THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 3/17

BIG IDEAS IN MATHEMATICS

INSIDE

MAKING CONNECTIONS IN MATHEMATICS

Making connections between different ideas in mathematics is a feature of a highly efficient maths teachers (Askew, M. 2008). What does this mean? How can teachers use this information to assist planning? How will making connections support students to learn? In this article the notion of 'Big Idea' thinking is explored, along with practical ways teachers can use these approaches in their planning to enhance student learning.

The Australian Curriculum is a natural place to start, it states 'Mathematics is composed of multiple but interrelated and interdependent concepts and systems which students apply beyond the mathematics classroom'. The intent is to maintain attention on 'developing increasingly sophisticated and refined mathematical understanding, fluency, reasoning,

Continued on page 5

THE COMMON DENOMINATOR
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FROM THE PRESIDENT

Michaela Epstein

Mathematics is a bit like hiking. The esteemed mathematician, Professor Sylvia Serfaty recently brought these two excellent things together when she said: 'You enjoy solving a problem if you have difficulty solving it. The fun is in the struggle with a problem that resists. It's the same kind of pleasure as with hiking: You hike uphill and it's tough and you sweat, and at the end of the day the reward is the beautiful view.' So more than just its practical benefits, there is a deep good that comes from doing mathematics. Solving mathematical problems is hard work, and it challenges us to the point of frustration. Yet through this challenge, mathematics provides a perspective and way of seeing the world that would never otherwise be possible.

Imagine if problem solving was like relying on your GPS to get somewhere, where each step you are told what to do next. 'At the next line, take all terms with x to the other side. Now, divide by five. You have arrived at your destination.' Nope. Why would we bother with mathematics if it was that mundanely easy? It's hard and mathematicians knowingly struggle. Serfaty took nearly 18 years to solve one problem.

Without a doubt, a devotion to mathematics of Serfaty's kind comes from years of dedicated practice and commitment, and is embedded by a strong sense of curiosity. What I've always found wonderful about mathematics, is that these same attitudes towards it are possible for students, and they are important. There's a reason that the proficiency strands of fluency, understanding, reasoning and problem solving underpin students' learning in mathematics from Foundation up until the end of Year 10. From an early age, the brain can be engaged in different ways with students exposed to new forms of thinking about increasingly complex mathematical ideas.

Carefully crafting the right learning experiences for students so that they access these layers of the curriculum is no easy task. The MAV supports this vital work in three ways. Firstly, through professional learning opportunities. Whether it is the Primary or MAV17 Conferences, support from the MAV education consultants, webinars or other events, there is something for you, wherever you are in Victoria. Secondly, the MAV runs events specifically for students, including the Maths Talent Quest, Student Games Days, and Maths Camp for regional students. These are aimed at encouraging students to stretch their mind and see where their mathematical skills can take them. Finally, at the heart of all these events and services, are the connections and conversations that take place across the teacher community. It is the strength of our connections that governs the scale of our impact.

I encourage you – and your students – to make the most of these opportunities with the MAV!

REFERENCES

www.quantamagazine.org/20170221-mathematical-truth-sylvia-serfaty-interview

NEW MAV COUNCIL

Welcome to the incoming MAV Council.

President:
Michaela Epstein (Maths Pathway)

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For more information on your councillors, visit www.mav.vic.edu.au/about-us/mav-council.html.

PROFESSIONAL DEVELOPMENT

During Term 3 2017 a variety of presenters and MAV's own mathematics educational consultants will present workshops focussing on innovative teaching practice.
Make sure you reserve a place by booking online early, www.mav.vic.edu.au/pd.

TOPIC	DATE	YEARS	PRESENTER
Worded questions, problem solving, engaging games and your maths program	22/7/17	F-6	Dr Paul Swan
Enhancing the use of CAS in Mathematical Methods (TI CAS calculator)	26/7/17	VCE	Ray Rozen
Hands-on masterclass: real world problem solving	31/7/17	5-10 and VCAL	Craig Becker
Enhancing the use of CAS in Mathematical Methods (CASIO calculator)	3/8/17	VCE	Sue Garner
Number and algebra: problem solving for the mixed ability classroom	10/8/17	7-9	Ann Kilpatrick
Lessons and tasks that encourage mathematical inquiry - the reSolve project	15/8/17	F-6	Nadia Walker
A growth mindset in mathematics learning and teaching	16/8/17	F-6	Carmel Godfrey
Mathematics assessment interview online: implicatins for learning and teaching	7/9/17	F-6	Carmel Godfrey

YEAR 7-10

The MAV has appointed a Mathematics Education Consultant, Ann Kilpatrick, to focus on mathematics excellence in secondary year levels.

Ann has a strong background in mathematics education – both in teaching and also writing resources. Ann has taught in all sectors, government, catholic and independent and has covered single sex and co-educational settings. She has been a passionate and committed teacher of mathematics and has always tried to raise the profile of mathematics within the schools she has been involved with.

'I am thrilled to be at the MAV and to support my fellow teachers of mathematics and represent the MAV which I have a strong belief in. I am privileged to have an opportunity to meet many wonderful practitioners, who are like-minded in their purpose as mathematics educators.'

A major focus for the MAV is the Strategic Partnerships Program funded by the Department of Education and Training. Part of this funding goes to our Safety Net program.

Ann is working with schools in rural and regional areas of Victoria and looking at ways to enhance the engagement of students in the learning of mathematics and to make the learning more student -centred, positive and productive.

If your school is in the Benalla, Cobram, Echuca, Shepparton and Mildura regions and would be interested in more information regarding this fully funded opportunity, contact Ann Kilpatrick, akilpatrick@mav.vic.edu.au or phone 0423 189 240.

MATHS ACTIVE SCHOOLS

DEVELOPING A MEANINGFUL MATHEMATICS PROGRAM

Teachers from MAV's Mathematics Active Schools can attend a free professional development workshop with Dr Paul Swan at Fintona Girls' School on 25 July 2017.

Dr Swan will equip you with the knowledge and skills to develop a meaningful maths program within your teaching context. During this hands-on workshop, you will be equipped with games, activities, planning documents, examples of materials and assessment techniques.

The workshop will focus on:

- worded questions, their presence in national testing
- understanding and application of the mathematics involved
- broadening the problem solving process so that it becomes a natural part of the lesson
- mathematics behind engaging games and links to the Australian Curriculum
- developing fluency by linking the proficiencies.

If you are a teacher at one of MAV's Mathematics Active Schools and would like to attend, email jdiamond@mav.vic.edu.au.

For more information on becoming a Mathematics Active School, visit www.mav.vic.edu.au.

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BIG IDEAS IN MATHEMATICS (CONT FROM PAGE 1.)

Ellen Corovic - Mathematics Education Consultant, Mathematical Association of Victoria

and problem-solving skills'. The proficiencies can serve as an organising principle that promotes a connected view of the curriculum strands (www.australiancurriculum.edu.au/mathematics/rationale).

Despite this intention to have a curriculum full of connections, it is often thought of in terms of a list of curriculum dot points (Askew, 2008). These dots points are often ticked off as they are taught throughout the year, frequently with little joining of the dots to create a bigger mathematical picture. Research (Tout, et al 2015) indicates that students learn best when they make connections with ideas and transfer these ideas into long term memory. It's due to this notion that keeping the 'Big Ideas' in mind is now – more than ever – fundamental to mathematics teachers.

There are two frameworks for viewing the 'Big Ideas' in mathematics: the top down and bottom up approaches. Both frameworks provide an opportunity for teachers to turn the list of curriculum dot points into a meaningful sequence of ideas that provide students with an opportunity to develop at first surface level knowledge, but then move on to deep and transferable knowledge.

TOP DOWN APPROACH: START FROM THE REAL WORLD AND LINK IT TO THE CURRICULUM

Think of an object, issue or theme using real world examples or perspectives. Grab a whiteboard or some butchers paper and brainstorm all the mathematics involved. Link ideas that are related and think of all the possible connections. This is a great task to do as a part of a team. Once the brainstorm is complete, narrow down the focus. Select the strongest mathematical needs and design the learning sequence based on these. Keep in mind the other aspects and at various stages touch on them, but remember that the focus is to move beyond surface level knowledge. Lastly plan what resources will be required and how you plan to assess.

For example, the image on page 7 indicates a brainstorm on of the mathematical ideas involved in the question 'How to build a playground?' The team created the brainstorm thinking of as many maths aspects as possible. The teachers then selected the key mathematical focuses that would drive the learning sequence. Using the example of how to build a playground, a team of teachers decided to focus on:

- money and financial arithmetic
- using metric measures to establish and calculate linear, cubic and square shapes, and
- reading, drawing and interpreting maps.

It is important to consider the assumptions you make about your students' skills and knowledge. For this unit, teachers had assumed some prior knowledge due to preceding learning:

- students can read, create and interpret survey data,
- students understand the metric system (mm, cm and m), and
- students can name and describe 2D and 3D shapes.

BIG IDEAS IN MATHEMATICS (CONT.)

There are several planning models that can be used to aid teachers along with this approach for example the model (right).

BOTTOM UP APPROACH: START FROM THE CURRICULUM AND FIND THE CONNECTIONS

To work with the bottom up approach, start with the curriculum. The Victorian curriculum's Scope and Sequence documents are a great staring point. The documents can be found at http://victoriancurriculum.vcaa.vic.edu.au/mathematics/introduction/scope-and-sequence.

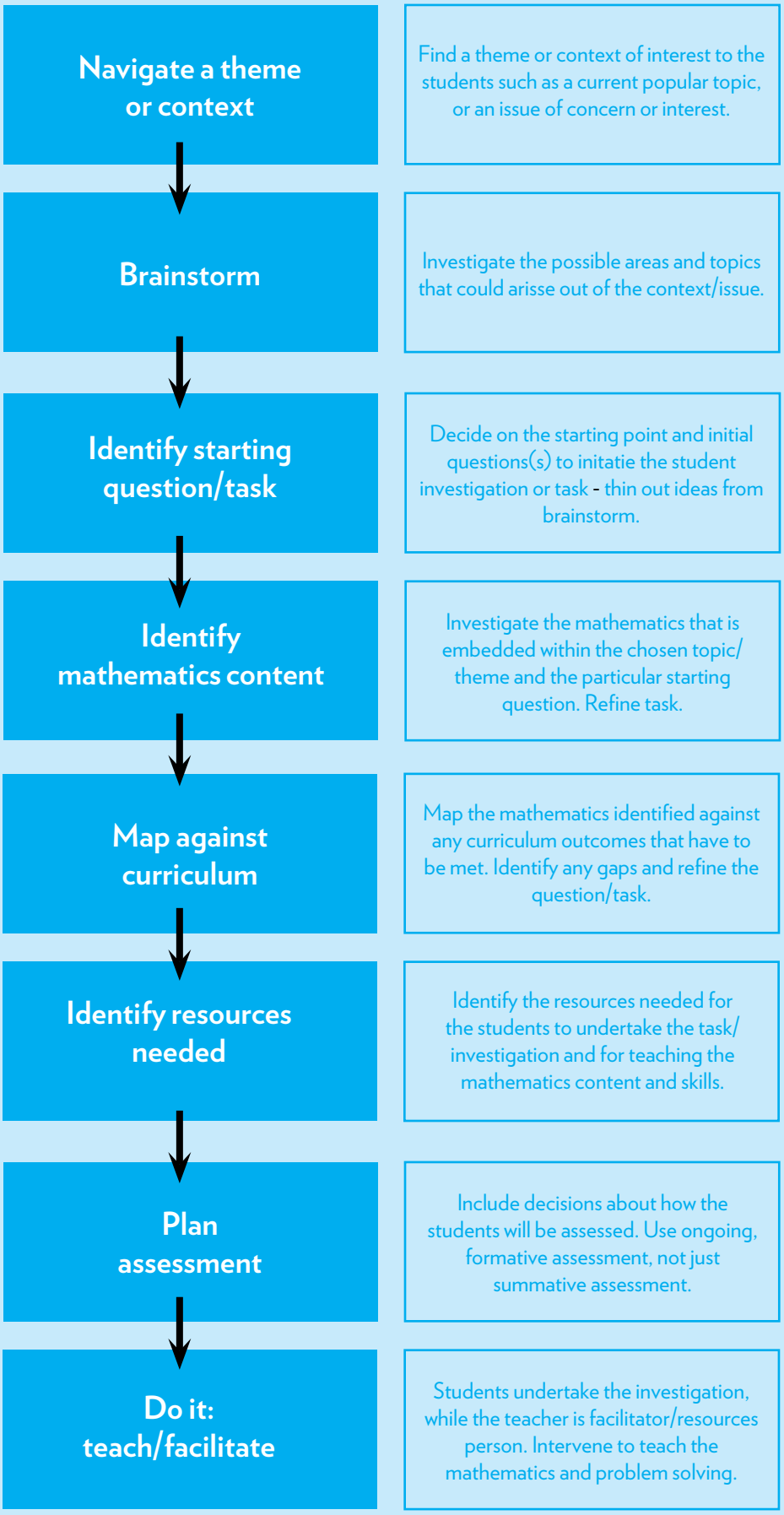
Print off the scope and sequence charts on A3 paper, grab some highlighters and your teaching team. For this exercise, look at the curriculum across content strands and identify 'clusters of math understandings, ideas that seemed to be connected to something bigger (Charles 2005)'.

Find common themes (for example pattern, equivalence, multiplicative thinking, comparisons) and highlight these ideas across the content strands. Using this method is a way to make connections between the dot points. Below are some brief snippets related to the big idea of 'order and compare' in the Victorian Curriculum.

- Number and Algebra Level 4: Recognise, represent and order numbers to at least tens of thousands
- Measurement and Geometry Level 4: Use scaled instruments to measure and compare lengths, masses, capacities and temperatures
- Measurement and Geometry Level 5: Compare 12 and 24 hour time systems and convert between them
- Statistics and Probability Level 4: Describe possible everyday events and order their chances of occurring
- Statistics and Probability Level 6: Compare observed frequencies across experiments with expected frequencies

(Tout, & Spithill. 2017)

There are so many ways to make connections, so play around and have a go. Create big ideas that make sense to you and your teaching. In saying that, it is advisable to stick to a handful of big ideas as overarching themes that assist students and



Brainstorm in practice: identifying maths content for the Big Idea of building a playground.

teachers to make sense of the curriculum. Further, if you get your whole team, or even school on board, the big ideas will be expressed in common language and familiar representations that will be easily transferred and understood by students from year to year.

SUMMARY

'The concept of Big Ideas is powerful because is assists teachers in developing a coherent overview of mathematics' (Tout, et al).'

When it comes to planning your next unit think about how you could create lasting connections for your students through thinking and planning around the big ideas.

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Askew, M. (2008). Mathematical discipline knowledge requirements for prospective primary teachers, and the structure and teaching approaches of programs designed to develop that knowledge. In P. Sullivan & T. Woods (Eds.), *Knowledge and beliefs in mathematics teaching and teaching development*, (pp. 13-35). Retrieved from www.sensepublishers.CcomCOEllmedia/1079-the-handbook-of-mathematics-teacher-education-volume-1.pdf#page=22

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The MAV's Mathematics Education Consultants can deliver Big Idea PD at your school. For more information, contact Ellen Corovic, ecorovic@mav.vic.edu.au.

REMEMBERING MALCOLM SWAN

Damian Howison - St Mary MacKillop College, Swan Hill

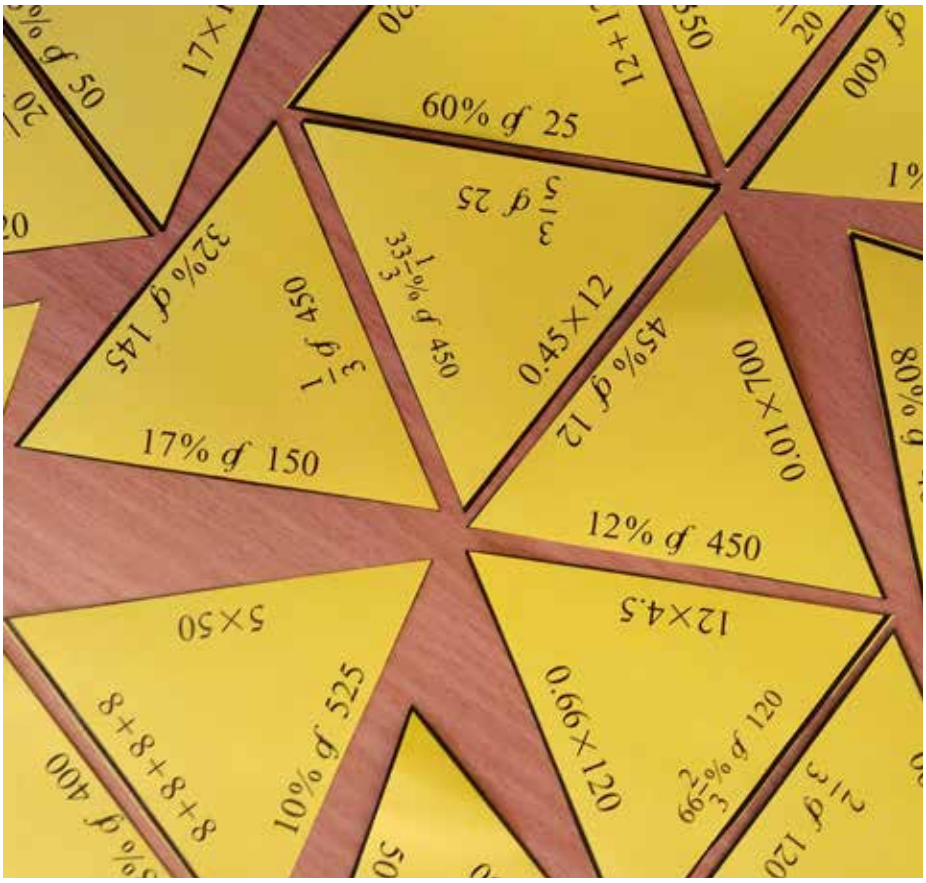
In April this year our world of secondary mathematics education lost one of its true champions – Malcolm Swan. Tributes have ensued. A quick look through the twittersphere using #malcolmswanday hints at the scope of Malcolm's work and the lives he touched.

Never having met Malcolm personally, I have listened to him speak, read his work and his advice for teachers, and delivered to my students many of his wonderfully designed lessons. All of this has left me with an unmistakable sense of someone who cared deeply about learning and the plight of young people in our education systems. Those who knew Malcolm personally described him as a lovely and kind-hearted man, someone with a touch of genius.

While Malcolm has certainly left classrooms all over the world with wonderful lessons and tasks to experience and learn from, perhaps a greater gift was that he, through his work and leadership, invited and enabled teachers to transform their own practise. I am one of those teachers.

My first encounter with Malcolm's work happened during a workshop with Matt Skoss at an AAMT conference some years ago. We played with an accessible task about increasing and decreasing percentages using cards, moving them about the table, making sense of them as we discussed the task. This, I learned early on, is part of the charm and genius of his tasks; discussion, debate, questioning and resolution readily and happily flow in classrooms, uninhibited by note-taking or completion of copious textbook questions, creating an enthusiastic buzz. What more does a teacher hope for in their classes?

I came into closer contact with the ideas and vision of Malcolm soon after when reading *Challenges and Strategies*, a companion booklet to *Improving Learning in Mathematics* – a professional development package made freely available to schools in the UK. I have since used many of the tasks and learned to develop my own too, based on the designs contained within the package. Engaging in this type of design can be quite a lot of fun for a mathematics teacher, and even more rewarding to bring these tasks to your students.



Helping learners address misconceptions and develop new and refined strategies through one of Malcolm's approaches: Many ways to calculate percentage.

More recently Malcolm's Shell Centre team at the University of Nottingham has collaborated with the University of California, Berkeley, to develop the Mathematics Assessment Project. There is much of Malcolm's earlier work in this resource but there is also a well-considered focus on formative assessment, not to mention ample teacher support in implementing the strategies contained within. Again, and quite amazingly, this is all freely available. To my knowledge, and in my opinion, this is the single most successful resource that blends engaging mathematical activity, differentiation and formative assessment so naturally and seamlessly, with student learning and growth at the forefront.

Because of Malcolm Swan, I have had wonderful experiences as a teacher in my classrooms. The learning is authentic and the teaching is rewarding. I will remember Malcolm when I am surrounded by students who are engaged, challenged, learning actively, and loving it. I owe him a great debt of gratitude.

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The Language of Functions and Graphs (www.stem.org.uk/elibrary/resource/25495)

Challenges and Strategies (www.stem.org.uk/elibrary/resource/26057)

Improving Learning in Mathematics (www.stem.org.uk/elibrary/collection/2933)

The Mathematics Assessment Project (http://map.mathshell.org/index.php)

If Malcolm Swan impacted your teaching, share your thoughts on the MAV's Facebook page, www.facebook.com/mathematicalassociationofvictoria.

MAV17 CONFERENCE

Achieving excellence in M.A.T.H.S | 7 - 8 Dec 2017

The MAV is pleased to announce the MAV17 conference keynote speakers. Each speaker will explore the conference theme, Achieving Excellence in M.A.T.H.S.

DAN FINKEL (INTERNATIONAL SPEAKER)
Dan is the Founder and Director of Operations of Math for Love, he works with schools, develops curriculum, leads teacher workshops, and gives talks on mathematics and education. You can see his work at mathforlove.com. Dan is sponsored by Maths Pathway.

CATHERINE ATTARD
Catherine is an Associate Professor in primary mathematics education and Distinguished Teaching Fellow at Western Sydney University. Catherine's research explores the effective use of mobile technologies to enhance the teaching and learning of mathematics.

DR DAVID BUTLER
David is the coordinator of the Maths Learning Centre at the University of Adelaide. He helps hundreds of students every year to learn and love maths wherever they meet it.

PROFESSOR DAVID CLARKE
David is Director of the International Centre for Classroom Research (ICCR) at the University of Melbourne. His research has addressed teacher professional learning, metacognition, problem-based learning, assessment, multi-theoretic research designs, cross-cultural analyses, curricular alignment, and the challenge of research synthesis in education.

NORM DO
Norm is, first and foremost, a self-confessed maths geek! He is currently a Lecturer and ARC Research Fellow in the School of Mathematical Sciences at Monash University. He spends his time playing with strange shapes, counting interesting objects, and wondering what might be true.

HAYLEY DUREAU
Hayley is Head of Student Voice / Mathematics Teacher at Mount Waverley Secondary College. Hayley introduced *Teach the Teacher*, giving students the opportunity to provide professional learning for staff, drive elements the school's strategic plan, and design feedback tools which teachers use regularly, allowing students to provide feedback and discuss their learning with their teachers.

SARAH FERGUSON
Sarah teaches in primary schools as a classroom teacher and in mathematics leadership roles. She is editor of the MAV's *Prime Number* journal.

SARAH HOPKINS
Sarah is a senior lecturer in the Faculty of Education at Monash University. Sarah has a long-term interest in research that will help address Australia's 'long tail' of underachievement in mathematics. She is currently investigating the role confidence plays in the development of retrieval-based strategies and how number fluency can be taught using cognitively-demanding tasks.

AMY MACDONALD
Amy is a Senior Lecturer in Early Childhood Mathematics Education at Charles Sturt University. Her research focuses on the mathematics experiences and education of children in birth to five education settings, and the mathematics professional learning of the educators who work with these young children.

CARMEL MESITI
Carmel is Centre Coordinator of the International Centre for Classroom Research at the University of Melbourne. Her research interests have included lesson structure, lesson beginnings, mathematical tasks and more recently, as part of her doctoral work, the nature of differences in the pedagogical lexicons of education communities internationally.

DAVE TOUT
Dave is Senior Research Fellow, Numeracy and Mathematics, ACER. He is an experienced numeracy and mathematics educator who is particularly interested in making mathematics relevant, interesting and fun for all students especially those students disengaged from mathematics.

ROSS TURNER
Ross is the Principal Research Fellow, Centre for Global Education Monitoring, ACER. He managed the mathematics domain for the OECD's PISA survey for several PISA survey cycles; and has recently developed a description of mathematical growth for use in the international development context.

TRISH JELBART
Trish Jelbart is a Mathematics Education Developer at Victoria University, working with lecturers to assist with making the maths in various courses more accessible for students, to help improve students' mindset toward maths.

For more details regarding the sessions at MAV17 conference, the full biographies of the keynote presenters and how to register for MAV17, visit www.mav.vic.edu.au/conference.

SPONSORS

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DILEMMA OF DIFFERENTIATION

Jennifer Bowden - Mathematics Education Consultant, Mathematical Association of Victoria

Jen Bowden modelling teaching at South Yarra Primary School using the Multiplication: reSolve Bakery resource.

BUILDING TEACHER CAPACITY AND RESOLVING THE DILEMMA OF DIFFERENTIATION

MAV Education Consultants are often engaged by schools to build teacher capacity. This professional learning partnership relies on the consultant, school leadership and teachers to work collaboratively around pedagogy, planning and practice. The most common question is 'How can I cater for the diverse range of learning outcomes in my class?'

Differentiation is not a new term. Teachers have been differentiating and catering for the diverse ranges of needs in their classroom effectively for many years. However, whether you are an experienced leader, or an enthusiastic graduate, differentiation is always a challenge. We meet many outstanding teachers wanting to cater for each child in their class to give them the best opportunity and challenge their learning. It's inspiring and exhausting!

Recently much of the work we have been doing with teachers is through modelling, planning and reflecting on lessons that cater to differentiation through presenting rich tasks. Planning a series of lessons that

- start with a warm up activity that engages students and continues to work on the fluency and understanding of mathematics
- move to an effective launch that explains the mathematical goal whilst engaging each student in a task or problem to solve
- allows students to explore, ensuring the task has an entry point in which each student can engage and be challenged
- ensures teachers know what learning outcomes they are focusing on and have effective record keeping
- is prepared with a repertoire of explicit teaching workshops, enabling prompts, extension tasks and deep questions to lead students through their explorations
- summarises the students learning so they can consolidate their explorations and connect it to their further learning experiences.

MODELLING DIFFERENTIATION

Professional learning around differentiation is most effective when teachers observe a lesson modelled in practice, participate in discussions around pedagogy and lesson content, have time to plan their own series of lessons and finally trial their lessons and discuss its impact.

This lesson study is most effective as part of a coaching process with an education leader and their teaching teams.

Teachers second biggest challenge is time. Where do they find the time to create activities for the diverse range of students in their classroom? Whilst ability group classroom rotations can be effective, teachers find creating multiple activities, with a range of supporting resources extremely time consuming. The model of a rich lesson allows teachers to focus on one open-ended rich task and concentration

DILEMMA OF DIFFERENTIATION (CONT.)

The Victorian reSolve: Maths By Inquiry writers workshop in the MAV's Education Centre.

explicit teaching time (workshops on enabling prompts for students who may require assistance to enter the task or extending prompts for those students who are displaying an understanding of the mathematical goal and mastering the concepts presented).

Planning time can be focused on questioning techniques to develop deeper thinking, creating effective enabling prompts and extension prompts and investigating effective assessment techniques.

QUALITY RESOURCES

Teachers do not need to reinvent the wheel. Too often I ask teachers where they get their tasks from. Google, Pinterest and other online education sites may provide a range of ideas however how do we ensure they are effectively trialled, meet Victorian curriculum outcomes and are based on best practice? There are many quality resources that we utilise to support teachers in developing their pedagogy, planning and practice.

Recently we have been using lesson sequences from the reSolve: Mathematics by Inquiry online resource. reSolve: Mathematics by Inquiry is a national program that provides Australian schools in Foundation to Year 10 with resources to help students learn mathematics in an innovative and engaging way. The program is managed by the Australian Academy of Science in collaboration with the Australian Association of Mathematics Teachers

The reSolve resources are a series of learning sequences built around quality rich tasks, with suggested enabling and extension prompts. The resources are written in an accessible manner to classroom teachers with printable resources, animations and videos. Tasks are highly engaging and relate to real world problems.

Lesson sequences have been created based on research, best practice and have been trialled in classrooms across Australia, providing teachers with an outstanding resource that assist with differentiation.

The program is supported by a professional learning resource with modules written by Professor Peter Sullivan along with Special Topics which are substantial units of work that address current gaps, prioritise the proficiencies of reasoning and problem solving, provide opportunities for using new technologies and real world contexts written by Professor Kaye Stacey.

At the centre of reSolve is the reSolve: Mathematics by Inquiry Protocol. This sets out a vision for teaching and learning mathematics and underpins all aspects of the project. The protocol is organised around three focal points:

- reSolve mathematics is purposeful
- reSolve tasks are challenging yet accessible
- reSolve classrooms have a knowledge building culture.

WRITING AND TRIALLING LESSONS

Whilst being able to access and trial completed lesson sequences online, MAV education consultants have had the pleasure of contributing to writing and trialling units of work and lessons in schools.

The MAV hosted two days of writer's workshops at our Education Centre in Brunswick. This event was led by the executive director Dr Steve Thornton and resource developer Kristen Tripet. The session was also supported by Nadia Walker the Victorian Outreach Officer, whose role on the project is to support and lead champion schools trialing the resources in their teaching and learning context. Writers ranged from the experiences of Catherine Pearn (University of Melbourne) and Carly Sawatzki (Monash University) to classroom teachers and consultants. Writers collaborated to produced series of lessons based on research, expertise and best practice. We then refined lessons and trialled them in our own education context.

PLANNING RESOLVE: MATHS BY INQUIRY LESSON SEQUENCES

The workshops were followed by an additional session at Benton Junior College where lessons were trialled with students and observed by the developers and writers.

MAV Education Consultant Ellen Corovic modelling the reSolve task from Directed Number with Year 5/6 students at Derrimut Primary School

A Year 3/4 teacher using the Multiplication: reSolve: Bakery Resource to investigate multiplicative agility with her students.

This was a wonderful chance to for the writers to work together to analyse the lessons, student responses and impact on planning, teaching and learning. Not only will this practice and series of workshop ensure the materials written for reSolve are of a high quality, it gave the teachers involved a fantastic opportunity to develop themselves professionally and make invaluable contacts to enrich the teaching and learning in their own contexts.

These lessons are currently being added to the reSolve: Maths By Inquiry resource. For more information http://resolve.edu.au.

PROFESSIONAL LEARNING OUTCOMES

The results of the MAV's professional learning programs in school are very positive. Students are engaged in lessons where their individual learning requirements are being catered for and challenged. Teachers can focus on big picture thinking and more effective planning using quality resources. Students can participate in explicit teaching workshops with activities that scaffold their learning.

Overwhelmingly, teachers have told us that after our workshops, they have a shared and clear understanding of the schools' mathematics teaching and learning pedagogy, their planning is based on best practice and research and is more efficient and teaching practice caters for the different learning needs of their students and regardless of their context students. Teachers are gaining more enjoyment from the teaching and learning of mathematics.

For more information on a MAV Professional learning program to build teacher capacity in your school contact Jen Bowden, jbowden@mav.vic.edu.au.

For more information on reSolve: Maths By Inquiry, contact Nadia Walker, nwalker@aamt.edu.au.

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MATHS: CREATIVE AND RELEVANT

Rebecca Cooper - lecturer, Norman Do - lecturer and Joanne Burke - teaching associate, Monash University

Norman Do describes fractals in the REMSTEP video.

> The mathematician's patterns, like the painter's or the poet's must be beautiful; the ideas, like the colors or the words must fit together in a harmonious way. Beauty is the first test: there is no permanent place in this world for ugly mathematics.
> - G. H. Hardy (1877 - 1947), *A Mathematician's Apology*, Cambridge University Press, 1994.

HOW IS MATHS PORTRAYED IN YOUR CLASSROOM?

Research into mathematics education shows there is more to mathematics than an accumulation of rote facts and algorithms (Cobb, 2000). Whilst procedural fluency is a goal of mathematics education, 'mathematics has its own value and beauty and it is intended that students will appreciate the elegance and power of mathematical thinking, [and] experience mathematics as enjoyable' (ACARA, 2009, p.5). Unfortunately, the vast majority of resources currently available for mathematics teachers are aimed at the mechanics of teaching or the mechanics of mathematics. So, staff in the Faculties of Education and Science at Monash University collaborated on a project to challenge traditional views of mathematics in secondary schools. The result was a series of three videos aimed for teachers looking to appreciate the concepts, philosophy, and attitudes of mathematics. More concretely, they provide maths teachers with inspiration for classroom activities that deal with the ideas, rather than the technical aspects, of mathematics.

STRUCTURE OF THE PROJECT

Each video begins with an introduction by a teacher educator, Rebecca Cooper, describing the educational purpose of the videos. Mathematics lecturer, Norman Do, then introduces the maths content with links to real life examples to be considered by the audience. The associated activities give maths teachers the opportunity to consider connections between maths concepts and real life and to promote deep thinking and learning in the maths classroom (Frykholm & Glasson, 2005). In addition, Sullivan (2011) states that using students' familiarity with a social context when teaching mathematics can also lead to greater student engagement with the mathematics and a greater disposition to continue to learn mathematics.

HOW IT FITS INTO THE CLASSROOM

The three produced videos are: parabolas, fractals and knots. These topics are not necessarily part of the Australian (or Victorian) Curriculum; however, they demonstrate how aspects of mathematics occur in a range of interesting, real life situations. It is our intention to have maths teachers consider mathematics through a different lens in an effort to broaden their approach to teaching maths to include more contemporary mathematical ideas.

The primary goal of this project was to produce content that showcases the nature and beauty of mathematics. The resources are aimed at teachers looking to appreciate the concepts, philosophy, and attitudes of mathematics. More concretely, they will provide them with inspiration for classroom activities that deal with the ideas, rather than the technical aspects, of mathematics.

The videos and questions can be found at Monash Science Education Research Group website: http://monash.edu/science-education/category/resources/. This resource will be used in the Graduate Certificate of STEM Education at Monash University (www.monash.edu.au/pubs/handbooks/courses/D4005.html).

Acknowledgement: This video project was part of the REMSTEP Project, a national initiative funded by the Australian Department of Education and Training.

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GIPPSLAND MATHS CONFERENCE

ENGAGING ALL STUDENTS IN MATHEMATICS

This conference is aimed at primary to Year 10 teachers and maths leaders.

Teachers and leaders will enjoy a full day of captivating maths activities and strategies that will assist in engaging all students in mathematics. The conference will include a keynote and three workshops throughout the day. Concurrent workshops will be offered in three streams: early years, primary and secondary

Date
Tuesday 8 August 2017

Venue
Federation University Churchill

Time
9am – 3.30 pm (including networking morning tea and lunch)

- Online bookings only
- Registration is not confirmed until payment is received
- Registrations will close when capacity is full, or on Monday 31 July, whichever comes first.

Session	Presenters	Title
Keynote 9.30am - 10.15am	Doug Williams	Fascinating, captivating and absorbing kids in maths
Morning tea and networking 10.15am - 10.45am		
Workshop rotation 1 10.45am - 12pm	Doug Williams	Working mathematically with infants (Early years F - 2)
	Jen Bowden	Lets hook them with games (Years 3 - 6)
	Helen Haralambous	Engaging students through maths games (Years 7 – 10)
Lunch and networking 12pm - 1pm		
Workshop rotation 2 1pm - 2.15pm	Jen Bowden	Engaging students with picture story books (Years F - 2)
	Doug Williams	Working like a mathematician in the primary school (Years 3 - 6)
	Helen Haralambous	Hands on algebra (Years 7 – 10)
Changeover break 2.15pm - 2.20pm		
Workshop rotation 3 2.20pm - 3.20pm	Jen Bowden and Helen Haralambous	Being a professional maths teacher (Primary)
	Doug Williams	Working like a mathematician in the secondary school (Years 7 – 10)

Register at http://registration.mav.vic.edu.au/Reg/

WORKSHOP PRESENTERS

Doug Williams

Doug is a story-teller in mathematics education. His role is to work with colleagues to collect and retell stories of success from classrooms. This work involves professional development sessions; working in classrooms to act out stories; and publishing stories, in the main through web sites. The stories are structured around students at all levels learning to work like a mathematician and the teaching craft which encourages that process. He has been sharing these stories for more than two decades. Currently he works as Project Manager for Mathematics Centre and has played a part in developing Maths300.

Jen Bowden

Jen is a Mathematics Education Consultant for the Mathematical Association of Victoria. She works with teachers to build teacher capacity, increase knowledge of curriculum content, develop pedagogies and establish school-wide improvement plans.

Jen takes a variety of approaches whilst working with teachers, including modelled teaching, coaching, intensive curriculum planning, afterschool workshops and whole school professional development days. Whether it be exploring engaging picture books or investigating big picture thinking, her approach is always engaging, hands-on and guaranteed to challenge teachers' thinking.

Helen Haralambous

Helen is a secondary Mathematics Education consultant at the Mathematical Association of Victoria. She has been involved in education for over 30 years; including teaching secondary school mathematics and holding leadership positions including mathematics faculty coordinator, year level coordinator and leading teacher positions in numeracy, curriculum and professional development.

Helen also spent time working as an education consultant at the Australian Bureau of Statistics and has co-authored a series of Year 7–10 mathematics textbooks. Her interests include incorporating hands-on mathematical tasks, real life application activities, and games into the maths classroom.

BUILDING FINANCIAL LITERACY

Justine Sakurai - VCAL Coordinator, VCE Math and VCAL Numeracy teacher, Sandringham College

Sandringham College students collaborated with Bentmoor Men's Shed group to revitalise the pavilion on their local oval.

Time and money is an outcome for VCAL Numeracy. This outcome reflects the need to equip our students with strong financial skills so that they can navigate the complexities of the financial society in which we live and work. It was reported this year that the average financial literacy score for Australia in PISA has been falling since 2012.

There is a strong push internationally for financial education of students to better prepare them for the financial challenges they will face in their lifetime (Financial Education in Schools: challenges, case studies and policy guidance (OECD Publication, 2012)). We have a responsibility as numeracy teachers to ensure our students are prepared for the current and future world that awaits them.

There is a growing body of resources to help teachers with financial literacy and the most current and extensive of these is MoneySmart, www.moneysmart.gov.au.

At Sandringham College VCAL unit, we place a strong emphasis on financial literacy and financial numeracy skills. We endeavor to teach students the language of money and provide them the tools to make calculations involving money.

Students complete a unit of work looking at taxation in Australia. They learn why we pay tax, what we pay tax on, and all aspects of record keeping to ensure tax compliance. With a focus on the trades and industries they are aiming for, students keep vehicle log books, and make calculations with allowable deductions. They look at pay slips to understand the difference between gross and net pay, and learn to look for discrepancies.

Demystifying taxation through activities and discussion, and filling out mock tax returns removes the stigma and fright with which most students approach the dreaded taxation issue. The aim is to teach responsible participation in our democratic society.

Another financial literacy project we look at is buying a house. Using the web, students investigate a range of mortgages and investigate the differences between fixed and variable loans. There are unforeseen lessons in here, as students find the information is often deliberately hidden or obfuscated. There have been some hilarious moments as students have conducted interrogations over the phone with mortgage brokers. As with taxation, by making the scenarios real, students gain confidence and skills to tackle these initially terrifying investigations.

The second part of this project asks the students to find three properties they would like to buy. Armed with their information on interest rates, students use the mortgage calculators on Moneysmart to make decisions about what they could afford. There are always extensive discussions that arise around location, property prices and the challenges their generation will face in terms of affordable housing.

As with all aspects of buying and selling online, there is a risk to students' financial safety. Learning about scams and how to identify them makes for the fun part of the unit. There are a host of government resources devoted to spotting and reporting scams, and the media also provides a rich resource bank. Protecting oneself whilst online is paramount and VCAL is the perfect vehicle to explore this with your students. There are cross-curriculum links here with literacy units.

Another way we address financial skills at Sandringham College is through project based activities. The last 18 months has seen Sandringham students team up with four blokes from our local Men's Shed organisation (Bentmoor Men's Shed) to give a new lease of life to the previously dilapidated pavilion on the shared-use oval. Students planned all aspects of the project and found many applications of numeracy in aspects of the planning, organisation and execution of the work.

Initially students had to measure the building and site and produce detailed plans and scaled drawings of the pavilion. After site meetings and planning meetings, and many packets of chocolate biscuits, students began the difficult challenge of ordering supplies for their work and keeping detailed financial records of their purchases.

They learnt about structuring quotations, invoices and receipts. The ATO website has clear instructions about the legal requirements for these documents. Students reported that that they felt creating and working with these documents was preparing them for real life.

Some students elected to keep time sheets for 'employees' work done and these provided fruitful material for the classroom, as did the keeping of petty cash records.

Our experience of teaching financial skills has shown us that the closer you can make activities to real life, the more enjoyment students will derive from them. This enjoyment translates through to a willingness to learn and participate.

Do you teach VCAL?

MAV is keen to receive article submissions from VCAL teachers. If you have an interesting story to share, email it to Darinka Rob, drob@mav.vic.edu.au.

TACKLING MATHS METHODS EXAMS

Mary Papp - VCE Mathematical Methods Assessor, Senior Mathematics Teacher, Methodist Ladies College

There is no doubt that the best way to prepare for the final Mathematical Methods examinations is to get plenty of practice, via past VCAA papers, as well as commercially prepared trial/practice examinations.

These are generally undertaken with a view to consolidating knowledge and skills; as well as ensuring supplementary notes (aka 'cheat' summary notes), permissible in exam 2, are complete and accurate. Honing exam technique, particularly under time pressure situations is equally important.

The most common (and heart-breaking) reason students do not obtain the full marks allocated to a question is their failure **to answer the specific question**.

This is easily overcome by following the checklist below. While at first this checklist may appear onerous, with practice it becomes automatic and takes only nanoseconds to complete.

1 Read the question in its entirety, then ask yourself:

- What am I required to find: an equation, one or more values, a function, an angle etc
- Is there more than one possible answer? (e.g. solving trigonometric equations)
- Is there a specified format for the answer? Remember answers should be exact. Use decimal approximations only if the question invites you to do so.

Consider the instruction

Express your answer in the form $\left(\frac{a}{b}\right)^c$, where a, b, c are positive integers.

(VCAA 2016 exam 1 Q4c)

- Is there an instruction that must be obeyed?
  - *Hence* means you must use an answer or information from a previous part of the question
  - *Show that* is best handled by manipulating one side of the equation to match the other side. In essence it is proving that the **R**ight **H**and **S**ide is equivalent to the **L**eft **H**and **S**ide or vice versa. Sometimes it may be more beneficial to work each side separately. Show that questions often are there to help set up a latter part of the problem.
  - *Label*: ensure required points are accompanied by both x and y coordinates, asymptotes should be dashed and accompanied by an equation.
  - *Use differentiation, use calculus, solve algebraically* are self explanatory directives
  - *at least one*: one or more (include one)
- Do I need to be wary of units? Do I need to convert metres to centimetres, hours to minutes, to ensure the same units and what unit do I give my final answer? State the unit!
- Is there a restricted domain involved?

2 Underline/highlight the important directives in the question

Here are a few typical examination questions with the key directives underlined.

A: Find the equations of the tangents to the graph of $f:[0,8\pi] \to R, f(x) - 2\cos\left(\frac{x}{2}\right) + \pi$ that have a gradient of 1.

Note: answer requires equations to more than one tangent in a given domain with the restriction that the gradient =1.

B: Find the coordinates of the stationary point of h and state its nature.

Note: two things to find and a specified format for the answer.

3 As you work through the problem take care to be vigilant with:

- Transcription errors: check that you have copied the correct equation/ value.
  - Correct mathematical notation : $f(x) = \log_e x + 1$ is not the same as $f(x) = \log_e(x+1)$ nor is $\log_e(x+1)$ appropriate.
  - is a $+ c$ required/necessary? (antidifferentiation)
  - do not omit dx
  - $y =$ is incorrect if a named function has been given.
  - Clear negative signs
  - R^+ is not the same as $[0, \infty)$
  - Take extra care with curved and square brackets when stating intervals.
- Use the marking scheme to guide how much reasoning is required. Generally one mark questions require only an answer. More than one mark means you need to show some reasoning/ formulation or even a diagram. For probability questions, identify the distribution.
- Legibility of your reasoning: of you can't read your own writing you can not expect others to decipher your symbols. E.g. x should be distinguishable from pi, 7 should not be possibly a 4 or a 9, 5 should not be written as s etc. Write larger - it forces you to slow down a bit (most of us think faster than we write) and forces you to look carefully at what you are writing.
- Don't try to perform too many steps in one line of reasoning. Work down the page rather than across it.

4 Finally when you have completed the question.....

Is your answer feasible?

- An area is not negative
- A probability is a value between 0 and 1 inclusive
- When considering the log of a number or square root of a number, the number cannot be negative nor does $\log_e(0)$ exist
- Should you use radian measure?
- Answers are best given in simplest form. Answers such as $\frac{15}{32} + \frac{3}{24}$, $\frac{1+0.5}{2}$ are incomplete.

- It is vital that you check that your final answer does comply with the key words that you have highlighted in the question.

Few students have time in an examination to redo every problem to check their answers. All the above tips will assist you in getting it right the first time.

One very worthwhile activity that I require my students undertake is 'You are the official assessor'. Students complete an extended analysis question or even a complete a trial examination (try the MAV trial exams). They are given the worked solutions together with a marking scheme and are asked to grade some other student's paper. (Take care to match students of comparable ability).

I steadfastly refuse to umpire any disputes, nor give clarifications. Each pair or group of students must produce a fair grade for the paper they marked and be prepared to justify their grade. To add a bit of spice to the task, an extra rule is that if a student has marked unfairly or incorrectly that must deduct the marks from their own total and gift it to the student whose paper they marked. After the arguments and disputes die down – it's reflection time. Students work collaboratively to give viable answers to the question. What do I need to do to obtain full marks? Or where did I lose marks and why?

Honing exam technique also means improving time management and effective use of reading time.

You are at an advantage in examination one if you:

- Have drilled your algebraic techniques, specifically expansions and factorisation
- Have drilled yourself with manipulating and simplifying fractions (especially algebraic ones)
- Can correctly deploy log and index
- Memorised exact values (trigonometric functions)
- Memorised the graphs of the standard functions and effects of various transformations

- Take extreme care with brackets and negative signs
- Remember $\cos(0) = 1$ but $\log_e(1) = 0$.

You are at an advantage in examination two if you:

- Remember a multiple choice question is worth only one mark. If the question is complex or you do not know how to do it, your time may be better utilised dealing with a question worth more marks. Remember also that you are not penalised for an incorrect answer, *do not leave a blank*. Guess an answer, there is always at least one option that is clearly wrong so your chances of picking the correct answer improve.
- Know how and when to use your calculator. *Define*, *solve*, the various graphing, calculus and probability functions have been well rehearsed. Remember to take care (especially with brackets) when inputting and transcribing functions or equations. Remember also that answers should be given in correct mathematical notation and not calculator syntax.

Finally, remember an examination is written to allow students to showcase their knowledge, skills, mathematical understanding and their communication of logic. No setter of an examination sets out to lay traps and trick the student.

MAV 2017 TRIAL EXAM PAPERS

Each year the MAV writes Trial Exams for Mathematical Methods (CAS), Further Mathematics and Specialist Mathematics studies. Each trial exam features: original questions, fully worked solutions for all sections and clear marking schemes. Exam formats are similar to those used by the VCAA.

The trial exams are available from the MAVshop, http://shop.mav.vic.edu.au.

MAV VCE STUDENT REVISION LECTURES

VCE students are invited to attend the MAV's VCE revision lectures in the three VCE Mathematics subjects: Mathematical Methods, Specialist Mathematics and Further Mathematics.

Students receive comprehensive notes and the lectures are delivered by highly qualified and experienced, practising teachers. Lectures will be presented in Glen Waverley, Mt Eliza, Caroline Springs, Warrnambool, Sale, Horsham and Wangaratta.

Make sure you reserve a seat by booking online early, www.mav.vic.edu.au/revisionlectures.

MATHS CAMP

Carolyn McHugh - Teaching and learning coordinator, Wedderburn College

During the Term 1 holidays, two students from Wedderburn College, Sam Lockhart and Oscar Van Veen were among 20 students who attended the MAV's Mathematics Camp. The camp was aimed at regional Year 10 students who have shown extra skills in the mathematics area.

The aim of the camp was to provide a chance for students to gather with like-minded peers and explore hands-on, industry related real-life problems.

Sam and Oscar were introduced to the Victorian Space Science Education Centre (VSSEC), Ford Engineering and Technology Centre, the Reserve Bank of Australia and, Defence Science and Technology Group. All places emphasised the role of mathematics in their work.

Students worked in groups, with assistance from an industry mentor, solving real life problems. Sam's group were at the Reserve Bank and used data to find the right interest rate so that labour supply and labour demand could be as balanced as possible. Oscar's group were at VSSEC with a human-bioscience team, and worked on creating a more inclusive and accurate body mass index. Every evening, they went to RMIT to work on their group projects. On the last day, each group presented their projects to peers, teachers, industry professionals, parents and the MAV staff at Latrobe University.

It was not all work - the students participated in social activities and formed friendships.

Apart from the chance to view industries at work, both Sam and Oscar felt they had learnt other skills:

- Becoming independent by using Myki to get around Melbourne's public transport system
- Meeting new people and making friends
- Learning that you can be 'sporting and smart'
- Co-operating in a group to achieve a common goal.

The MAV Maths Camp was a fantastic opportunity to experience something that they would not be able to otherwise. Participation in the camps was made possible by the Mathematical Association of Victoria supporting costs such as meals, accommodation and travel.

2018 MATHS CAMP
Details regarding a similar camp in 2018 will be released in Term 4 2017.

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INDIVIDUAL STUDY $199.66 (MEMBER) $249.57 (NON MEMBER)

ALL STUDIES $461.21 (MEMBER) $576.51 (NON MEMBER)

PASMAP - BOOK 1

F–2

The Pattern and Structure Mathematics Awareness Program is a network of related learning experiences developed for children. It is based on research evidence that the foundation of mathematical development is an awareness of mathematical pattern and structure, and that engaging children in exploring core patterns and their structure leads to an improvement in general mathematical understanding. PASMAP focuses on developing children's awareness of the patterns and structures that underlie the concepts and processes common to all the early AC strands.

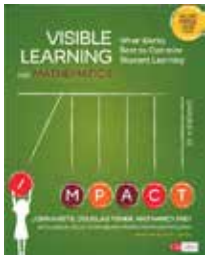
$66.38 (MEMBER) $82.98 (NON MEMBER)

QUATERNIA

9–VCAL

14 year old Ivan is mathematically gifted and obsessed with gaming. Excelling in online war games, he falls behind in his studies, withdraws from family and friends, and is manipulative in satisfying his obsession. A mysterious, online exchange introduces him to equipment that enhances the gaming experience. Through ivan, his mirror image, he embarks on a quest for the secret of Quaternia, a virtual world where mathematical ideas come alive.

$14.50 (MEMBER) $18.13 (NON MEMBER)

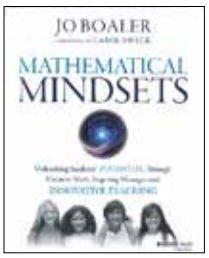


VISIBLE LEARNING FOR MATHEMATICS

EY–12

Rich tasks, collaborative work, number talks, problem-based learning, direct instruction...with so many possible approaches, how do we know which ones work best? In *Visible Learning for Mathematics*, six acclaimed educators assert - it's not about which one, it's about when. Equipped with video clips, planning tools, rubrics, and templates, you get the inside track on which instructional strategies to use at each phase of the learning cycle - the surface learning, deep learning or transfer phase.

$55.77 (MEMBER) $69.71 (NON MEMBER)



MATHEMATICAL MINDSETS

1–VCAL

This book provides practical strategies and activities to help teachers and parents show all children, even those who are convinced that they are bad at maths, that they can enjoy and succeed in maths. Jo Boaler Stanford researcher, professor of maths education, and expert on maths learning has studied why students don't like maths and often fail in maths classes. This book bridges that gap by turning research findings into practical activities and advice. Boaler translates Carol Dweck's concept of 'mindset' into maths teaching and parenting strategies, showing how students can go from self-doubt to strong self-confidence, *Mathematical Mindsets* provides a proven, practical roadmap to mathematics success for any student at any age.

$26.34 (MEMBER) $32.93 (NON MEMBER)

BEEP BEEP, VROOM VROOM

EY–2

The yellow cars beep! The red cars vroom! As Molly plays with her big brother's toy cars, readers will see and recognise patterns, an essential first step in learning to reason from the specific to the general. But can Molly put the cars back in the right order before her brother returns?

$9.75 (MEMBER) $12.19 (NON MEMBER)

THE MATHEMATICAL ASSOCIATION OF VICTORIA

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