and refined mathematical understanding and fluency, reasoning, and problem-solving skills (VCAA).

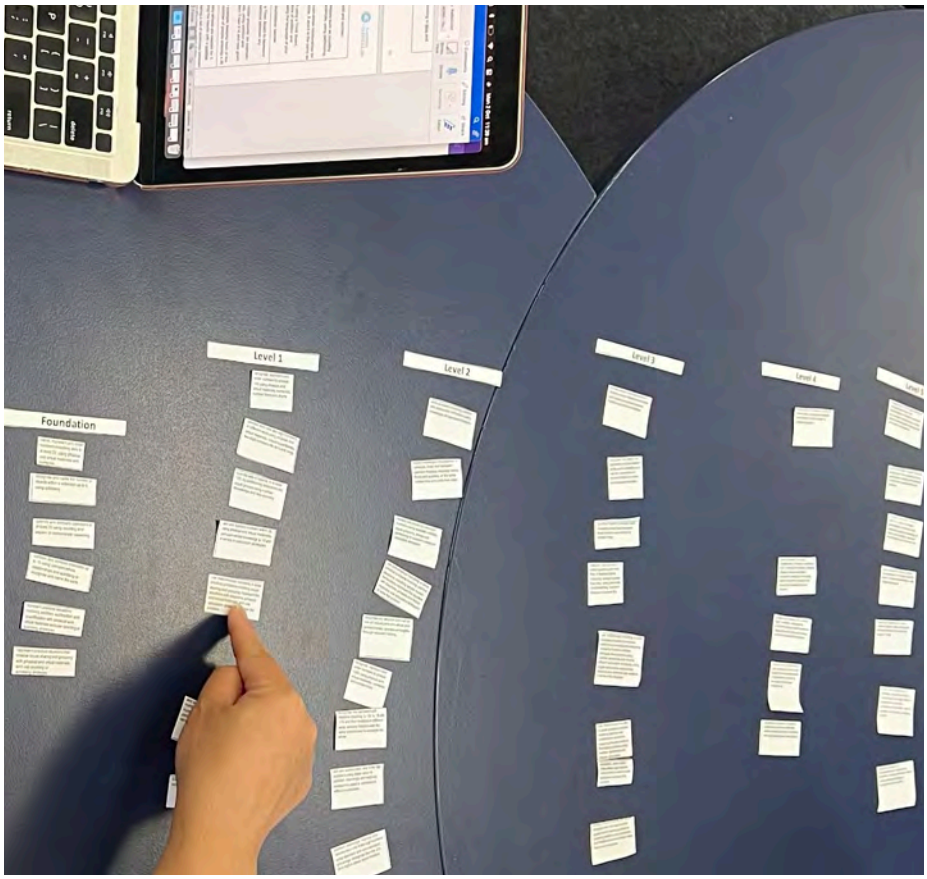


Figure 1. Teachers working together to discuss, sort and compare the scope and sequence of descriptors from Foundation to Year 7.

At Albanvale Primary School, the teachers have been exposed to the revised curriculum in professional development sessions prior to planning for upcoming units of work, using the Comparison Guide created by VCAA. Leading into the Measurement unit for Term 3 and then the Number unit for Term 4, each year level went through the comparison guide and recorded the outcomes they would be reporting on, discussed how it might be similar or different and then implemented the discussion into working planners. Working together we thought about task design and how tasks reflect the proficiencies that are now embedded in the descriptors. We considered the Instructional Model being used, where the explicit teaching happens and where students have time to focus on the proficiencies now more explicitly expected of them.

These questions developed rich dialogue:

- What verbs are in the descriptors?
- What are the differences/similarities?
- How do you interpret the statements?
- What questions do you have?

Once the comparisons had been explored, there was a sense of relief from teachers and a stronger understanding of the continuum of skills being developed and emphasised, particularly in the Foundation - Year 2 levels. There are considerations that need to be made for the school moving forward to adjust current learning maps and proficiency scales, but aligned with the guide, this will be comfortably adapted as 2024 progresses, meaning they will be fully equipped with the changes to mathematics and prepared for the further curriculum areas being released in 2024 and 2025.

MAV recommends that the school leadership team sits down together and make executive decisions regarding the timeline and roll-out.

MAV supports schools with implementation of the revised curriculum as well as offering tailored consultations. Contact Renee Ladner, rladner@mav.vic.edu.au to learn more.

MINDSET MATHEMATICS

Larissa Raymond – Mathematics education consultant, MAV

> 'Mathematics is not a set of methods: it is a set of connected ideas that need to be understood. When [young people] understand the big ideas in mathematics, the methods and rules fall into place.' (Boaler, Munson & Williams, 2020, p.9)

With one book for each year level, from Foundation to Year 8, the *Mindset Mathematics* series explores the Big Ideas: fundamental concepts in maths, through an inter-connected sequence of learning experiences. Each learning sequence is designed to support learners slow down and engage in rigorous tasks that promote visualising and investigating; a pedagogical approach where deep conceptual understanding is more likely to be realised for all young people.

The latest neuroscientific research demonstrates the importance of learners connecting different areas of their brains as they engage in mathematics. While traditionally the emphasis has been on symbolic representation, developing one area of the brain, we now know,

> '...a more productive and engaging approach is to develop all areas of the brain that are involved in mathematical thinking, and visual connections are crucial to this development' (Boaler, Munson, Williams, 2020, p.11).

The 9 books have a similar structure. Chapters are organised under Big Ideas that are intrinsically linked. Each chapter provides a brief overview of the Big Idea before introducing the learning tasks. Learning tasks accompanied by detailed explanations, move through the design phases, **Launch**, **Explore**, **Discuss** and **Extend**. This design process aligns seamlessly with the Victorian Curriculum, Mathematics v2. Each chapter ends with an explanation of things to look for, including how best to address misconceptions.

MINDSET MATHEMATICS: GUIDING PRINCIPLES

Guiding principles are fundamental concepts or core tenets that quietly but effectively shape the approach and actions in a particular context. In *Mindset Mathematics* series, these principles serve as essential anchors, guiding the pedagogical approach to support all young people thrive in their mathematical learning.

Some of these guiding principles include:

Activating mathematical proficiencies and productive dispositions

Activating mathematical proficiencies and productive dispositions plays a pivotal role in shaping the learning experience throughout the *Mindset Mathematics* series. The carefully curated learning sequences amplify the four mathematical proficiencies: Reasoning, Problem Solving, Fluency, and Understanding through privileging questioning, where young people ask questions of themselves and their peers and teachers, and, representing and analysing their thinking in a variety of ways. The design of learning experiences also provides opportunities for the creation of a learning environment where the activation of a productive disposition, such as being curious and willing to tackle challenging problem is likely to emerge.

For further information on activating the proficiencies and productive dispositions, you might enjoy reading, *A Powerful Image of Mathematical Thinking, Doing and Being: The Four Proficiencies as Verbs.* (Burrows, Raymond & Clarke, 2020).

Prioritising understanding over speed

The design of each learning experience promotes an awareness that speed is unimportant and even counterproductive. By prioritising understanding over speed, the series promotes a supportive environment where young people are more likely to dig deeper, connect ideas and concepts; to develop a conceptual understanding - 'an integral and functional grasp of mathematical ideas' Kilpatrick et al. (2001).

Designing low floor-high ceiling tasks

All learning tasks are designed with a low floor-high ceiling.

> 'A low floor-high ceiling task is one in which everyone can engage, no matter what their prior understanding or knowledge, but also one that is open enough to extend to high levels, so that all students can be deeply challenged.' (Boaler, Munson, Williams, 2020, p.3).

When tasks are designed in this way there is greater likelihood all learners experience success and challenge. Low floor-high ceiling tasks position young people actively in their learning through engagement in tasks that are open enough to support, challenge and extend all learners.

Co-creating learning spaces that privilege learning with and from others

With a strong belief in all young learners, mindset mathematics tasks position learners actively in their learning. All tasks are designed to ensure young people have the opportunity to learn through collaborative engagement, alongside and from others. Collaboration that privileges and draws on the various gifts each unique learner brings to the experience.

Questioning is another key design feature. Questioning where young people ask and are asked carefully curated questions that enable them to develop new insights, for themselves, is a core element of developing one's mathematical thinking, reasoning and convincing.

Accompanying the 'mindset mathematics' series, you can access Jo Boaler's positive classroom norms to further support you in co-creating safe, dynamic learning environments where all learners experience agency and a sense of belonging and connection in their learning. With a strong focus on Big Ideas, student-led inquiry, carefully curated progression of the big ideas in mathematics, emphasis on visualisation, and commitment to fostering a positive mathematical mindset, the *Mindset Mathematics* series provides a roadmap for transforming classrooms into dynamic hubs of mathematical exploration.

REFERENCES

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Washington DC: National Academy Press.

The *Mindset Mathematics* series is available to purchase via the MAVshop. Visit www.mav.vic.edu.au/mav-shop.

STIMULATING THINKING

Jessica Kurzman – Maths leader, St Patrick's Primary School

A picture sparks 1000 maths concepts! Use this picture as a prompt to stimulate thinking. If you have other ideas for investigations or lessons that could stem from the ideas here, add them to the conversation on our social channels. You can find us on Facebook and Instagram @maths.vic, LinkedIn @ maths-vic and on X, @maths_vic.

EARLY YEARS

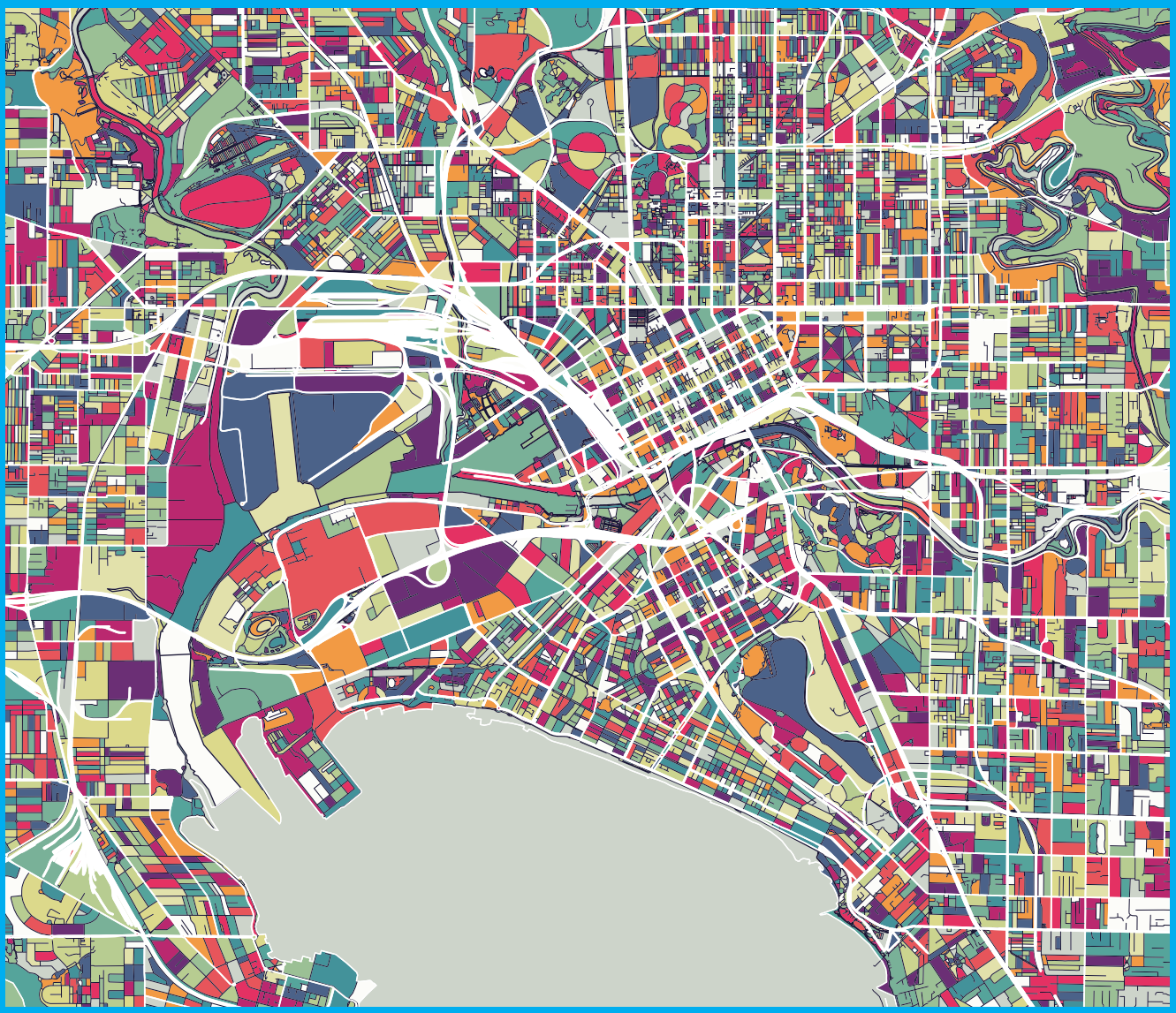
- Trace your finger over the white lines. What do you think these lines are for?
- What do you think this is a picture of? Why? How would someone take a photo that looked like this?
- Get a piece of string and place it from one side of the picture to the other. Which side is bigger? How do you know? What are some other words for bigger? Move the string to make the other side bigger. Describe how you moved the string.
- Put a counter on the picture. Close your eyes, move the counter up, to one side, down, then to the other side. Open your eyes, describe what the counter lands on.
- What shapes can you see? What might the shapes represent? Is there anything around you that looks similar to one of the shapes in this picture? What makes them the same? What makes them different?
- Can you find; A straight line? A curved line? A circle? A square? A triangle? A rectangle? What other interesting things can you see?
- Every house in this picture has a number on the letterbox! Imagine the number on the letterbox was a 7, Can you draw a letterbox with the number 7 on it? Could you draw a picture that shows 7 things? What numbers are smaller than 7? What numbers are more than 7? Can you find 7 of something in your room?
- What do you notice? What do you wonder?
- Can you guess how many sticky notes it would take to cover this whole picture, with no gaps? Guess and then check. How close was your guess? What about how many square counters it would take to cover this whole picture, with no gaps? Try pegs, paper clips, pompoms, buttons, dice, dominoes, playing cards! What do you notice?

FOUNDATION - YEAR 2

- Throw a counter onto the image. Record if it stops on land or water. Do this 20 times and present your results in a graph.
- Have you seen any pictures like this before? Who do you think would use a picture like this and why? Have you ever used a picture like this? How was it helpful?
- If each house has the same number of people living in it, and there are 10 houses, how many people might be living in each house, and how many people would that be in total?
- In 'Pattern Street', all the houses are painted one colour each that follows the pattern; red house, red house, green house, red house, red house, green house, but the owners have all decided to paint their houses and change the colours! Since they live in Pattern Street, the colours still have to be a pattern. What suggestions could you give them so they can have new colours, but still have a pattern? Can you draw what the new houses in the street might look like?
- I visited an apartment building in Melbourne. Each floor had the same number of apartments on it. There were 24 apartments in total in the building. How many floors might there have been, and how many apartments on each floor? Can you find all the possibilities?
- Choose 2 places on the map. Give directions for someone else to get from one place to the other.
- There are 13 sporting ovals on this map. Can you draw 13 stars so someone knows straight away that there are 13, without having to count them?
- This image is known as a 'bird's eye view'. Can you draw a bird's eye view of your dream bedroom?
- Pick one of the buildings represented in the image. Create a model of what the actual 3D building might look like.

YEARS 3 - 6

- Draw a grid map reference system over this image. Find 5 locations where you think people might play sport, mark them each with an 'x' on the map, and record their grid reference. What other locations can you find and give the grid reference for?
- Find at least 2 acute angles, 2 obtuse angles and 2 right angles.
- The average cost of buying a house in Melbourne in 2023 is $918 350. What are 5 (6 digit) prices that would be lower than the average price, and 5 prices that would be higher than the average price. Order them from cheapest to most expensive.
- Imagine there was a new rule that every house had to have the same number of people living inside! In one street, there were 128 people living in it. How many houses might be in that street, and how many people would be living in each house? How many different possibilities can you come up with?
- Odd street only has 3 houses. Those 3 letter boxes each have an odd number! And... each of the numbers has 3 digits! What might the numbers be? And what would be the sum of the three numbers? How many different combinations with a sum between 500 and 600 can you come up with?
- If 7.4 times as many people live in houses as live in apartments. How many people might live in houses, and how many people might live in apartments?
- If it takes 37 minutes to walk from Flinders Street Station to the MCG, what time might I have left Flinders Street Station, and what time would I then arrive at the MCG? Can you record your answers in 24 hour time?
- Choose 2 locations on the map, and without using words, provide instructions for someone to get from one location to the other. You can add elements to your map to assist.



YEAR 7 AND BEYOND

- Draw a cartesian coordinate system over this image. Provide the locations of at least 6 different locations where 2 roads intersect at right angles.
- What percentage of this image represents water? What percentage represents land? What is the ratio of water: land?
- If the scale is 1cm = 2km, and land in Melbourne is worth $1087 per square metre. What would be the value of the land on this map?
- 47% of dwellings in Melbourne are apartments. How many apartments might there be, and how many other dwellings would that mean?
- In Melbourne the time is 7.45pm. What would the time be in 5 different cities around the world? What is the time difference between those cities and Melbourne?
- Choose a small section of the image and redraw it by applying the enlargement transformation by a scale factor of 2.
- If the average size of a block of land in Melbourne is 560 square metres. What dimensions are possible for this sized block? Keep in mind not all blocks are rectangular in shape!
- The population of Melbourne in 2023 is estimated to be 5 235 407. If it grows by 1.5% every year. What would be the population in 2028? What year would the population reach 10 million?

MAV education consultants can come to you and create a professional learning plan to build the capacity of teachers at your school.

If you have an idea for a stimulus image in future editions of *Common Denominator*, we'd love to hear from you. Email office@mav.vic.edu.au with your suggestions.

ONE MINUTE WITH LENNOX LEE

I'M LENNOX...

I'm the founder of the Meet Pi Maths Festival. I created the festival when I was 9 years old.

I CREATED A MATHS FESTIVAL....

Because I saw that many kids had become disengaged and uninterested in maths, and I wanted to change that by teaching it in a more fun and engaging way.

I came across a maths festival that was being held overseas. It looked interesting, so I got in touch with them and they helped me create a festival in Australia.

AT THE FESTIVAL...

Young people of different ages and abilities come together to participate in a range of hands-on games, puzzles, and craft challenges, which are run without competitive pressure or time limits.

FESTIVAL ACTIVITIES ARE FUN...

One of the activities is Towers of Hanoi, students need to move different sized disks from one tower to create another tower without putting a larger disk on top of a smaller disk.

We have a game called Dimension, where participants must position coloured spheres to make a pyramid that follows certain constraints. For example, the pyramid might need to have two orange balls, or two certain colours of balls cannot touch, or maybe there has to be more black balls than green balls.

One of the craft challenges we have is called Hexaflexagons. Participants fold paper to create an object which can be twisted to reveal multiple faces, and ask questions about how it works or could work differently.

I'VE ALWAYS LOVED MATHS...

Ever since I was in kindergarten I've loved the logic and problem solving involved in maths. My parents would get me new tangram-style puzzles which I always enjoyed doing.

IN PRIMARY SCHOOL...

New maths concepts were taught with concrete materials, like beads and counters.

This really helped because I could see and touch, which I think helped me grasp the concepts.

AFTER I FINISH SCHOOL....

I might pursue acting. Although I'm also interested in studying science and medicine. I will take time to explore the world.

JAPAN WAS MY FIRST OVERSEAS TRIP....

I went to Osaka Castle and found its history, the shape and materials used in the design, very interesting.

THE NEXT MEET PI MATHS FESTIVAL...

Will be held in the second half of 2024, I'm excited! If you're interested in joining the fun, particularly if you'd like to become an activity leader, then please get in touch!

I LIKE MEAT PIES....

And somehow that made its way into the name of the festival!

HOW CAN KIDS GET INVOLVED?

You can follow Meet Pi Maths Festival at facebook.com/meetpi314 for updates. We will reach out to local schools for student ambassador and activity leader opportunities.

METACOGNITION MATTERS

Rachael Gore – Leading teacher of numeracy, Albert Park College

'What is a word for moving too slowly, starting with m?'

'Meandering, Miss!'

'That's it!'

WHY METACOGNITION?

Metacognitive strategies, one of the 10 High Impact Teaching Strategies drawn from John Hattie's research, can unlock student agency and self-efficacy as students are empowered to think about their thinking. Metacognitive strategies allow students to be in the driver's seat for their learning and become responsive to their learning needs.

5M ANALYSIS FRAMEWORK

The 5M analysis is a metacognitive strategy that invites students to review their lost marks during assessments. They sort these lost marks into five buckets:

- Missing
- Mistake
- Misread
- Misunderstanding
- Meandering

Students can quickly sort their marks into these categories using a tally chart, see Figure 1.

Missing marks are the result of a lack of content knowledge or skills. Students will look at the question and comment, 'I don't know, did we even learn this?'

Mistakes are the result of errors in working. Students may have written $3 \times 4 = 7$. These are the lost marks that often frustrate the students the most as they ask themselves 'What was I even doing? I know this!'

Misreads are when students do not answer the question that is being asked. They may neglect to respond to the entire question, for example, only state the equation and leave out the domain. They may give their response in a format that is different from the format required in the stem of the question. They may even answer a related question that is not the question on the paper. Students often take some time to realise that they have misread the question and will need to be prompted to re-read the question when their work is returned.

Mistake	Missing	Misread	Misunderstanding	Meandering
𝍸	𝍸	𝍸	𝍸	𝍸

Figure 1. Using the 5M analysis framework to sort lost marks into categories.

Misunderstandings are the most insidious errors as students are often convinced that their response is correct. In these cases, students have learned the content incorrectly and will have missed a nuanced idea. Students often argue that the marking scheme is wrong for these lost marks.

Finally, **meanderings** are the result of students moving too slowly through a set of questions. This category only occurs for time-constrained assessments. There is an expectation that students work with a sense of urgency through problems under test conditions. I am quick to point out that this is not an authentic expectation for professional mathematicians but is a reality for this period of their education. The ability to work quickly is seen as a measure of a student's fluency and is a skill that needs to be developed for the context of schooling.

BUILDING A PROFILE

By completing the tally chart (see the example in Figure 1), students can look at the distribution of lost marks across their paper to build an individual profile.

These insights allow students to see if they tend to misread questions, work slowly through problems, or make small mistakes in working. This tallying of errors demystifies their result and allows students to understand their performance.

PROMPTING ACTION

Once students understand their response profile, they can be prompted to undertake certain actions based on their 5Ms.

Each M within the framework invites students to work through specific tasks or make changes to their mathematics study.

Missing marks invite students to revise core content and skills. This could involve students revising their notes, reviewing video examples, or referring to previous lessons.

Marks lost to **mistakes** are an indication that students are rushing or experiencing a large cognitive load when working through questions. They should be encouraged to slow down, proofread their work, and complete additional questions to build fluency. Students may wish to note down the common mistakes they will make (such as leaving off the dx in an integral) so they know to check for these particular errors.

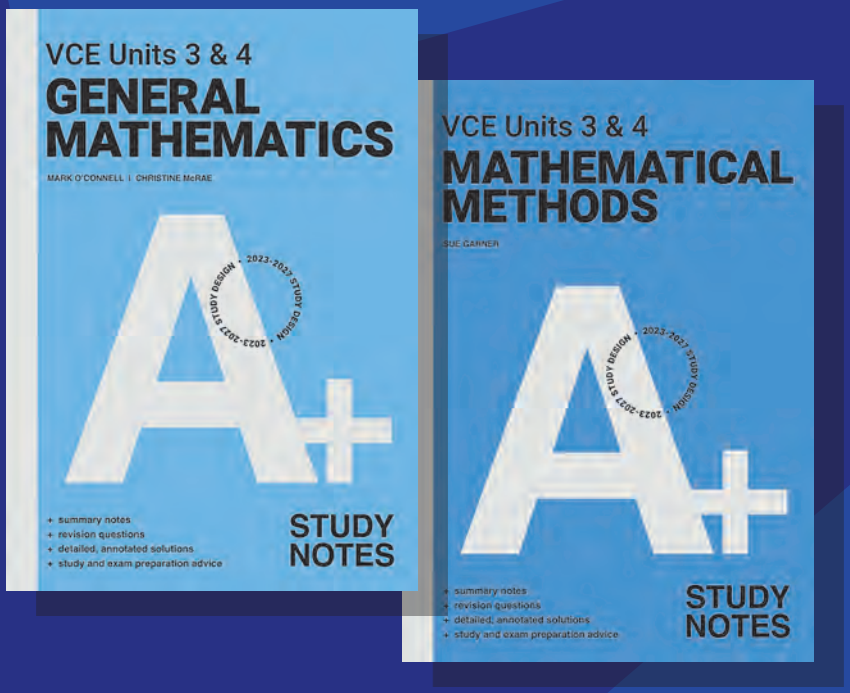
Misreads require students to annotate each question using highlighters and their pen. They should underline keywords and re-read the question once they have completed their working to check their mathematics matches the requirements of the question stem.

Misunderstandings can be the trickiest errors to correct and often require teacher or peer intervention. Students need to have a conversation to unpack their thinking and find the point at which they may be misapplying their mathematical skills and knowledge. Misunderstandings uncover misconceptions in mathematics.

Correcting **meandering** requires greater work under time conditions. Students can be invited to consider how they are using their time. Are they allocating an appropriate time to each question, as guided by the number of marks available, or are they getting stuck and spending 15 minutes on a two-mark question?

FROM PASSIVE TO ACTIVE

The 5M mark analysis framework was created to give students a structure to study their work and then prompt further action based on their analysis. It also reframes assessment as a learning opportunity. Students who engage with this framework can accelerate their growth in mathematics as they understand their learning journey.



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General Maths

Maths Methods

Nelson

BIG IDEAS IN MATHEMATICS

Paul West and Tanya Webb – Bairnsdale West Primary School

Figure 1.

An issue that schools can face when developing whole-school focuses is how to provide quality internal professional learning for teachers. As most people involved in schools know, having 'experts' on tap is not something we all have access to – for the most part it is up to us to figure out what information could help or hinder our colleagues if we decide to share it.

At Bairnsdale West Primary School (BWPS), when our Numeracy Leaders request time at staff meetings to present, our leadership group need to be confident that what is going to be delivered is targeted and meaningful – as everyone who works in schools will understand, time is of the essence and we, as leaders, need to ensure that whenever we request teacher's time, it is not wasted. When we say 'not wasted', we mean that our teachers ultimately have take-aways from the PL that have short-term and long-term positive impacts across the teaching and learning cycle.

This is why the leadership group have invested time and other resources into our development as Maths Leaders.

Being on-site and available all of the time to staff, our role becomes even more critical and, while we may not have the expertise of the maths gurus who we source much of our information from, what we do have is an in-depth understanding of our teachers' knowledge and skills as maths facilitators in their classrooms.

Over the past 18 months, teaming up with MAV's Big Ideas Program has enabled our Maths Drivers to deliver high-level learning for staff. Hearing from experts including Di Siemon, Aylie Davidson, Michael Minas, James Russo, Dr Ange Rogers and others has put our learning on turbo. Not to mention our catch-ups with MAV staff who have been a constant, often discussing our own unique situation and answering any questions that may arise.

As a school, we have been guided down the 'Big Ideas' path for some time now. The Big Ideas of Maths have helped our teachers to be able interpret the way that their students see maths and, in turn, cater more specifically for their individual needs.

As a school, we appreciate that the curriculum is only as strong as each and every teacher's own understanding of those statements. The Big Ideas of Maths are no different – in our school we believe that the Big Ideas of Maths are for teachers to understand and, without this, there would be no rhyme or reason for having the Big Ideas as part of our curriculum at BWPS.

This is the reason that the Big Ideas of Maths at BWPS do not look exactly the same as any other Big Ideas of Maths that we have seen. Our Big Ideas documentation and understandings were created using the knowledge that our teachers gained through listening and reading over a long period of time. Alongside this, there is the ongoing dialogue between staff, which means our knowledge and understanding has evolved and will continue to into the future.

MAV's Big Ideas Program has helped us to strengthen our ability to build our teacher's understanding of the Big Ideas in Maths.

Our most recent maths professional learning was primarily resourced by our 'multiplicative thinking' session through the Big Ideas program. Trust me when I quote Michael Minas as saying that 'Maths should not be taught in silos', it comes across much more effectively than if that statement was 'my idea' (and by no means do I claim to be the original architect of that quote!).

What teachers found most helpful from this session were Michael's 'key features of transition from additive to multiplicative thinking' (see Figure 2.), particularly the characteristics which came from his analysis of each of the features. For teachers to then be able to go away with this new learning and see their own students demonstrate these characteristics in their problem solving assisted teachers them to identify holes that may have been blockers for kids to see problems multiplicatively. This whole process, followed by in-depth reflection and ongoing dialogue with colleagues, results in this constant evolution (and growth) of teacher's knowledge. In turn, the benefits of this are a greater collective understanding and improved maths teaching and learning in classrooms.

Gathering all of the information about the individual needs of teachers (understanding that teachers, like the students we teach, are all at different stages of their development as maths teachers) and matching that with our learnings from our exposure to experts through the MAV's Big Ideas Program has driven our professional learning focus at staff meetings. And just as importantly, ensuring that our leadership group are extremely confident that we, as the Maths Leaders, are going to present targeted and meaningful professional learning.

One thing that we learnt from our involvement in this program is that we certainly do not have the answers for everything. And let's be clear, the role of middle leaders is not to have the answers for everything! Our role is to provide relevant information and facilitate dialogue and collaboration to eventually build knowledge and confidence in the maths teachers that they work with – MAV's Big Ideas Program has certainly allowed us to do that.

Key features of transition from additive to multiplicative thinking:

- Skip counting
- Equal groups
- Part-part-whole
- Doubles and halves
- Arrays

Figure 2.

The Big Ideas program continues to be available to MAV member schools who participated in the program. If your Primary school is interested in accessing the program, please contact Di Liddell, dliddell@mav.vic.edu.au.

Thanks to the generous funding from the Department of Education through SPP Funding, MAV will run a similar program for secondary school teachers in 2024 and 2025. Please contact Danijela Draskovic if you or your school is interested in participating, ddraskovic@mav.vic.edu.au.

SHAPE MAVCON24

MAVCON23 surpassed all expectations, thanks to the collective energy of 940 delegates, 190 presenters, 35 exhibitors and sponsors, devoted volunteers, and MAV staff. Now, you have the opportunity to help us build on this success. Tell us how we can tailor MAVCON24 to meet your evolving professional learning and networking needs.
Your suggestions will help us curate an event that resonates with you and your peers. If you attended MAVCON23, please scan the QR code and take a few minutes to share your feedback. Thank you!

MATRICES IN A SPREADSHEET

Andrew Stewart

One key advantage of graphic calculators for General Mathematics students is that they can perform many matrix-based calculations easily. One problem when writing tests, investigations or SACs is setting up matrices in particular calculations and fine tuning the solutions. Resetting matrices is a fiddly business with the calculator!

A spreadsheet can make this process easier. By using cell addresses in key formulae, a system of calculations can be set up to operate automatically. Fine tuning becomes a matter of changing element values in the key matrices and observing the consequences.

BUILDING THE SPREADSHEET

A separate sheet approach is used in demonstrating how each set of matrix calculations is set up using array-based calculations. The word in brackets after each sheet number describes the matrix calculations shown on that sheet.

SHEET 1 (ARITHMETIC)

Set up a spreadsheet page as shown in Table 1. Select cells G2:H4. Enter: =A2:B4+D2:E4. Press and hold the Control and Shift keys, and then press Return.

(If this combination does not work, check the help pages for your spreadsheet)

Select cells J2:K4. Enter: =A2:B4−D2:E4. Press and hold the Control and Shift keys, and then press Return. The spreadsheet should now look like Table 2.

Notes: As with normal matrix addition/subtraction, the arrays (matrices) must be exactly the same size (order) for the array calculation to proceed.

In this case, (3 x 2) + (3 x 2) = (3 x 2), so the sum array would be G2:H4. Changing a single value in either, or both, of M or N will lead to new values being automatically being calculated in the sum and difference matrices.

The formulae in the sum and difference matrices now have braces ({}) around them, indicating that array-based calculations are being used. It may seem trivial using these formulae for small matrices, but it comes in handy when using larger matrices.

	A	B	C	D	E	F	G	H	I	J	K
1	M			N			M+N			M−N	
2	7	2		5	4						
3	3	8		3	7						
4	4	9		8	3						

Table 1.

	A	B	C	D	E	F	G	H	I	J	K
1	M			N			M+N			M−N	
2	7	2		5	4		12	4		2	−2
3	3	8		3	7		6	15		0	1
4	4	9		8	3		14	12		−4	6

Table 2.

	A	B	C	D	E	F	G	H
1	M			M^−1			DET	
2	4	2						
3	3	1						

Table 3.

	A	B	C	D	E	F	G	H
1	M			M^−1			DET	
2	4	2		−0.5	1		−2	
3	3	1		1.5	−2			

Table 4.

SHEET 2 (INVERSE, DETERMINANT)

Set up a spreadsheet page as shown in Table 3. Select cells D2:E3. Enter: =MINVERSE(A2:B3). Press and hold the Control and Shift keys, and then press Return. Click in cell G2. Enter: =MDETERM(A2:B3). Press and hold the Control and Shift keys, and then press Return. The spreadsheet should now look like Table 4.

Notes: The selected array for the MINVERSE calculation must be identical in size to the data array and **must** be square. Changing a single value in M will lead to new values being automatically calculated in the inverse matrix and the determinant.

SHEET 3 (TRANSPOSE)

Set up a spreadsheet page as shown in Table 5. Select cells E2:F4.

Enter: =TRANSPOSE(A2:C3). Press and hold the Control and Shift keys, and then press Return. Select cells M2:Q4. Enter: =TRANSPOSE(I2:K6).

Press and hold the Control and Shift keys, and then press Return. SeeTable 6.

Notes: The selected array for the TRANSPOSE calculation must have the order of the transposed matrix, not the original one. In these cases:

(i) (2 x 3) will transpose to (3 x 2), so the transpose array would be E2:F4.

(ii) (5 x 3) will transpose to (3 x 5), so the transpose array would be M2:Q4.

Changing a single value in either, or both, of M or N will lead to new values being automatically being calculated in either, or both, of the transposed matrices.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		M			M^T				N				N^T					
2	7	4	8						6	9	4							
3	9	1	3						7	4	2							
4									5	6	4							
5									3	1	8							
6									9	2	5							

Table 5.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		M			M^T				N				N^T					
2	7	4	8		7	9			6	9	4		6	7	5	3	9	
3	9	1	3		4	1			7	4	2		9	4	6	1	2	
4					8	3			5	6	4		4	2	4	8	5	
5									3	1	8							
6									9	2	5							

Table 6.

SHEET 4 (MULTIPLICATION)

Set up a spreadsheet page as shown in Table 7. Select cells I2:J3. Enter: =MMULT(A2:D3,F2:E5). Press and hold the Control and Shift keys, and press Return.

Notes: The selected array for the MMULT calculation must have the order of the product matrix, not necessarily one of the data matrices.

In this case, (2 x 4) x (4 x 2) = (2 x 2), so the product array would be I2:J3.

Changing a single value in either, or both, of M or N will lead to new values being automatically being calculated in the product matrix.

As with normal matrix multiplication calculations, the number of columns in matrix M must equal the number of rows in matrix N for the array calculation to proceed.

Move down the sheet a few rows, and set up on the page as shown in Table 8. Select cells G12:H13. Enter: =MMULT(A12:B13,D12:E13).

Press and hold the Control and Shift keys, and then press Return. Select cells J12:K13. Enter: =MMULT(D12:E13,A12:B13). Press and hold the Control and Shift keys, and then press Return. See Table 9.

	A	B	C	D	E	F	G	H	I	J
1	M					N			M x N	
2	5	3	7	1		3	4			
3	2	6	9	8		7	2			
4						1	8			
5						5	9			

Table 7.

	A	B	C	D	E	F	G	H	I	J	K
11	R			S			R x S			S x R	
12	7	2		3	2						
13	3	1		1	4						

Table 8.

	A	B	C	D	E	F	G	H	I	J	K
11	R			S			R x S			S x R	
12	7	2		3	2		23	22		27	8
13	3	1		1	4		10	10		19	6

Table 9.

Notes: This set up would find two square matrices which, when multiplied together, gave the same product, regardless of the order of multiplication.

In the next edition, Andrew will explore transition, complex transition and permutation. Register for MAV's VCE conference in February 2024 for insights into all VCE mathematics studies. www.mav.vic.edu.au/events.

COMMITMENT TO COMMUNITY

Claire Embregts – Community strategy manager, MAV

MAV'S COMMITMENT TO AN ENGAGING ONLINE COMMUNITY

In today 's digital age, online communities serve as invaluable platforms for knowledge-sharing, networking, and fostering meaningful connections. However, the success of these platforms is determined not by their user count but by the depth and quality of interactions. At the heart of these interactions lies a vital principle – inclusivity. At MAV, we want all members of our community to feel included and valued.

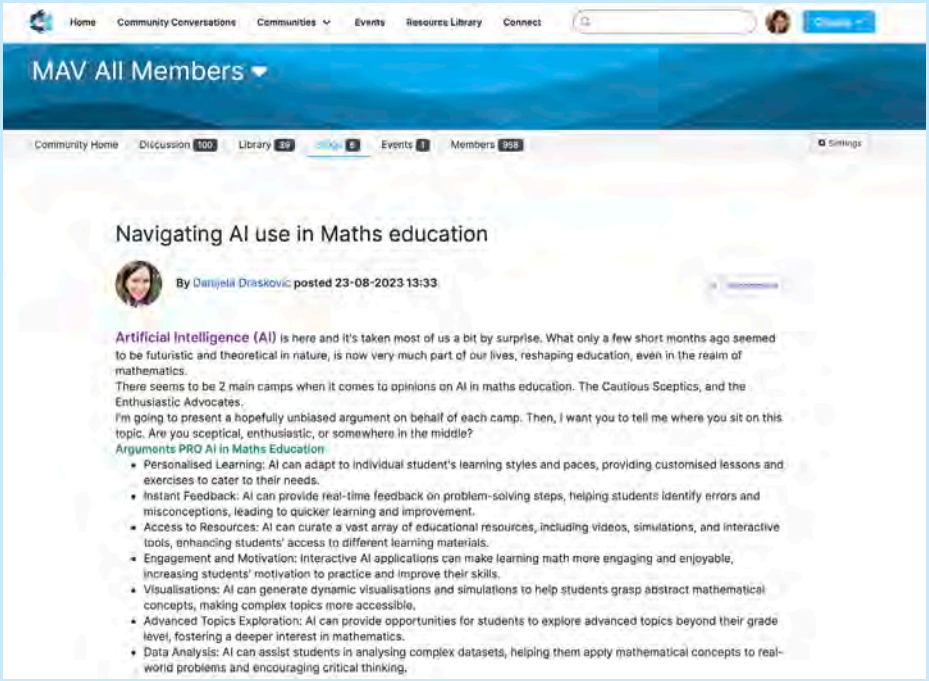
As our online community grows, sub-groups will naturally emerge. These niche groups can cater to specific interests or events, such as regional conferences or our annual MAVCON. After trialling two closed conference groups earlier this year, our recent strategic reassessment revealed that these closed groups witnessed little engagement, notably those exclusive to delegates from our 2023 Strathfieldsaye Regional and 2023 Primary Conference. This confinement meant that vital discussions and resources remained largely inaccessible to the broader community. In keeping our commitment to the MVC method of community building, we will look to our community and allow them to lead the way, letting us know when they feel ready to create more tailored subject groups.

BREAKING BARRIERS FOR A UNIFIED EXPERIENCE

Recognising this challenge, we embarked on a mission to enhance accessibility and inclusivity. Our strategy was simple yet effective: we transitioned all threads, blogs, library entries, and members from these closed groups into the main community groups. In doing so, we ensured that resources and discussions, once limited to a few, were now available to everyone. The effect? A chance for shared interaction, collaboration, and shared knowledge.

COMMUNITIES OF PRACTICE

> 'Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.'
> - Etienne Wenger



The MAV online community is a rich source of information and inspiration for mathematics educators. With nearly 1000 members, the community is growing quickly.

This quote perfectly encapsulates our vision. It's not just about having a shared interest but about continuous learning, growth, and betterment through regular interactions.

Feedback, both positive and constructive, is the cornerstone of this evolution. It enables us to reflect, adapt, and ensure that our platform remains responsive to the changing dynamics of our community. We want our members to feel comfortable coming to us with any positive or negative feedback so that we can create the best space for everyone. It's one thing to implement change, but it is another to ensure it aligns with the needs and aspirations of our members.

THE WAY FORWARD

Communities, much like the individuals that comprise them, are ever evolving. As we look ahead, MAV's dedication remains unwavering: to offer an enriching community experience that resonates with its members. This journey is not one we undertake alone. We aim to create a vibrant, inclusive, and resource-rich space for all by capitalising on expert insights and continuously reassessing our strategies.

Inclusivity is not just a buzzword; it's an ethos we embed in every facet of our MAV community. By recognising barriers and actively working towards dismantling them, we reaffirm our commitment to fostering a digital space where every voice is heard, every opinion matters, and every member feels a sense of belonging.

Join us in this endeavour, for together, we can shape a community that not only grows in numbers but thrives in the richness of diverse interactions.

REFERENCES

Sherry, n.d. A guide to building a Minimum Viable Community (MVC) https://rosie. land/posts/a-guide-to-minimum-viablecommunity-mvc

Wenger, E., & Trayner, B. (n.d.). Introduction to communities of practice, www.wenger-trayner.com/introduction-to-communities-of-practice

If you're a maths educator looking to grow your skills, expand your network, and access valuable resources, you can join our community at www.mav.vic.edu.au/Membership/Community.

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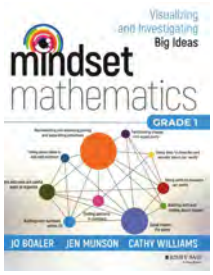
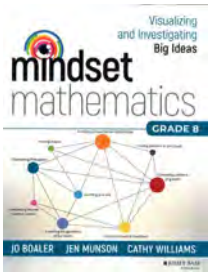




MINDSET MATHEMATICS

1–8

Engage students in mathematics using growth mindset techniques. The most challenging parts of teaching mathematics are engaging students and helping them understand the connections between mathematics concepts. You'll find a collection of low floor, high ceiling tasks that will help you by looking at the big ideas through visualisation, play, and investigation.

The authors designed *Mindset Mathematics* around the principle of active student engagement, with tasks that reflect the latest brain science on learning. Open, creative, and visual math tasks have been shown to improve student test scores, and more importantly change their relationship with mathematics and start believing in their own potential. The tasks in *Mindset Mathematics* reflect the lessons from brain science:

- There is no such thing as a maths person - anyone can learn mathematics to high levels.
- Mistakes, struggle and challenge are the most important times for brain growth.
- Speed is unimportant in mathematics.
- Mathematics is a visual and beautiful subject, and our brains want to think visually about mathematics.

With engaging questions, open-ended tasks, and color visuals that will help kids get excited about mathematics, *Mindset Mathematics* is organised around nine big ideas which emphasise the connections within the Common Core State Standards (CCSS) and can be used with any current curriculum.

$38 (MEMBER)
$47.50 (NON MEMBER)

WHAT'S THAT THERE?

K–2

A lyrical story for the very young about birds featuring Indigenous artwork by Balarinji and aerial views of Australia's distinctive landscape. An exhilarating celebration of the Australian landscape as seen from the sky featuring vibrant illustrations by Balarinji, Australia's leading Indigenous design studio.

$12.70 (MEMBER)
$15.90 (NON MEMBER)

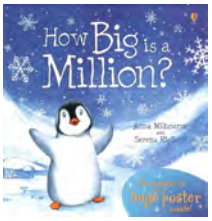
MAPPING MY DAY

1–5

Meet Flora, a precocious little girl who loves drawing, especially drawing maps - of her buried treasure, the breakfast table, the route to school, and more! Follow Flora and her family as she takes us through her day with maps.

Learning to read and draw maps is a fun and interactive way for children to develop spatial thinking skills - how we think about and understand the world around us and use concepts of space for problem solving. Early exposure to map concepts can help foster this type of cognitive development in children and boost their maths and science learning as they progress through school.

$21.85 (MEMBER)
$27.30 (NON MEMBER)



HOW BIG IS A MILLION?

K–1

This picture book helps children understand the concept of big numbers. Pipkin the smallest penguin is always asking questions, but what he wants to know most of all is how big is a million? So he sets off to find out, and along the way meets a hundred penguins, sees a thousand snowflakes and meets one new friend before being amazed to finally find out how big a million really is. A special fold-out poster at the end of the book shows Pipkin looking at the sky, which is printed with exactly one million stars.

$17 (MEMBER)
$21.25 (NON MEMBER)

CAMILLA, CARTOGRAPHER

F–3

Camilla loves maps. Old ones, new ones, she loves them all! She often imagines what it must have been like to explore and discover a new path for the first time. One morning, Camilla wakes up to a huge snow storm. Her neighbour Parsley can't find the path to the creek. But Camilla has her old map - which inspires her to make her own path and her own map!

$31.20 (MEMBER)
$39 (NON MEMBER)

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