THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 4/22

VCE FOUNDATION MATHEMATICS

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22 Time to do away with the false dichotomy in mathematics instruction

Claire Delaney, Lalor Secondary College and Michael O'Connor, Casey Grammar School

Next year is a big year in mathematics with the launch of the new VCE study designs. Arguably, the biggest change is in the VCE Foundation Mathematics course which will now continue through to Year 12. Students will be able to access a course of study designed to develop their mathematical skills in identifying, investigating, understanding and solving the problems they encounter in every day real world experiences in life and work.

Students choosing to pursue Units 3 and 4 Foundation Mathematics will be provided with a credited study program, study score and an examination at Year 12. Focused on catering for the needs of students going into trades and further studies directly from school, as well as the skills required to navigate through aspects of everyday life at home and in the

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FROM THE PRESIDENT

Kerryn Sandford

The theme of the 2022 annual MAV conference in December is *Valuing Mathematics in a Changing World* and it would be difficult to propose a more fitting theme for these times. Right now, in classrooms and schools across the globe, we are seeing unprecedented levels of change in almost all aspects of schooling; from the ways in which schools are structured and operate, to the attitudes and dispositions that students bring with them into classrooms, the disparity and variance between learners within the same classrooms and shifts in the ways in which schools and teachers are interacting with their wider communities.

In Victoria, just this year alone, we have seen changes to how we manage and deal with COVID-19 infections and isolation requirements, the implementation of a new FISO framework (FISO 2.0) with a much stronger emphasis on the importance of wellbeing, new Child Safe Standards being rolled out to all schools, possibly the most significant reform that we have seen in senior secondary school provision for a generation, the introduction of a new enterprise bargaining agreement (VGSA2022) and the subsequent changes to funding models and staffing calculations, enhancements to how disability and inclusion is supported in schools with a very different funding model being introduced and a plethora of other changes that we are experiencing 'on the ground' as we go about our work on a daily basis.

Add the significant pressures due to staffing shortages as a result of COVID-19 and the growing difficulties that schools are experiencing with recruiting staff that they need to run their programs, and you can see that we are working in a very dynamic and constantly changing space.

The scary part is that this year is not over yet, for many of us, there are likely still more changes to come.

As a school leader, I know that my mathematical and numeracy proficiency is being tried and tested more than I remember at any time previously across my career and I can only assume that similar challenges are being experienced in many industries. This fits with much of the research that has, for some time, been showing that the level of mathematics and numeracy required for success in work and life is increasing (see Dave Tout's Monograph at www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/Pages/research_connectionsbetweennumeracyandmaths.aspx). At the same time, in schools we are experiencing greater challenges to engage students and families and to help them to see the importance and relevance of mathematics for their ongoing success both at and beyond formal schooling. This is playing out in declining participation rates in senior mathematics courses in secondary schools and in universities (see AMSI report, https://amsi.org.au/wp-content/uploads/2022/04/year-12-participation-2022.pdf).

It is for this reason that I encourage you to attend the MAV22 conference. It is offered in both online and face-to-face formats. The conference will showcase a wide range of presenters and keynote speakers, many of whom are practicing teachers and all will have advice, guidance, resources or strategies to help teachers and schools meet the changing demands of their work. With such an impressive array of speakers and an anticipated attendance of around 800 educators, it is shaping up to be a fantastic couple of days of professional learning and networking. I look forward to seeing you there!

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 primary mathematics showcase: highlighting best practice and pedagogy	14/10/22	F–6	MAV consultants and special guests
Making the most efficient use of your Casio ClassPad	25/10/22	9–12	Kevin McMenamin
MAVCON22	1/12/22-2/12/22 Hybrid	All levels	Various

MAV MEMBERSHIP

'Being a MAV member has opened our eyes to the plethora of support available, all with the aim of making maths interesting, engaging, and fun for students,' said Robyn Twyford, Principal, Templestowe Park Primary School.

Most organisations consider experience one of an employee's most valuable attributes. Experienced professionals bring insights, knowledge, and highly developed skills to support an organisation's goals and work. MAV is invested with building your experience as a professional educator so that you can better contribute to the learning outcomes of students in your school and support your colleagues.

HOW DO WE GAIN EXPERIENCE?

We collect knowledge and build experience as we go through life. Some people actively seek out experience, and others accrue it passively as events occur. Maths educators who actively read journals, magazines, and books and practice their craft in professional learning and in training scenarios, and who share and interact actively with teaching teams and their community of educators, gain experience at a faster rate than those who do not.

Robyn shared insights on her MAV membership. 'Our school membership with MAV was reignited back in 2014, along with the appointment of our new principal, Mark. I say 'reignited' because we, as a school, were members of MAV previously, but like most things in schools, if something is only driven by a passionate individual, rather than as a whole school, interest, and drive wanes when that person moves on. Mark came from a MAV Maths Active School, and it was time for us to turn the spotlight on the teaching and learning of maths at our school. It wasn't long before we worked hard towards our MAV Maths Active School accreditation, which we achieved in 2017. Being a MAV member school and all the benefits are now embedded within our school culture.

TEACHERS BENEFIT

Teachers at school enjoy reading MAV's publications: *Prime Number* and *Common Denominator*, they often have inspiring articles that are thought-provoking and backed by research. Many of the ideas in these articles have been tried and tested in real classrooms and can be adopted by teachers within their classrooms the next day. They help to motivate and inspire teachers about maths.

STUDENTS BENEFIT

Being MAV members, we have the opportunity to enter our students into competitions and challenges designed to make maths learning a lot of fun. Our school enrols Year 4-6 students into the MAV Maths Games Days, we participate annually in the Maths Talent Quest (MTQ) with multiple entries.

We get member discounts on conference registrations. Just as teachers pivoted to remote learning, MAV was quick off the mark with this too. Webinars and online games days were delivered when they couldn't be held in person.

PROFESSIONAL LEARNING

Some of our best professional learning, which has made whole significant school change, has been stimulated by MAV. We were participants in the Maths Collaborative two year program, designed to increase student outcomes in maths. It challenged our thinking and helped us to understand the importance of embedding the teaching and learning of the proficiencies across the school.

A MATHS ACTIVE SCHOOL

We earned a Maths Active school accreditation through MAV, we have worked as part of the Maths Collective, group of like-minded schools to have professional learning delivered by renowned experts, with MAV facilitating professional networking and sharing. I have always found MAV responsive to questions. MAV's consultants are knowledgeable and tailor their expertise to address the needs and direction of where we are at on our maths teaching and learning journey.

Years of learning and teaching experience are more valuable than just years of education.

If you'd like your school to join an innovative community for mathematics educators, to ultimately build your team's experience, become a MAV member - or renew your membership for 2023.

Visit www.mav.vic.edu.au/membership.

VCE FOUNDATION MATHEMATICS

Claire Delaney, Lalor Secondary College and Michael O'Connor, Casey Grammar School

CONT. FROM PAGE 1.

community, students following this course of study emerge with the requisite skills to be curious, responsible global citizens.

AREAS OF STUDY AND CONTEXTS

The flavour of the Year 11 course is similar to previous incarnations. Beginning with the cosmetic changes, the areas of study have been renamed to align with the other VCE studies. The old, Patterns and Number is now Algebra, Number and Structure. Similarly, Data is now Data Analysis, Probability and Statistics. Don't panic though, there is no probability in the key knowledge or skills of any of the four units.

Units 1 and 2 are now detailed separately with the prior knowledge and skills lists divided between them. There are some terms that appear explicitly for the first time, such as pro-numeral and truncation, but not many. There also seems to be a notable omission, Pythagoras' Theorem, but it seems impossible for it not to be part of the intent of the Space and Measurement when including standard calculations for length. While it is not listed, it is also not precluded and may provide a good opportunity for learning within the right context.

There are some additional dot points to both the knowledge and skills, primarily in the Financial and Consumer Mathematics Area of Study 3. Indeed, this seems to be the largest single section of development from the old course.

Units 1 and 2 remain focused on the application and use of mathematics to personal life skills and work-related endeavours. Units 3 and 4 build on that to develop mathematically informed and literate citizens at regional, state, national and international levels. As has been made all too clear in recent years, it is impossible to conduct reasoned debate about issues of importance to the species and the planet without an understanding of mathematics.

SCHOOL ASSESSED COURSE WORK: MATHEMATICAL INVESTIGATION

The other significant change in the study design is the inclusion of the mathematical investigations. They are a sustained exploration of a mathematical context or scenario based on the content from the areas of study and application of key knowledge and key skills for the outcome. Described for Units 1 and 2 as comprising 'one to two weeks of investigation into one or two practical or theoretical contexts' this appears to be a formalisation of the thematic approach to learning that has been part of Foundation since its inception. Indeed, the mathematical investigations are formalised at Units 3 and 4 as the type of SAC to be used. For Units 3 and 4, each investigation must incorporate two or more of the areas of study. Divided into three sections, Formulation, Exploration, and Communication, the mathematical investigations contribute to 60% of the study score with the remaining 40% being allotted to the end of year examination.

PREVIOUS STUDY DESIGN	REVISED STUDY DESIGN FOR 2023-2027
UNITS 1 AND 2	
Area of study 1: Space, shape and design	Area of study 1: Algebra, number and structure
Area of study 2: Patterns and number	Area of study 2: Data analysis, probability and statistics
Area of study 3: Data	Area of study 3: Discrete mathematics, financial and consumer mathematics.
Area of study 4: Measurement	Area of study 4: Space and measurement
UNITS 3 AND 4	
–	Area of study 1: Algebra, number and structure
–	Area of study 2: Data analysis, probability and statistics
–	Area of study 3: Discrete mathematics, financial and consumer mathematics.
–	Area of study 4: Space and measurement

EXAMINATION

In becoming a fully certified study at Unit 3-4 there is also now the inclusion of an external examination at the end of the year. For Foundation Maths there are differences in how this is structured to the other mathematics studies. Firstly, there will only be a single examination of two hours in duration. Students will, as in Further Mathematics, have access to a handheld scientific calculator and notes. There is no requirement that the calculator have graphical or CAS capability. In fact, CAS calculators are not approved for the examination.

The question styles for the examination will be a combination of multiple choice and short response. The VCAA will publish more details later in the year. It is understood that all the multiple choice will be grouped together as a section, divided into areas of study. Similarly, the short response items will be grouped together and contained in sub-sections related to the areas of study. The questions will be contextualised in a range of familiar and unfamiliar situations. An example of a possible questions may include:

> A builder starts work at 7.30 a.m. and has a break at 10am for 15 minutes. They have an hour for lunch starting at 12.30 pm, then worked through to 3.30pm If they earn $22.50 per hour how much have they earnt?

CONCLUSION

The extension of Foundation Mathematics into the 3-4 space represents an acknowledgement of the importance of personal, vocational, and collective mathematical knowledge and skills in the modern world. For many students, mathematical ideas need to be embedded in practical experiences and relatable contexts in order for them to be understood. Foundation Mathematics has provided this link for over twenty years, and it is pleasing to see its profile raised in this way.

TECH(KNOW)LOGY

Mitchell Leyton - Sunshine North Primary School

Gone are the days technology is scrutinised in our 21st century classrooms. Some of the things that have been labelled taboo over the years are now the most engaging and insightful ways we can assist our students in their learning journey. My students know me as Mr Leyton, my colleagues as Mitch and I am also known on the 'teachergram' as @mrleytons_littlelearners. I'd love to spark or affirm ways that you can use technology and media in your upper primary classroom.

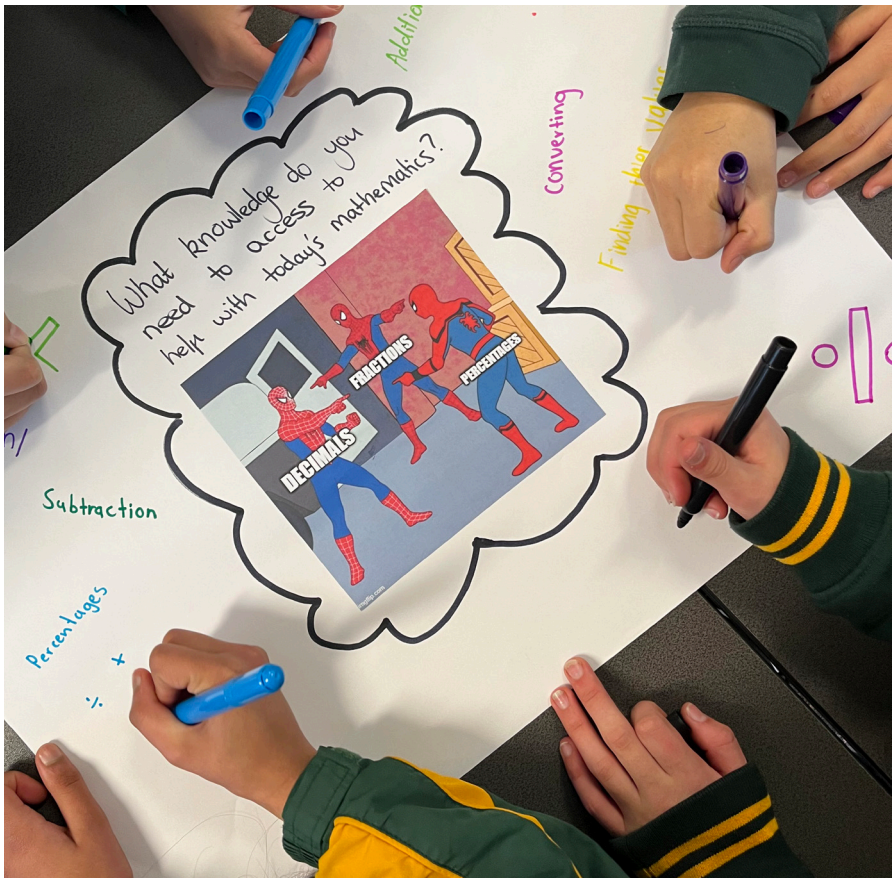
If I am using technology and media as a platform to engage in professional learning, communicate with other like-minded educators and build a digital portfolio to reflect on my practise, it makes sense that our students could do the same (with clear boundaries). If we can learn anything from the last two years in education, technology and media has been our saving grace.

I became a teacher to inspire lifelong learners and build 21st Century skills so every child, every day, leaves the classroom feeling a sense of responsibility for their future. To achieve this, I must know what is relevant and trending in today's society.

Memes, TikTok and Nerdle are some of the things you will hear in the four walls of my room to engage students. To access prior knowledge of my students, I typically use memes. Students firstly begin to question your 'trending status' and then they begin to connect prior experiences and events to the meme. So before you launch your next unit of study, try using a meme as your hook. Trust me – there will be an instant outburst of chatter.

Don't be afraid to use technology in the classroom. It can seem overwhelming but one thing I have learnt is to keep it simple and accessible for **you**. Teachers are natural control freaks (self-proclaimed of course) so we should only focus on the things we can control.

Google Slides is a great platform to let your creative juices flow. Start by creating create daily presentations that help scaffold your students learning throughout their day by making their learning visible. You can also import visual timers from YouTube that help your students learn to read time, whilst simultaneously working on their ability to calculate duration of time.



Alternatively, I teach students mathematics by using a *Bop or Flop* segment throughout my day. I use it as a brain break activity where different songs are playing and they choose to either stand and dance (bop) or sit and judge (flop). You can easily turn this into a mathematics lesson where students record data of what their peers liked and disliked. Students then start sampling their data collections. It's pivotal that we make mathematics fun!

If you have Apple TV, you have one of the biggest classroom hacks right at your disposal! By combining technology and the use of social media you can showcase your teaching. I find useful current affairs on Instagram (such as @thedailyaus) to help facilitate and model interactive read alouds. Using any Apple product and Apple TV, you can mirror content onto your interactive whiteboards. This a simple, yet powerful and engaging tool in our classrooms.

You can use it in other ways: sharing student worked samples, explicitly teaching or modelling a game, or to correct student work in live time.

Teaching mathematics with authentic links using technology and the media helps students make real connections to societal and global content. Think of all the mathematical projects that have yet to be discovered! Minimise the worksheets and get your students immersed in hands-on problem-solving tasks using technology and the media!

How do you use technology in your classroom? Perhaps you'd like to share your experiences with our readers? MAV welcomes article submissions from mathematics educators. To find out more, visit www.mav.vic.edu.au/Services-and-News/Common-Denominator-Magazine or email office@mav.vic.edu.au.

To see more from Mitchell, visit Instagram @ mrleytons_littlelearners.

CAS CALCULATOR PROFICIENCY

Kevin McMenamin - Mentone Grammar School

FOCUS: CASIO CLASSPAD

The use of technology within the school environment is ingrained and is under constant development to meet the expectations of an academic curriculum and the changing needs of a modern workforce. For the mathematics disciplines within a school environment the technology emphasised in lower and middle classes is the scientific calculator while in the middle and senior classes it is CAS technology. While it has been a mandated requirement in Victorian senior VCE Mathematics classes to use CAS technology, a user must have an enthusiasm and desire to develop and maintain a competent proficiency in the workings of the CAS in order to stay up to date.

As advances in technology develop quickly, a user trying to keep abreast of changes must be committed and possess research skills that enable shifts in usage to be recognised. Interestingly if time is taken to look back over the last twenty years of CAS use in schools, observations would show the focus of some questions, while predominately similar in content, has changed to now assume and encourage CAS use. A good example of this is where less emphasis is placed on the technique/methodology and more on the result where it can be used and applied. An example of this change in focus can be seen in the 2021 Mathematical Methods Exam 2 Question 1, parts c, d:

> c. Find the derivative of V_{box} with respect to x.
>
> d. Calculate the maximum possible volume of the box and for which value of this x occurs.

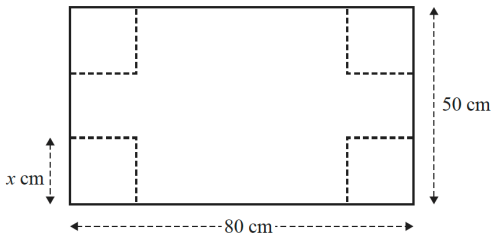
compared to the 2004 Mathematical Methods Exam 2, Question 1, part d.

> d. The rule of the function f can also be written as $f(x) = x^3 - 4x^2 + 5x - 1$.
>
> Use calculus to find the area, correct to three decimal places, of the region bounded by the graph of $y = f(x) - 1$ and the x-axis.

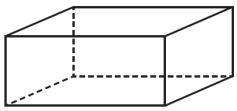
An awareness of the capabilities of the calculator provides a very efficient means for a solution to be constructed for a problem.

Question 6

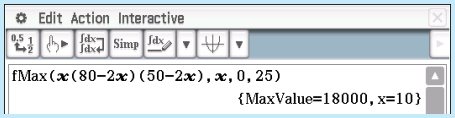
A rectangular sheet of cardboard has a length of 80 cm and a width of 50 cm. Squares, of side length x centimetres, are cut from each of the corners, as shown in the diagram below.



A rectangular box with an open top is then constructed, as shown in the diagram below.



The volume of the box is a maximum when x is equal to



VCAA 2019 Mathematical Methods Exam 2 Q6 (above). A CAS solution (below).

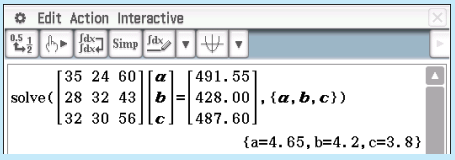
This generally involves the development and coding of an equation, expression or statement into the CAS. Its inbuilt functionality can then find a solution. A good example is multiple choice question 6, found in the 2019 Mathematical Methods Exam 2 as seen here. The question is clearly explained and provides a visual stimulus but does not provide a starting expression or equation. As there is very little provided as a pathway to a solution, it is up to the user's proficiency in mathematics and CAS knowledge to enable a solution to be found quickly and efficiently as seen in the image above.

With modern CAS platforms having the capacity to be updated, it is important that new releases of software be installed as close to the release date as possible. In this way, the operating system will always have the most recent improvements and updates which generally allows more complex equations to be solved via alternate and more efficient CAS processes.

One of the many recent improvements is linked to the Further Maths course and questions that were previously answered via inverse matrix arithmetic. Improved operating systems now have the capacity to use the 'solve' functionality on the CAS.

An example is in the VCAA 2017 Further Mathematics Exam 2, Matrices module, question 1c as seen below.

> A school canteen sells pies (P), rolls (R) and sandwiches (S). The number of each item sold over three school weeks is shown in matrix M.
>
> $$M = \begin{array}{c} \\ \text{week 1} \\ \text{week 2} \\ \text{week 3} \end{array} \begin{array}{c} \begin{array}{ccc} P & R & S \end{array} \\ \begin{bmatrix} 35 & 24 & 60 \\ 28 & 32 & 43 \\ 32 & 30 & 56 \end{bmatrix} \end{array}$$
>
> Consider the matrix equation
>
> $$\begin{bmatrix} 35 & 24 & 60 \\ 28 & 32 & 43 \\ 32 & 30 & 56 \end{bmatrix} \times \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 491.55 \\ 428.00 \\ 487.60 \end{bmatrix}$$
>
> where a = cost of one pie, b = cost of one roll and c = cost of one sandwich.
>
> What is the cost of one sandwich?



These ongoing improvements in CAS functionality strongly encourage the user to seek out the most efficient processes and methods to solve questions. The benefit of this strategy would be to save time on calculations so it can then be spent on thinking, processing and analysing.

To encourage the quest for efficiency and proficiency a structured and detailed teaching and learning program would need to be implemented in the middle years to provide as much time as possible for confidence in CAS use to be acquired. Noting this as a major factor influencing the development of the user, the availability of numerous learning resources would be critical.

For users of the Casio fx-CP400 ClassPad II, Casio Australia has numerous classroom resources freely available for students and teachers to use to help with the attainment of CAS skills and knowledge. These include classroom lessons and activities, videos and playlists. The Casio Education, Australia website can be quickly navigated to locate the available classroom resources, https://casioeducation.com.au/classroom-resources/.

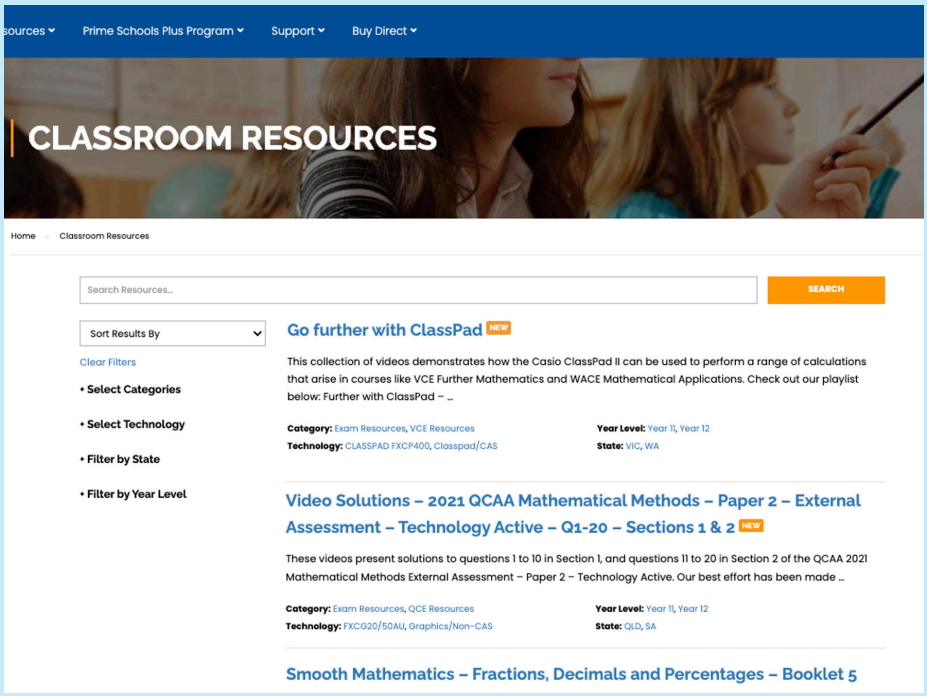
These resources contain complete classroom activities as well as short (2 – 3) minute videos that provide a detailed guide to a CAS process or function. The audio accompanying the calculator work allows the description or application to be easily followed and understood. The variety and number of resources provide opportunity for the novice through to the expert to acquire knowledge and skills well beyond their current status.

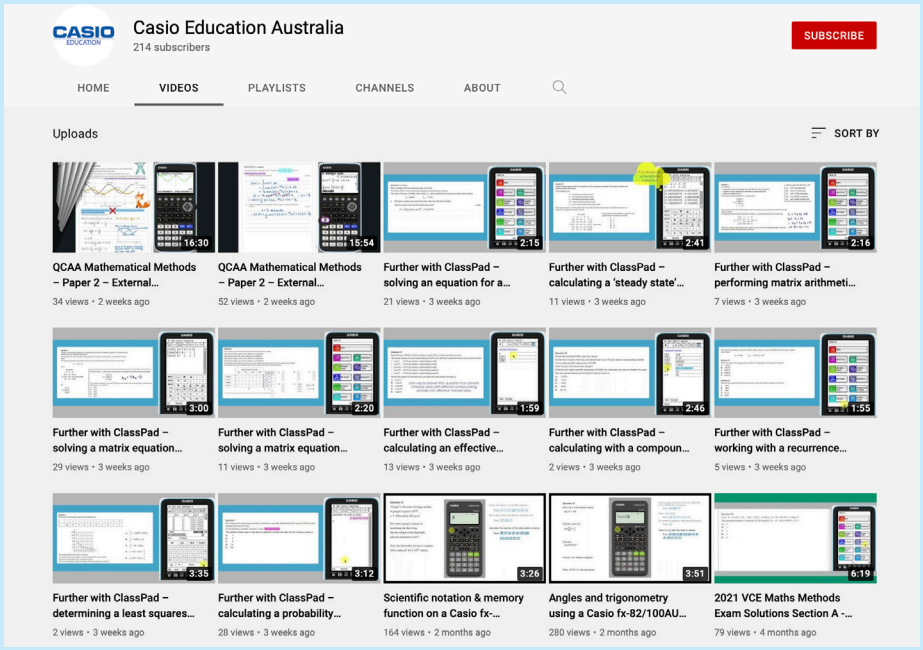
A second resource dedicated to just the videos and playlists exists at the Casio Education Australia You Tube channel (www.youtube.com/c/CasioEducationAustralia/videos).

As this site is dedicated to videos and playlists it is easier to navigate and find the resources linked to a functionality. One seen on this page describes how to solve matrix equations, which was a technique referenced earlier.

With the numerous resources available, users have every opportunity to acquire and enhance their proficiency in CAS knowledge which would then lead to a greater confidence in tackling the variety of questions that appear on the end of year VCAA Mathematics examinations as part of the VCE.

Kevin McMenamin will present a professional learning session on Tuesday 25 October, Making the most efficient use of your Casio ClassPad. Register for this session at www.mav.vic.edu.au.





Find out more about using CAS at MAV's 2022 conference. The conference will be held on 1 and 2 December. For more information and to register, visit www.mav.vic.edu.au/Conference/Annual-Conference.

ABC OF ACTIVITIES

Shelley Pendlebury - Nazareth College

Year 11 Mathematical Methods students determined equations of graphs of various functions (Treasure Hunt by Mathsbox).

RESOURCES TO ASSIST IN PLANNING WITHIN JUNIOR SECONDARY CLASSROOMS

Over years of teaching, I've witnessed a great variety of lesson plans, from scribbling on the back of paper envelopes, to reinstating previous years lessons, lesson plans that resemble a piece of artwork and those that read as a novel. Teachers differ greatly in the time they spend and how they present lesson plans. In many cases, schools direct not only how teachers plan but how they present those plans to their school communities. Whatever your planning habit, it is easier if you have a toolkit of resources at your disposal.

In planning lessons, I consider:

- the content to be taught and
- the skills I wish my students to develop.

Students that perform well in mathematics usually have quick recall of prior knowledge and perform mental arithmetic quickly. High achieving mathematics students typically have a very good number sense, and therefore good approximation skills. They are often able to think logically and have a willingness to try different strategies when solving difficult unstructured problems. They commonly present with good executive control, fast processing speed and a good working memory. Developing these skills can only have a positive impact on mathematical performance.

PLANNING

Generally planning starts with a teaching team considering the year ahead, then terms, and modules. Individual teachers then commence planning their individual lessons. Assigning particular lesson each term to problem solving activities and not on learning content will ensure its inclusion and give students the opportunity to work as mathematicians. Students can 'work as mathematicians' through exposure to problem solving and investigations. Investigations that allow for the identification of patterns are brilliant for junior secondary, such as Pascals triangle and Fibonacci sequences. Team discussions when planning should go beyond content, and include discussion on how to model thinking, and make reference to further developing the personal attributes associated with able mathematics students. This will encourage teachers in the team to include activities to develop these attributes in their planning. These tasks don't need to take up a lot of time, rather frequent exposure to quick activities, often presented as warm-ups or a closing activity of each lesson will enable student improvement. Teaching teams should also identify topics or problems to be used to extend students performing above the expected level.

The general sequence of my lesson plans:

1. Quick warm up activity that focuses on review of previous lessons, required knowledge or building the personal attributes identified as being present in strong mathematics students.

2. Gain attention, pose a problem and/or give real life context to introduce the new skill or concept being taught.

3. Teaching and learning explanation or guided discovery. In the teaching of new

content, I value visual representations, especially to explain how concepts relate to other concepts.

4. Quick engaging activity or questioning time to check understanding and provide opportunity for feedback and correction of any misunderstandings.

5. Student practice, consolidation and or opportunity for further exploration. Further checking of understanding while students work.

6. Restate the learning and connect learning to prior understanding. I often do this with an activity such as an Exit ticket (see the activity list at the end of this article), or a 'pair and share' discussion asking students to articulate their learning to a friend.

STUDENT ENJOYMENT

I am conscious that student enjoyment assists in knowledge retention and fosters a love of mathematics. When I plan lessons, I try to include at least one activity that improves student enjoyment and/or encourages students to communicate mathematical ideas with other students.

Playing games generates enthusiasm, excitement and improves overall engagement, as students cannot play games passively. Communicating ideas verbally has been shown to improve the firing of synapses essential for learning. Games may occur in any part of the lesson sequence depending on their design. Short games and interactions such as 'think, pair, share' activities are a valuable inclusion and the length of time the activity occupies is not necessarily proportional to the value of the learning experience.

A large part of class time is typically spent on the teaching and student practice. I follow these rules in relation to practice, worksheets and textbook work:

- No time for busy work! The time doing the activity needs to be proportional to what the students (or teacher) can get out of the activity.
- Must provide feedback! Is there a way for the students to know whether their answer or working is appropriate or wrong?
- Activities designed to consolidate understanding should have an easy entry level and increase in difficulty to be just a little challenging and thought provoking.
- The low floor and high ceiling approach should also be used whenever providing a whole class with a common activity to complete, as it is unrealistic to expect one activity which requires little variation in skills will be beneficial for the whole class in a middle or junior secondary setting.

Low floor means that a task should be easy enough that all students, even those who struggle with mathematics, can initially engage with the task. High ceiling means that the task is appropriate for high achieving students to have multiple opportunities to challenge themselves and think deeply and/or complete challenging problems.

Problem solving tasks should be low floor/high ceiling. Problem solving tasks can be solved by well-practiced understood skills rather than new skills recently learnt. The content should not be the challenge, the challenge comes from a level of confusion about 'how to solve' the problem, which methods and strategies to use to help clarify and determine an answer is what makes a task a problem solving task. I aim to use problems that allow for multifaceted approaches to provide greater opportunities for discussion about thinking.

When planning, I regularly rely on a series of resources especially for practice, recall, and development of processing speed. I've compiled a list of the resources I use the most, I recommend you check these out and add them to your lesson planning toolkit. The list of my favourite activities follows. All the resources listed are free and easily accessible.

Arithmagon or **Arithmogon Puzzles.** Use of shapes to practice addition, easy problem solving. https://nzmaths.co.nz/resource/arithmagons.

Angles estimation. I love this activity for estimating angles using GeoGebra. https://nrich.maths.org/1235.

ASMI. Resources for planning modules and other resources. https://schools.amsi.org.au.

BINGO. There are many available online and you can easily make physical games. https://mathsstarters.net/bingo.

Bizz or **Buzz Bizz Game.** Students in turn call out consecutive numbers, (can let them say 1, 2, or 3 numbers or just 1.) When students get to a multiple of the number, they call Buzz. Using multiples of two different numbers on is assigned Bizz and the other Buzz.

Cartesian Battleships Maths Game. This is a game played in pairs, based on the battleship game, students practice reading and writing points on a Cartesian plane. See http://static.zerorobotics.mit.edu/docs/ms/CoordinateGraphBattleship.pdf or www.geogebra.org/m/YgnVY9K8.

Coordinate dot to dot. www.math-salamanders.com/coordinate-plane-worksheets.html.

Crosswords. Make your own crosswords and word finds to improve vocabulary. www.education.com/worksheet-generator/reading/crossword-puzzle.

Dominoes. Make sure you have enough in the class set so that students can work in pairs or individually.

Number Detective. Students write numbers 1 to 25 and are instructed to cross out certain numbers such as multiple of 3, primes, factors of 50, digits that sum less than 7, then add all the numbers remaining to detect the mystery number. www.mathsbox.org.uk.

Desmos. Online calculator and graphing. Desmos also has interactive activities to help explore concepts. www.desmos.com.

Estimation Golf. Online game for estimating number. This activity is good for able students as it includes estimation of squares and roots as well as the four operations. www.transum.org/software/Fun_Maths/Golf.

EngageMe. Lots of starter games that strengthen fluency of number. www.engagememathematics.com/resources.

Exit Ticket. A5 paper with one to three questions relevant to the teaching objective, ask students to answer some or all of the questions and give a short reflection on how

ABC OF ACTIVITIES (CONT.)

Shelley Pendlebury - Nazareth College

they found the lesson. This allows teacher to check for understanding and gives student opportunity to both reflect on their own practice and give the teacher feedback on the lesson.

Fraction Wars. You'll need decks of playing cards. Two pack per pack of cards. Players turn over two cards each and make a fraction. The highest number player keeps all four cards.

Fraction bars. This is helpful for weaker students. www.mathplayground.com/Fraction_bars.html.

Forms. Microsoft or Google Forms. As short quiz to provide immediate feedback to students and teacher. As a learning activity (Goggle Forms) insert videos and/or text to guide through examples and then follow with questions.

Fuse. Teacher resource portal for Victorian Government Teachers. https://fuse.education.vic.gov.au/Secondary.

Greedy Pig. Game designed for students to practice addition with an element of risk improves engagement. www.youtube.com/watch?v=gMFMpC3mC_0.

Guess my number. In groups of three, one student nominates a number for each of the other two students. They then explain how the two relate to each other for example, your number is four times the other number, or the product of your numbers is 21, the student that guesses wins and takes a turn at nominating the numbers.

GeoGebra. There are lots of ways GeoGebra can be used. There are lots of ready-made interactive activities that explain concepts.

Hard Times. A good five minute starter while you get yourself ready, or for practice of factors and multiples before a lesson on factorising. www.transum.org/software/SW/Starter_of_the_day/Students/Pairs.asp?Topic=16.

Itute. Many free resources for teachers and students. The resources are mainly aimed at upper secondary but there are some good ones for juniors. www.itute.com/download-free-vce-maths-resources.

Jeopardy. There are interactive versions, also you can play as a class if you create enough questions of different abilities. There are many different topics. www.math-play.com/math-jeopardy.html.

Kahoot. Kahoot is a great tool that students are very familiar with. You can stop and explain questions or run through without. You can use it to identify common misconceptions. https://kahoot.com.

Kenken Puzzles. Create your own or use the many available, quick puzzles giving practice to mental maths and problem solving. www.kenkenpuzzle.com.

Letters and Numbers. *Numbers game*: Give the class 6 numbers and a goal number. Each student has to use the numbers (no more than once) and try using any mathematical operation to make or get as close to the goal number as possible. *Letters game:* Take the letters of a mathematical word and jumble them to see if students can work out the original word.

Maths Playground. Loads of interactive games especially good for Year 7. www.mathplayground.com.

Nrich Maths. Brilliant website with a great number of resources from games to notes and videos. https://nrich.maths.org.

NZ Maths. Has professional learning for teachers, many resources for in the classrooms in lesson plans. https://nzmaths.co.nz. Another great website from New Zealand is www.mathscentre.co.nz.

Odd one out. Show a group of numbers or items and ask students to decide which is the odd one out. Ask students to think, pair and share their ideas.

Pixel Art Maths. Students enter the correct answer and an image appears. You'll need a Google account to use it. Try some examples and see how to make your own. https://youtu.be/o5jYoMGUP3c.

Quizlet. Cue cards to learn definitions, consolidate understanding and review content. There are different ways they can be used from testing yourself, matching them up and now there is an in class live interactive. https://quizlet.com.

Relays. There are a number of ways to do this. Make some cards in two or three different colours. Students can make a line answer their question and then pass the next question to the next person in a class race.

Sudoku. An engaging logic game involving numbers. https://sudoku.com.

Transum. The **best** (arguably) website for interactive games. https://transum.org/ When I use the Transum games that correct, I get students to take a screen shot of their results (I tell them for bragging purposes) and stick the screen shot onto their electronic notebook (OneNote) or post in Google Classroom.

Three Act Maths. Some video sequences to support introducing a concept by posing a problem or question or to use to support explanations. https://whenmathhappens.com/3-act-math.

Unstructured problems. Inclusion of unstructured problems as a warm-up or practice of application style questions. For example, how many different ice creams can you purchase, if there are three flavours and you can buy one or two flavours on a cone? Another example: What is the sum of the numbers from 1 to 100?

Visual Patterns. This site contains many visual patterns. www.visualpatterns.org.

Writing on the white board. Most students value being able to write on the white board or present their ideas.

Yohaku. The aim is to fill in the empty cells, so they give the sum or product shown in each row and column. You can find them for integers, fractions and decimals.

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Ernest, P. (1986). Games, a rationale for their use in the teaching of mathematics in school, *Mathematics in School. 15*(1).

Shelley almost covered the alphabet! If you have activities to add, head to MAV's social channels and contribute to the discussion, especially if you have activities that begin with Z!

STIMULATING THINKING

Brooke Brennan, Mathematics leader, St Francis of Assisi 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 Twitter, @maths_vic.

EARLY YEARS - YEAR 2

- Count the numbers in order.
- What numbers can you see that are less than 10? What numbers can you see that are more than 10?
- Find pairs of numbers that equal 20.
- Your teacher asks you to sort the numbers into two collections. How do you sort the numbers? Why did you choose to sort them that way?
- Find any pairs of numbers that are near double pairs.
- What shapes can you see? How many of each shape is there? Sort the information about the type of shapes and how many there are into a graph that you can discuss with a partner.
- You throw three darts at the board, your final score is 40, where might your darts have landed? How many possible combinations are there?
- How many times can you see the digit 3 on the board? Which digit appears on the board most often?

YEARS 3 AND 4

- What is the lowest and highest possible score you can get if you throw 5 darts and they all land on the board?
- Choose a number on the board to start from and create a counting pattern. Count by 2's, by 4's, by 6's.
- Choose two numbers and find the product of those numbers. Do any other sets of numbers produce the same product?
- Find an efficient way to find the total of all the numbers on the board.
- Sort the numbers on the board into odd and even numbers. What do you notice?
- Find as many fact families as you can.

- Create a graph based on how many times each digit appears on the board.
- You throw 8 darts at the board, your final score is 110, where might your darts have landed? How many possible combinations are there?
- What is the chance of landing on a number greater than 7?

YEARS 5 AND BEYOND

- How many multiples of 3 are on the board? How many multiples of 2 are on the board? How many numbers on the board are a multiple of both 3 and 2?
- Calculate or estimate what fraction of the board is black, what fraction is cream, what fraction is red and what fraction is green. Calculate these as decimals or percentages. What is the ratio of black to green on the board?
- What sum of three numbers will equal a prime/composite/square/triangular number?
- How many acute angles can you see on the board? How many obtuse angles are there? Find an efficient way to calculate this.
- Calculate the probability of throwing a dart and landing on a prime number. How about a composite number?
- The paint used to paint the red segments of the board costs 75 cents per segment. All the other colours cost 35 cents per segment. What is the total cost of paint for 15 boards to be produced?
- The boards are shipped in boxes that are 60cm wide, 10cm deep and 75cm in length, calculate how much space 20 boxes will take up when they are shipped.

MATHS AND THE ATAR

TOP 4 TIPS FOR STUDENTS

1. MATHS IS IMPORTANT

Maths is a competency required in most, if not all, university courses. Although many university courses no longer specify maths as a pre-requisite to entry, it is absolutely prerequisite to success in life beyond school.

Selecting the most challenging maths subject you feel comfortable with will keep your course options open.

Maths has never been more important for success in life and the wider world. There is a maths for every student to keep your options open for the future.

2. ATAR AND SCALING

Some maths subjects (typically Methods and Specialist) scale up, other maths subjects may be scaled down. But scaling and ATAR is not the reason to select your subjects. Studying VCE subjects that you work hard in, and get positive outcomes from, can give you a better ATAR result, as you are more likely be engaged and successful. Selecting subjects that set you up for success in your career or uni pathways is important – think maths!

3. ATAR IS NOT THE ONLY PATHWAY

Balance your ATAR goals and enjoyment of VCE against the inclusion of a maths subject to set you up for success.

It is not all about all about ATAR as there are many pathways to university. Only about 26% of students enter university through ATAR.

Some maths is always better than none!

You are welcome to publish these tips in your newsletter and share with parents and students, download at: www.mav.vic.edu.au/Resources/Parents/Secondary-School-parent-support

4. GETTING STARTED AT UNIVERSITY

Maths is required as part of most courses. Studying maths in Year 12 can assist you to thrive and succeed in your first year of university and help you to avoid taking catch up courses, paying extra fees and wasting time. Many university courses require students to complete a maths unit in the first year of study. Some students find that this offers a valuable opportunity to revisit and consolidate what's been learnt in VCE.

However, those who haven't studied maths in VCE tend to find these units a source of stress and struggle. Completing the most challenging VCE maths subject you can will ensure you are better prepared for the maths required at university, and in your career.

THE MATHEMATICAL ASSOCIATION OF VICTORIA

www.mav.vic.edu.au

ONE MINUTE WITH MICHAEL MACNEILL

I'M…

Michael MacNeill, the Curriculum Manager, Mathematics at VCAA.

AT VCAA I LOOK AFTER…

Structure, scope and sequencing and advice for implementation of the Mathematics curriculum from Foundation – Year 12.

I WORK WITH TEACHERS AT ALL LEVELS….

On a daily basis I am in contact with teachers seeking clarification around what maths concepts exist and in what form they exist in the F–10 and VCE curriculum.

MY JOURNEY…

My university studies were varied and included majors in neuroscience, astrophysics, mechanical and biomedical engineering across my undergrad years, with further postgraduate studies in educational leadership. I have taught science and mathematics at all secondary levels including the university extension program for mathematics, with mainstays of Mathematical Methods, Specialist Mathematics and Physics at the VCE level. I've held various leadership positions within schools, supporting teachers in their efforts to meet the needs of their students.

IF I COULD WAVE A MAGIC WAND…

I would reduce student anxiety around our subject. There is much richness and reward in the study of mathematics and for learning anxiety to present a prohibitive obstacle to student access to that richness and reward is a challenge that must be met by all involved in the teaching and learning of the subject. If I can cause the curriculum design and subsequent utilisation to be plain and transparent for teachers, this may help reduce teacher stress and crystallise what needs to be done in the classroom, which would optimise conditions for student wellbeing and student learning.

I'M ANDROID ALL THE WAY…

I have tried the main competitor, however, for me it's just Android.

A TYPICAL DAY STARTS WITH…

A cappuccino.

A SOLID GROUNDING IN MATHEMATICS IS APPLICABLE TO SO MANY CAREERS….

The emerging prevalence of mathematics within the workplace has long been recognised. Now, the benefits within any workplace for individuals whose school maths experience goes for longer and aims for the highest level of which the individual is capable are emerging. Historically subjects such as Mathematical Methods and Specialist Mathematics have been associated with engineering only. Now, the applicability of these concepts in finance and bioscience is gaining recognition. The development of problem-solving dispositions carries enormous value for potential employers, irrespective of which mathematics subjects students choose.

VICTORIA HAS A LEADING CURRICULUM….

Our curriculum is commensurate with other leading curricula internationally. It is deliberately not structured as a syllabus which works to reduce a 'box-ticking' approach, yet also facilitates a flexibility in learning that enables students to progress at a pace that optimises their own learning and is sufficiently specific. Where overlap of concepts occurs (for example, in calculus for Mathematical Methods and Specialist Maths), it does so in a complimentary and consolidating fashion. The inclusion of CAS, whilst still a source of debate and discourse, has opened access to mathematics for students who may otherwise have decided against enrolling. In a world that we are constantly informed is increasingly favouring citizens whose mathematics skills are higher, we have a framework for learning that meets the needs of Victorian students of all aptitudes and dispositions.

ON THE WEEKEND…..

My wife and I have two kids and two cats and like many parents, weekends are chock full of sport or competitions.

SPACE FASCINATES ME ….

I have long been fascinated with space. My first book was *Exploring space*. Early influences from *Star Wars*, *Dr Who* and space Lego evolved into the study of

astrophysics at university. The notions that the universe is expanding at a rate that would prohibit us from ever finding the boundaries, were that even possible, and that physical laws we have identified here on Earth, may be extrapolated through mathematics to predict the behaviour of the universe and gather evidence of how life came to be – noble and engaging pursuits!

GRIT IS VITAL FOR CAREER SUCCESS….

Behavioural scientist Angela Duckworth identified grit as a key characteristic that individuals possess that allows them to stay focused and push through obstacles to achieve goals. Applying this over time improves the individual's chances for success in their chosen pursuit. This is directly applicable to a mathematics classroom and to the school experience. Students come to a class with different levels of aptitude within the subject. While it certainly isn't the only parameter for success, having a goal to do better and be better at what you attempt, working both consistently and persistently towards it, and maintaining a clarity about the outcome you want is a vital ingredient for success.

ON A RAINY DAY ….

I love going for a walk. I live up in the hills – there is nothing more invigorating than walking bush trails in bracing conditions!

MY PILE OF BOOKS IS….

Mainly mathematical textbooks!

FLASH AND SHADOW…

Are our two adventurous cats.

BUILDING COMMUNITY

Claire Embregts - Community strategy manager, MAV

With exciting plans underway for MAV to create a community of practice for all Victorian mathematics educators, the MAV project team has been working with Southern Cross University to survey and collate data from Victorian mathematics educators. The research findings inform us on how best to design and implement an online community solution to support you - the maths educator and MAV member.

Through decades of research about professional communities, a key theme is the importance of community for creating a sense of belonging for their members (both to each other and their association).

Further, research holds true that community members grow their practice through purposeful behaviours and activities over time. 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 regularly interact (Etienne and Beverly Wenger-Trayner, 2015).

The MAV Board has been working on community building strategies under the 2021 to 2023 MAV Strategic Plan. During the past few years, much work has been done, and we have been looking at how best MAV can support educators through purposeful community engagement. The good news is that professional communities allow their members to grow, and we now have some exciting progress and strategies coming to life.

WHAT WE LEARNED

Time and distance are barriers: Distance and the related loss of time in attending traditional services and activities are significant obstacles for teachers in regional and remote areas. MAV must focus on reducing these barriers to increase educator participation in MAV activities to advance educator effectiveness, sense of belonging, and job satisfaction.

By further enhancing access to professional learning, offering more opportunities for online collaboration and networking, and providing resources to educators in a community, educators' sense of belonging to MAV can be improved.

Using social media to connect: We discovered that existing social media tools and solutions are insufficient to build real support and effective collaboration between educators.

Our research indicates that educators networked with other mathematics educators primarily within their school and only sometimes between schools across regions and the state. Educators sometimes use online conferencing tools, but only use social media to find resources and ideas, and not to build networks and share in purposeful ways. Educators indicated that they would like improved opportunities to interact with others across Victoria, including; sharing resources, networking to support them in their roles, and access to more professional learning.

Quality resources: Educators value being able to share resources with others within their education networks. Our research showed that it is essential to create a space for all mathematics educators to bring everyone together and create a sense of belonging for all, related to their needs, roles, and level of experience.

THE FUTURE

The next step is an online community. From the research undertaken, we now understand more about what will work to build better support for all educators.

A MAV-hosted online community will allow educators to share ideas and resources, raise issues, ask for help from MAV and others in the community, seek expert advice and support each other. Communities should be at the heart of what MAV does as an association for members and mathematics educators. Stay tuned for more news on this initiative!

REFERENCES

Introduction to Communities of Practice: A brief overview of the concept and its uses https://wenger-trayner.com/introduction-to-communities-of-practice/

We'd love to hear how a mathematics educator community could help you. Email your ideas to Claire Embregts, cembregts@mav.vic.edu.au.

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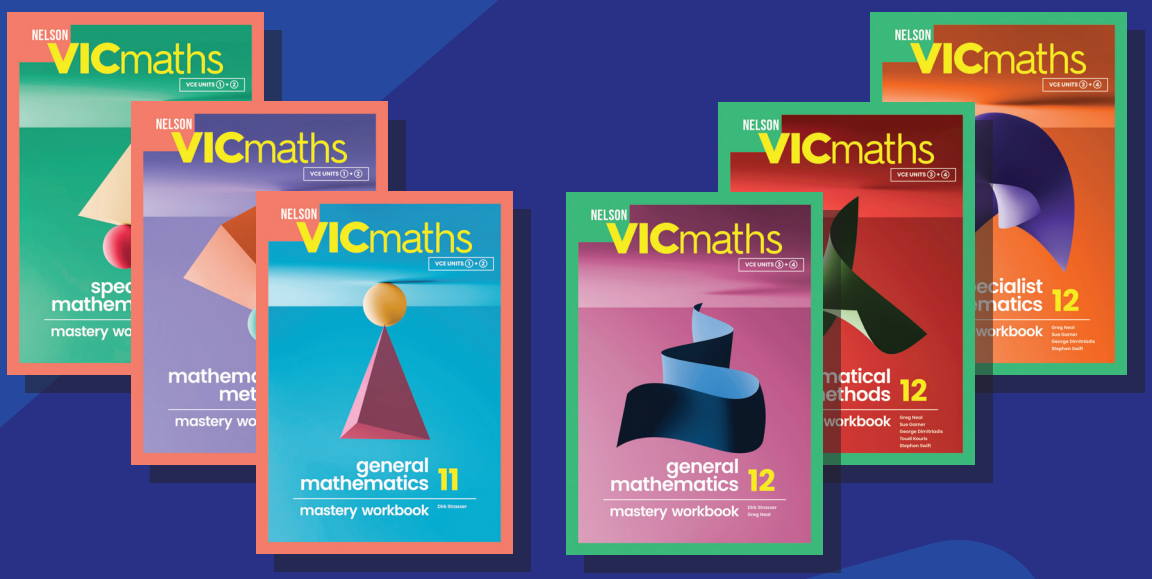

Workbooks contain write-in matched examples that pair with each of the worked examples in the student book.

To request page proofs, hear from the authors, and learn more please visit **cengage.com.au/vce-maths**

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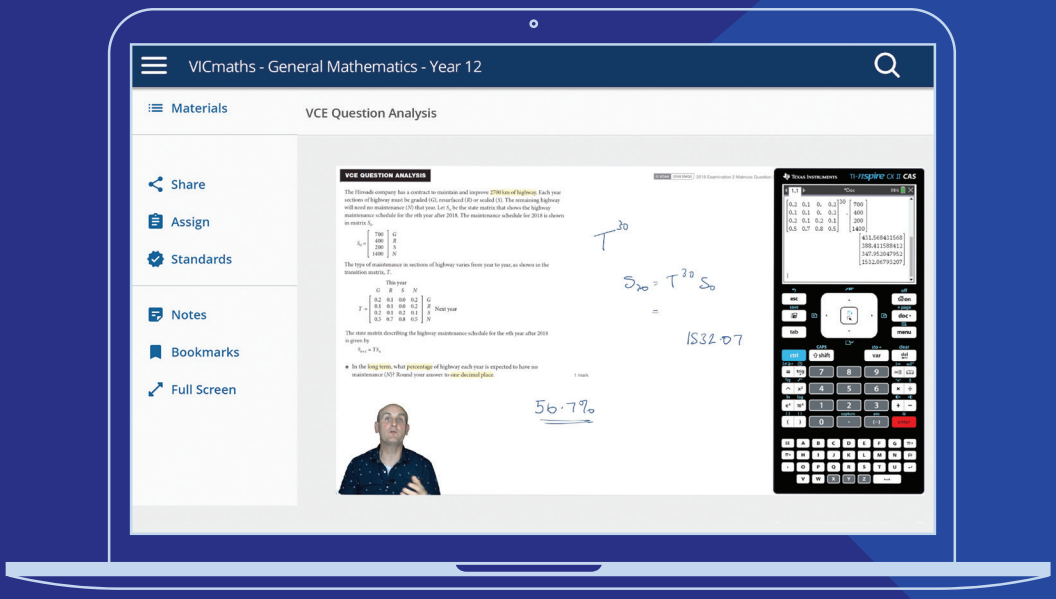

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ANALYSING CENSUS DATA

Andrew Stewart

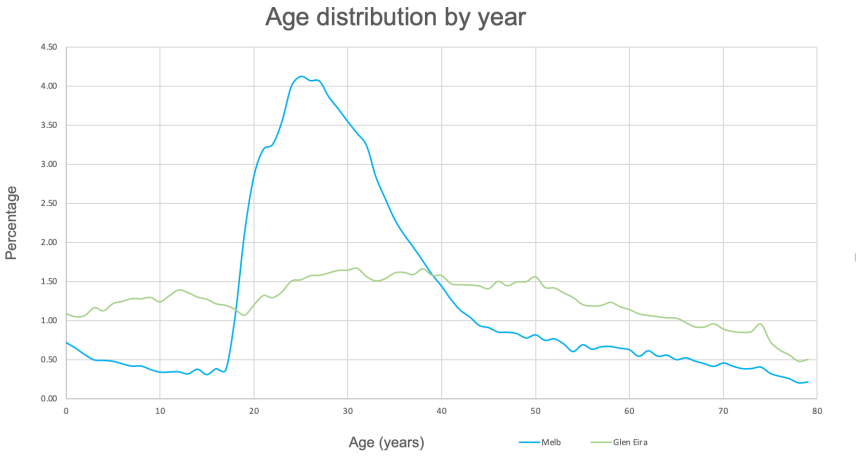
The Australian Bureau of Statistics (ABS) is now releasing data from the 2021 Census. This data is a rich information resource for classroom use in a variety of data investigations. Real world applications such as using population figures in particular locations to see where schools or other services, may, or may not, be required show how mathematics can be used in real world scenarios.

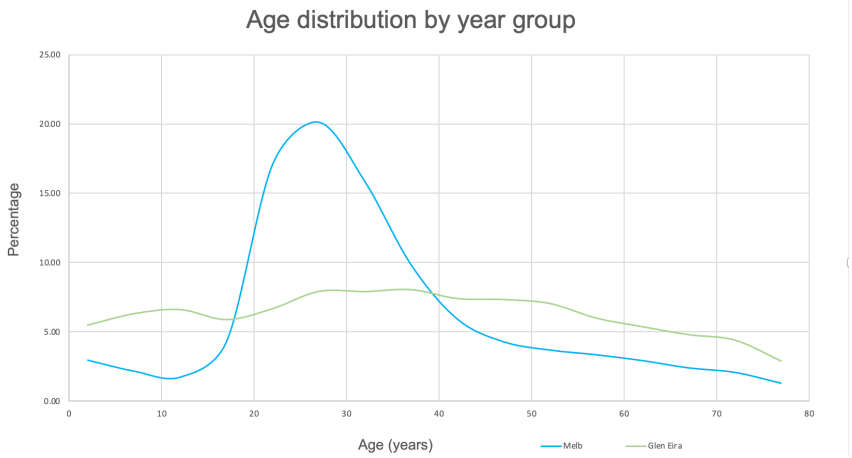
In this article I will compare data from one response between locations. The best way to analyse the Census data is using a spreadsheet, since the most accessible data from the Census is downloaded in this format. First, a few words about the special file that I recommended you download (see instructions on page 19.) This essential file identifies the source (location) of the coded files downloaded from the Census website.

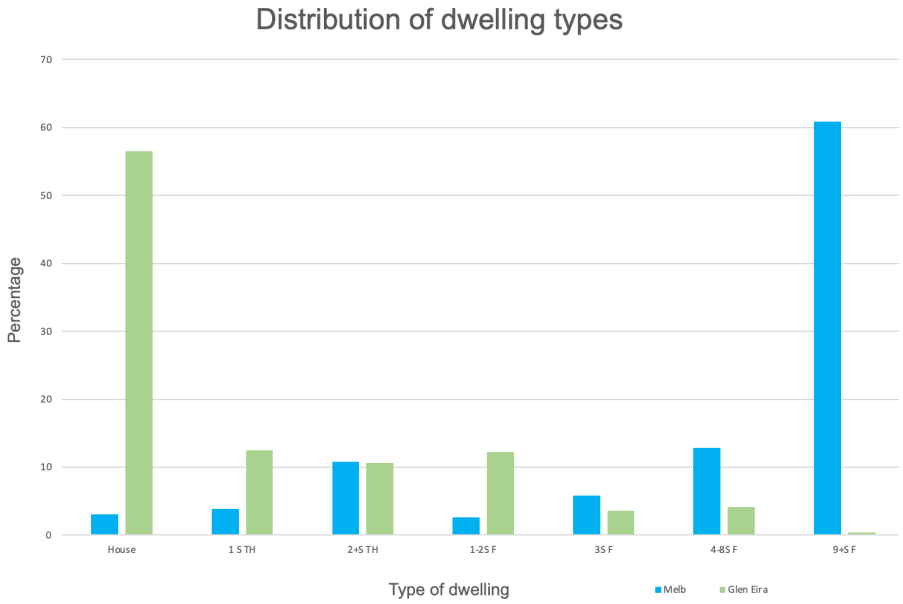
If you open the 2021Census_geog_desc_1st_release.xlsx file and click on the sheet labelled 2021_ASGS_Non_ABS_Structures (the fourth one), you will see a list of labels which starts with CED (for Commonwealth Electorates) and proceeds via SED (for State Electorates), LGA (for Local Governments), POA (for Post Office Areas based on Postcodes) and finishes eventually with SAL (for Suburbs and Localities). Each of these groups is in state order (NSW, Vic, Qld, ...). These are the key location types for which data is available.

If, for example, you have downloaded GCP_LGA24600.xlsx, this file will identify the data as belonging to the Melbourne City Council area. When you open one of these downloaded GCP files (each one is just over 700 KB) you will find about 40 sheets with data. Be prepared to enlarge a sheet as required, given the text size is 8-point Arial!! The data can be copied from the spreadsheet to another document. All these GCP files are identical in structure – the only things that are different are the numerical values for the data recorded.

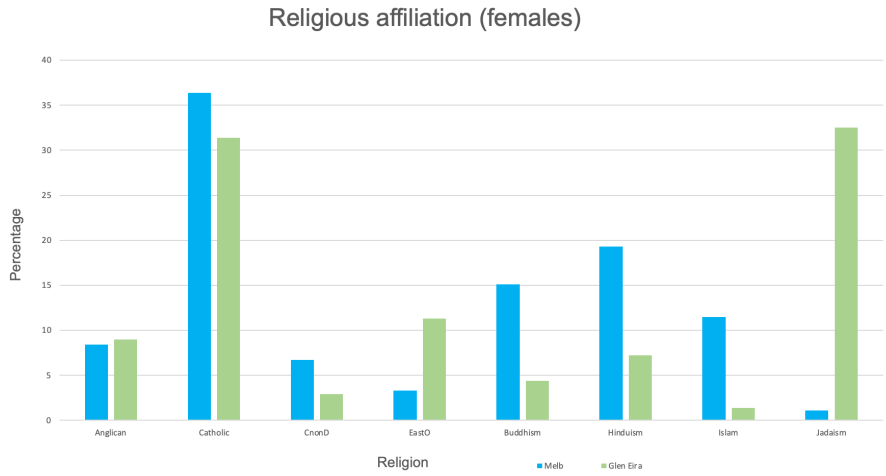
I downloaded the spreadsheets for every Local Government Area (LGA) in Victoria (all 79 of them!) and constructed a table of key measures (details of this process in the next article). I used this table to select the LGAs of Melbourne and Glen Eira for a comparative analysis of the population age distribution from 0 to 79 years of age. These two LGAs have similar populations, areas and population densities (149 000, 39 square kilometres, 4000 people per square kilometre, respectively), but their median ages differ, being 30 for Melbourne and 38 for Glen Eira.







From their respective GCP spreadsheets, the age distribution data from sheet G04 was copied and pasted into a new spreadsheet. This data was then separated into two lists – one containing the individual year age data and the other containing the summative data every five years. For the total population up to 79 years (because



all data above this age is grouped into five-year groups), the percentages of the total number of people at each age or in each age group were calculated. The comparative graphs for both LGAs are shown as X–Y plots with lines only on page 18 with the individual year data on top.

There is a considerable difference in the age distribution between these two LGAs. Melbourne has a large population of individuals in the 18 – 40 age years (or groups), with the biggest increase occurring with 18 – 20 year olds (see top graph on page 18). Glen Eira has a relatively consistent distribution across all ages.

A similar approach was used to look at the types of dwellings in each of these two LGAs. A limited selection of data was copied from sheet G36 for both LGAs, and the percentage distribution of the selected dwellings is shown in the bottom graph on page 18 . TH represents townhouses, F represents flats or apartments and the numbers represent the number of storeys in the dwellings.

Glen Eira is a typical suburb with about 58% of people living in separate houses, whereas in Melbourne nearly 61% of people live in nine storey (or higher) apartment blocks. These analyses can be taken a step further, as a lot of Census sheets have data separated by gender.

The graph above shows a comparison of the religious affiliation by females for the Melbourne and Glen Eira LGAs. The eight religions chosen were Anglican, Catholic, Christian (non-denominational), Eastern Orthodox, Buddhism, Hinduism, Islam and Judaism. The data was selectively taken from sheet G14, as there are up to 19 different Christian faiths for which data has been collected. The presence of large numbers of international students may account for the strong representation of three of the non-Christian faiths in Melbourne, but it also interesting to note the strong Catholic presence. By contrast, Glen Eira clearly has a large Jewish and Catholic population.

These kinds of comparisons in which we are comparing data from one sheet between different locations could be extended to compare metropolitan and rural LGAs or rural LGAs with different farming situations. Any of the other geographical divisions (Commonwealth or State electorates, Post Office areas or Suburbs and Localities) could be used in similar activities. The presence of gender-related data could be used for a gender comparison within one location, or between locations.

Giving students copies of the data sheets in order to process the data for graphing or tabulating would be a real challenge for many students. Students in earlier school years may need to be given processed data as they learn about graph or table preparation. However, it would emphasise how important background research is in making key decisions.

In the next edition, Andrew will show how to build a large table to compare the same data from a large number of locations.

ACCESSING CENSUS DATA

Accessing and downloading data from the Census website is quite straightforward. When data is downloaded from the ABS Census site, it is labelled with a code. A special support file will help identify the location of any downloaded file.

Download the special support file

1. Go to www.abs.gov.au/census
2. Click on the window labelled *Find Census data*.
3. Click on the window labelled *Census data tools*.
4. Click on the window labelled *DataPacks*. On the right of the window is a list of General Community Profiles, starting with Australia and then listing states and territories. Click to download on the top one, and save it to a folder labelled Important (or similar).
5. In the Important folder, double click on the .zip file to unpack it. The special support file is in the Metadata folder and is labelled 2021Census_geog_desc_1st_release.xlsx.
6. Move this file out into the Important folder, and delete all the rest of the download (and .zip file). This file is essential to identifying downloaded material.

Download Census data

1. Click the back arrow repeatedly to return to the *Find Census Data* page.
2. Click on *Search Census data*. On the left is a window with your options. Depending on the data you want, it may be easier to use one of the specific tools rather than the general Area tool at the top. These will list all the choices, say, for LGA's in Victoria.
3. Click or type your file choice. The map alongside shows your choice's location.
4. Under the map in *Search Results*, click on the Community Profiles button and a spreadsheet file will be downloaded to your computer. Keep all files with the same descriptor (for example, LGAs) together in the same folder.
5. Select and download another file.

THE HIDDEN CURRICULUM

Michael Nelson - Learning specialist, Drysdale Primary School

Multiplication has always been a difficult concept for many students to master, regardless of whether a rote memorisation approach, or a conceptual strategy based approach, is applied.

The strategy based approach leads towards a flexible understanding of how numbers can be composed and decomposed. However, there is still some resistance to adopting this approach. Putting aside the tradition of mathematics teaching and times tables, a common complaint to this author by teachers is that the approach simply doesn't work, especially with their lower-performing students. Teachers state that their students can recite the strategy but not perform it.

This article focuses on two reasons for their struggle with grasping the strategies based approach, looking at work done with students in Years 3 and 4 where multiplication became a significant focus. What became clear during my work with teachers and students, was that the student's struggles could be found in what this author terms *The Hidden Curriculum*. That is, relationships, connections and requirements for learning concepts that are not expressly found in the curriculum, but research says are crucial for understanding for students.

Working with the students, within their normal classroom setting rather than an intervention-type setting, the reasons for the students' struggle became quickly apparent. The first problem that most students presented with was a lack of ability to effectively use visual diagrams: arrays and area models.

ARRAYS AND AREA MODELS

Students were given a task of making 4 groups of 3 counters in any way they wanted. All choose to make 4 separate groups of 3, as shown in Figure 1.

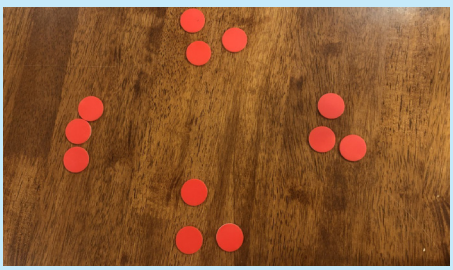


Figure 1.

I then made a 4 x 3 array and a 3 x 4 array, shown in Figure 2. The students were asked 'Is what you made the same as I made?' All students answered no, unsurprisingly, as visually they were different. They were then asked 'Is there anything similar?' to which they replied they all are 12. They were asked 'If they all show 12, does either of mine show 4 groups of 3 like yours does?' The students said that one of the arrays did and one didn't. The response showed no understanding of what an array actually showed and how to read it.

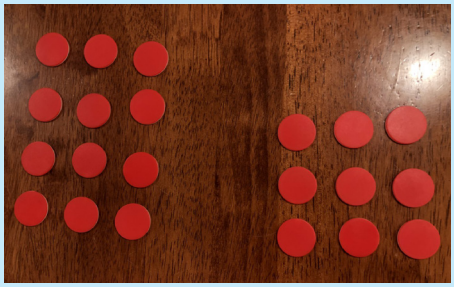


Figure 2.

Students need a deep understanding of what arrays are. Most students are more than comfortable with the following aspects:

- Identifying the number of groups
- Identifying the number in each group
- Identifying the total altogether

However, to be completely flexible with numbers, students need to also be able to:

- Understand the turnaround concept (commutative property)
- Being able to read partial arrays

These two concepts are some of the key building blocks of learning the multiplication strategies. Without understanding the fact that arrays can be turned around, students are required to learn 100 different facts.

Looking at the chart in Figure 3 shows how powerful the turn around concept is. Traditionally, students struggle the most with the higher numbers: 6, 7, 8 and 9. By using turnaround facts, once students get to these strategies there is a limited number of multiplication facts to learn.

Another problem that has been raised with this author is how to deal with the larger numbers, such as 6 and 8. The smaller strategies can be shown using counters, such as the 2's and 3's. But as the answers grow larger, it becomes too cumbersome to create arrays with counters. Students could potentially draw the arrays, but it this can also become time-consuming. Another potential problem is that often when drawing arrays, students don't see how the array breaks down into the components for the strategy. For example, when drawing arrays for the 3's, students often couldn't identify the 2 groups and the 1 more group that made up the strategy.

A solution to this problem is using pre-created arrays. This idea derives from Dr Paul Swan in his webinar on multiplication and division. These are simple to make, as the ones in Figure 4 (see page 21) are drawn on grid paper that was blown up. Whilst I have primarily used them with the higher numbers, they can be used for any strategy. With these array parts, students physically put the strategy together. In Figures 4-6, students were exploring the eights strategy of double-double-double. The array cards allowed the students to see the first double (double 8 is 16) (Figure 4), then they put the second double together (double 16 is 32) (Figure 5). Finally, they could see that there were two groups of 32 that made 64 (Figure 6).

	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9	10
2	0	2	4	6	8	10	12	14	16	18	20
3	0	3	6	9	12	15	18	21	24	27	30
4	0	4	8	12	16	20	24	28	32	36	40
5	0	5	10	15	20	25	30	35	40	45	50
6	0	6	12	18	24	30	36	42	48	54	60
7	0	7	14	21	28	35	42	49	56	63	70
8	0	8	18	24	32	40	48	56	64	72	80
9	0	9	20	27	36	45	54	63	72	81	90
10	0	10	22	30	40	50	60	70	80	90	100

Figure 3.

This approach allowed students to visually see the strategy they were working on, rather than simply trying to recite a series of steps.

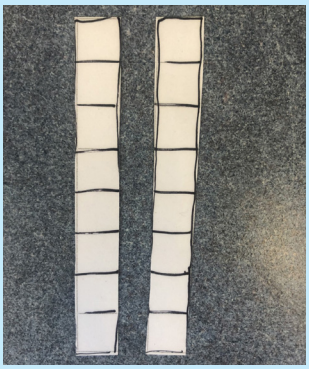


Figure 4.

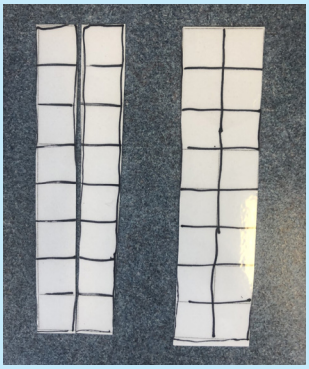


Figure 5.

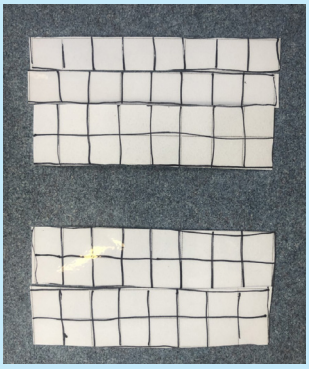


Figure 6.

ADDITION SKILLS

The second hindrance to an understanding of multiplication strategies for these students lay in their basic addition knowledge. The students could only make the link between multiplication and addition as repeated addition, not that they could use previously learnt addition strategies to add in multiplication.

To successfully use the strategies, three skills are required: doubling, partitioning and making to 10.

With doubling and making to 10, these skills are required to be extended to numbers to 100. The problem was, this is not expressly stated within the multiplication component of the curriculum, with the progression moving from recognising and representing multiplication as repeated addition, groups and arrays in Year 2 to recalling multiplication facts and using efficient mental and written strategies in Year 3. The link between the extended addition strategies and multiplication is not made clear.

The students could successfully recall the facts of 2, 10 and 1 but had no efficient strategies beyond skip counting for the others. But looking more deeply at the students, this was because they lacked the ability to use addition to 100, a vital skill needed for all the strategies.

When working with the 3s, these particular students could remember that for 3 x 7, they needed to double 7 and add one more group. They could double to 14, but then proceeded to count from 14 to 21 by ones, rather than use the efficient approach of partitioning one of the numbers to make the problem easier. This would involve identifying 6 more is needed to get to 20 and then add one more to get to 21. This ability to partition and use the make to 10 strategy is present in the 3s, 5s, and 6s and to an extent 9s, which requires subtraction as well.

A small diagnostic assessment task was then conducted with the students, in which a playing card was turned over and the students had to double that number until the answer would be more than a hundred, for example turning over a 7 and doubling to 14, doubling 14 to get 28, doubling 28 to 56 then stopping because doubling 56 would be more than 100.

The assessment revealed that students were lacking confidence doubling beyond 20 and in particular when doubling more than once, as required by the 4s and 8s in particular. So a lack of confidence and skill in using the addition strategies to 100 prevented them from moving beyond the 2's without skip counting.

The individual learning plan then became to focus on doubling, partitioning and making to 10 to 100, with small daily activities used as warm ups. After an extended period of time, the students had confidence in all strategies and could recall multiplication facts of 10 x 10 with ease.

What became clear from working with the students and teachers was the concept of the hidden curriculum. Teachers need to be given the skills to see how content in the curriculum is connected and what the prerequisites are for learning particular content.

Teachers need to be comfortable in seeing mathematics as being as series of connected ideas that build upon themselves. Once they are comfortable with this, they need to develop their instructional teaching in a way so that the students also see and develop these relationships.

FALSE DICHOTOMY IN MATHS

Peter Saffin - CEO, MAV

IT'S TIME TO DO AWAY WITH THE FALSE DICHOTOMY IN MATHS INSTRUCTION

The proposed revisions to the Australian Curriculum: Mathematics have sparked lively public debate comparing explicit instruction and inquiry approaches.

Some politicians and commentators are driving a false dichotomy – in fact, what works best for students is sensible and balanced use of a range of teaching strategies.

Explicit teaching on its own is basically how education worked in the '60s. Sadly, this model of teaching mathematics persists, particularly in some secondary schools.

Of course, explicit teaching has its place, such as when students need a concept unpacked and explained. Practising and working towards mastery of skills and processes is important, but together with other approaches to mathematics instruction.

Traditional approaches prepare students to copy procedures, but this generates only superficial understanding and students who can't wait to drop the study of mathematics.

We need our students to be able to do mathematics, and value it. They need to understand why it's important, as they require it for success in everyday life. The decline of students taking senior maths subjects is related to students feeling that maths is disconnected from their lived experience, and that mastery is required to succeed.

Traditional approaches can create pass or fail situations (think 'tick' or 'cross') that put students under stress. Many get left behind and disengaged when approaches expect everyone to be an expert, or they feel they can't succeed.

Good teachers mix approaches; inquiry-based learning supported by explicit instruction. Teachers select the best approach for their students at their point of need – and in a typical mixed ability classroom, not all students need the same explicit instruction at the same time.

Well planned, scaffolded inquiry-based approaches alongside explicit instruction can be effective in teaching conceptual understanding. Such approaches also create opportunities to highlight the usefulness of mathematics, by helping them understand the how and why.

An inquiry-based approach will allow students to identify and explore mathematics in various contexts, and use a variety of strategies allowing students to explore concepts, test ideas, discuss and teach each other, develop understanding, while increasing engagement and enjoyment.

In this approach, less information has to be memorised, and outcomes can include students that are better able to apply their knowledge flexibly when faced with new situations. Student stress levels are lowered, engagement is increased, understanding is deeper.

As an example, the teaching of times tables has been a hot topic. Explicit instruction would use military style drills and rote learning that emphasises speed and competition between learners, which is known to contribute to student anxiety and disengagement.

There is an expectation that you must 'know' and 'master' the times table. Inquiry-based approaches or teaching that develops deep thinking will explore multiplication strategies, and allow students to progress with a deeper understanding of multiplication and using times tables that can underpin success with higher level maths.

One recent media article stated that inquiry-based learning means 'holding back' information from students. This indicates that inquiry is reducing students' opportunity to learn, which is not correct. Inquiry-based learning holds nothing back, everything is open to explore.

Students develop knowledge with well scaffolded activities and teacher support (that may include explicit teaching) and develop a deeper understanding of maths, as they have increased agency over their learning.

Inquiry-based approaches also develop proficiencies including problem solving, and critical and creative thinking as students

learn to identify and apply mathematics in the real world, using a range of strategies.

Australia produces graduates who are good at problem solving, collaboration and communication. We need to value these attributes alongside mathematical knowledge.

The draft curriculum should be approved, but then evolve as further evidence comes to light including feedback from teachers. When it comes to implementation, the professional knowledge and expertise of teachers to ensure that the curriculum is enacted in ways that resonate with student learning needs and interests must be valued.

We need to continue to strengthen teachers' ability to interpret and deliver the curriculum through ongoing professional learning.

And for the significant problem of out of field teachers in mathematics classrooms, we must supply access to quality professional learning and mentoring to continually improve teachers' knowledge of the mathematics curriculum and how to teach it well.

This article was originally published in the March issue of *Australian Teacher Magazine*. Read the original article at edhq.co/36C39T1.

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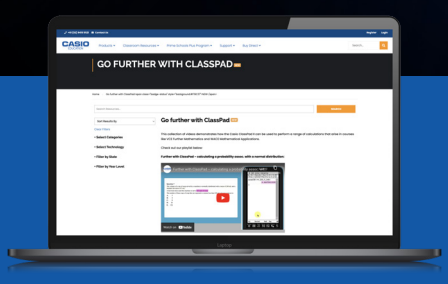

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BUBBLE BOARD - ADDITION AND MULTIPLICATION

K-5

Learn addition facts to twenty with the durable 'pop and learn' addition board. Addends one to ten are represented on the vertical and horizontal axes with the correct sum presented in the corresponding bubble. '

The multiplication board helps students to learn multiplication facts. Factors 1 to 10 are represented on both the vertical and horizontal axes with the correct product presented in the corresponding bubble. Pop bubbles as you practice and solve the equation. Bubbles on the reserve side are blank and can be used for creating visual addition, or multiplication array examples.

An activity sheet is included with each purchase of a bubble board.

$40 EACH (MEMBER)
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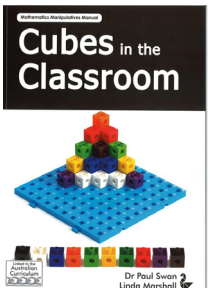

CUBES IN THE CLASSROOM

1-6

Linking or connecting cubes may be used for early years construction, particular with the addition of extra piece such double cubes, joiners and half cubes.

2cm linking cubes may then be used later in the school to introduce number ideas, algebraic thinking, measurement ideas such as volume and spatial ideas involving viewing cube constructions from different angles. This book by Dr Paul Swan will help teachers gain the most from the existing 1cm and 2cm cubes found in most storerooms and get the cubes into classrooms.

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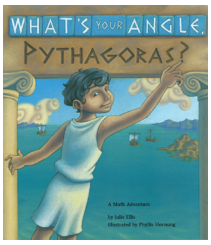

WHAT'S THE ANGLE PYTHAGORAS?

5-9

On a trip to Egypt, Pythagoras' curiosity helps him discover the secret of the right triangle. A clever introduction to the Pythagorean Theorem.

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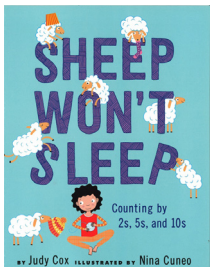

SHEEP WON'T SLEEP

3-7

Counting sheep is supposed to help you sleep — but a room full of yaks, alpacas, and llamas would keep anyone awake. A glass of warm milk, reading, working on her knitting—nothing can help Clarissa get to sleep. When even counting sheep doesn't help her doze off, she tried pairs of alpacas instead. Two, four, six . . . then llamas by fives . . . then yaks by tens!
Determined to unravel her problem, Clarissa counts back down until she's all alone, and she can finally get some rest.
Introducing addition and subtraction by ones, twos, fives, and tens. A perfect way to introduce and reinforce counting in groups.

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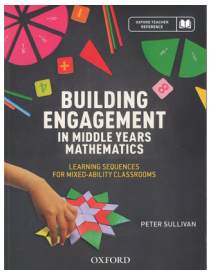

BUILDING ENGAGEMENT IN MIDDLE YEARS MATHEMATICS

4-10

Building Engagement in Middle Years Mathematics provides teachers with a range of original learning sequences focused on the mainstream content of the Australian Curriculum.

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