

LEARNING PARTNERSHIPS



Students eagerly contribute to the scale model of Derrimut Primary School.

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IMPROVING OUTCOMES THROUGH SUCCESSFUL LEARNING PARTNERSHIPS

Derrimut Primary School is an inquiry based school where students learn collaboratively in open learning spaces. On site and ongoing teacher learning is highly valued and reflected in our professional learning architecture. Our whole school Professional Learning Community (PLC) meet three times each fortnight to analyse data, research evidence-based practice and strengthen current structures and strategies. Professional Learning Teams (PLT) take place once a fortnight, this is the time when teams work towards a personalised goal based on their student data. We also engage external coaches in literacy and numeracy who work intensively with each team across the year for two hours a week, over a four week cycle.

In 2014, Derrimut Primary was involved in a 12-month partnership project with a number of local schools. The aim was to build teacher capacity to deliver high quality student outcomes in mathematics.

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FROM THE PRESIDENT

Jim Spithill - ACER

THE COMMON DENOMINATOR

The MAV's magazine published for its members.

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A FEW 'DAYS IN THE LIFE' OF YOUR MAV

December 1, 2016 saw the opening of the MAV Conference. I hosted the keynote by Paul Swan from WA. The session began with the announcement of awards of life membership of MAV to former CEO, Simon Pryor, and to distinguished contributor over more than 40 years, Doug Williams. The MAV is more than a century old, and its sense of purpose and focus continues to evolve. It was once more formally mathematical, but in recent times has become a leader in professional services and training for teachers of mathematics. The life membership awards were formally conferred on Simon and Doug before Christmas.

Dr Paul Swan's keynote was one of eight that opened the conference. He unpacked issues around 'word problems' by recognising the historical contributions of George Polya and subsequently Anne Newman. Paul delved into the language usage issues that complicate word problems for students. Like all good presentations, it left you with as many new questions as answers.

Over that Thursday and Friday the conference unfolded pretty much to plan, and for the vast majority of attendees it was a stimulating time professionally. That it ran so well was in no small part due to the year-long planning by Dr Ann Downton and the conference committee, and to the meticulous implementation by MAV's events manager, Julie Allen. After more than a decade with MAV, Julie has now moved on to other opportunities. The 2017 conference will be in the hands of new staff member, Jacqui Diamond, and the whole MAV team under CEO, Peter Saffin.

Any feedback from members about the conference is most welcome.

In December many members of the MAV Council attended a full day's training in the area of association governance, hosted by the Australian Association of Mathematics Teachers, AAMT, and with members from most State Affiliates in attendance. AAMT has a federated structure, whereby its members are the state equivalents of the MAV. This means that any members of MAV, whether as individuals or as part of a school, are automatically members of AAMT. It was a challenging day, but it meant that your Council was asked to confront the myriad issues that clamour for the attention of the leaders of a significant not-for-profit organisation. MAV is fortunate to have on its Council a very good spread of representation by age and by sector within the mathematics education community.

The Council takes seriously its function of stewardship of the MAV. It is perhaps an old-fashioned notion, but stewardship has both a looking-back function, about preserving the work of generations that have preceded us at MAV, and a looking-forward aspect of trying to anticipate the challenges of the future, with a firm commitment to maintaining and building the effective operation of your MAV. Long may it prosper.

REFERENCES

www.amt.edu.au/biogpolya.html

www.mav.vic.edu.au/files/conferences/2009/08White.pdf

www.drpaulswan.com.au/single-post/2016/12/03/Mathematical-Association-of-Victoria-Conference-Notes

www.aamt.edu.au/Membership

RON SMITH TRIBUTE

Long time member of the MAV, Ron Smith passed away in 2015. The MAV are working on a tribute to Ron Smith which we will publish later this year.

We are keen to get submissions from Ron's colleagues, friends and anyone who has been impacted by his contribution to mathematics education.

If you are interested in contributing, please email Darinka Rob, drob@mav.vic.edu.au with the subject 'Ron Smith tribute' in the subject line.

PROFESSIONAL DEVELOPMENT

During Term 1 and 2 2017 a variety of presenters and MAV's own mathematics educational consultants will present workshops focussing on VCE preparation and innovative teaching practice.

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

TOPIC	DATE	YEARS	PRESENTER
VCE Mathematics day out - Melbourne University	17/2/17	VCE	Various
VCE Mathematics day out - Gippsland	20/2/17	VCE	Various
Maths Talent Quest workshop -New Town, Tasmania	21/2/17	F-12	Jen Bowden
Let's Get Started! Engaging dice and card games to motivate students - Tasmania	22/2/17	F-6	Jen Bowden
VCE Mathematics day out - Ballarat	24/2/17	VCE	Various
Maths Talent Quest workshop	2/3/17	F-12	Jen Bowden
Differentiation in teaching number	2/3/17	7-8	Ian Lowe
VCE Mathematics day out - Bendigo	3/3/17	VCE	Various
Making confident maths teachers - teaching whole numbers	4/3/17	7-10	Ian Lowe
Meet the assessors - Wangaratta	7/3/17	VCE	Various
Coding - a hackathon for beginners	7/3/17	F-6	Sarah Longhurst
SACS - NE metro - Burwood (Methods)	8/3/17	VCE	Various
SACS - NE metro - Burwood (Specialist and Further)	9/3/17	VCE	Various
Meet the assessors - Horsham	14/3/17	VCE	Various
Meet the assessors - Geelong	15/3/17	VCE	Various
Maths Talent Quest workshop	16/3/17	F-12	Jen Bowden
Meet the assessors - Williamstown	20/3/17	VCE	Various
Using picture books to inspire a working mathematically approach	21/3/17	F-6	Ellen Corovic and Jen Bowden
SACS - NW metro - Thornbury (Specialist and Further)	22/3/17	VCE	Various
Maths Talent Quest workshop	23/3/17	F-12	Jen Bowden
Making confident maths teachers - Fractions and decimals	25/3/17	7-10	Ian Lowe
SACS - SW VIC - Terang (Specialist and Further)	27/3/17	VCE	Various
Making connections: Big ideas in mathematics teaching and learning	28/3/17	F-12	Dave Tout and Jim Spithill
Meet the assessors - Burwood (Methods)	28/3/17	VCE	Various
Meet the assessors - Burwood (Specialist and Further)	29/3/17	VCE	Various
Making confident maths teachers - Ratio, proportion and percentages	29/4/17	7-10	Ian Lowe
Meet the assessors - Terang	3/5/17	VCE	Various
Making confident maths teachers - linear functions, graphs and equations	13/5/17	7-10	Ian Lowe
Making confident maths teachers - integers, linear and quadratic expanding and factorising	27/5/17	7-10	Ian Lowe
Understanding sampling distributions and hypothesis testing - Specialist Maths	31/5/17	VCE	Susan James
Statistics and probability in mathematical methods	13/6/17	VCE	Susan James

If you'd like professional development tailored to the needs of your school, contact Jen Bowden, jbowden@mav.vic.edu.au.

VCEPD 2017

VCE MATHEMATICS DAY OUT

This full day VCE PD includes both Meet the Assessors and SAC workshops in all three studies Further, Methods and Specialist Mathematics. Workshop participants will receive the 2017 MAV SACs in all three studies. Morning tea and lunch are included.

Workshop fee: \$286 (members), \$380 (non-members)

WHERE

Melbourne University

Federation University, Gippsland

Federation University, Ballarat

La Trobe University, Bendigo

WHEN

Friday 17 February, 9am – 3.30pm

Monday 20 February, 9am – 3.30pm

Friday 24 February, 9am – 3.30pm

Friday 3 March, 9am – 3.30pm

If a whole day workshop doesn't suit, you are welcome to attend our individual SAC and Meet the Assessors workshops.

MEET THE ASSESSORS

Assessors will discuss the processes for setting and marking the 2016 examinations. The presenters will provide a full analysis of the 2016 examinations highlighting student responses and key misunderstandings. Assessors will comment on some of the questions new to the Revised Study Design. There will be time for questions and discussion. Please bring a copy of the relevant VCAA 2016 exam with you.

Workshop fee: \$75 (members), \$94 (non-members)

WHERE

Wangaratta

Horsham

Geelong

Williamstown

Burwood
(Methods)

Burwood
(Further and
Specialist)

Terang

WHEN

Tuesday 7 March, 5pm – 7pm

Tuesday 14 March, 5pm – 7.15pm

Wednesday 15 March, 5pm – 7pm

Monday 20 March, 5pm – 7pm

Tuesday 28 March, 5pm – 7.15pm

Wednesday 29 March, 5pm – 7.15pm

Wednesday 3 May, 5pm – 7pm

SACS

SAC workshops provide opportunities for teachers of VCE to be presented with and discuss possible starting points for SACs for their students. Participants will be provided with a selection of Application and Modelling and Problem Solving Tasks and the SAC starting points in **all studies**. The process of developing appropriate tasks, including criteria mapping and the inclusion of technology will be discussed with specific reference to the sample task provided in the sessions.

Workshop fee: \$162 (members), \$203 (non-members)

WHERE

NE metro - Burwood (Methods)

NE metro - Burwood
(Further and Specialist)

NW metro - Thornbury
(Further and Specialist)

SW Vic - Terang
(Further and Specialist)

WHEN

Wednesday 8 March

Thursday 9 March

Wednesday 22 March

Monday 27 March

Dates are subject to change. Check www.mav.vic.edu.au for the most up-to-date schedule.



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LEARNING PARTNERSHIPS (CONT FROM PAGE 1.)

Jen Briggs - Acting Assistant Principal, Derrimut Primary School

The project involved forming a Professional Learning Team with representatives from each school. It was here that I connected with Ellen Corovic, an Educational Consultant from MAV. The Professional Learning Team attended a whole day of professional learning with Ellen and Jen Bowden (also from MAV) each term and received targeted coaching within their own school between PLT days.

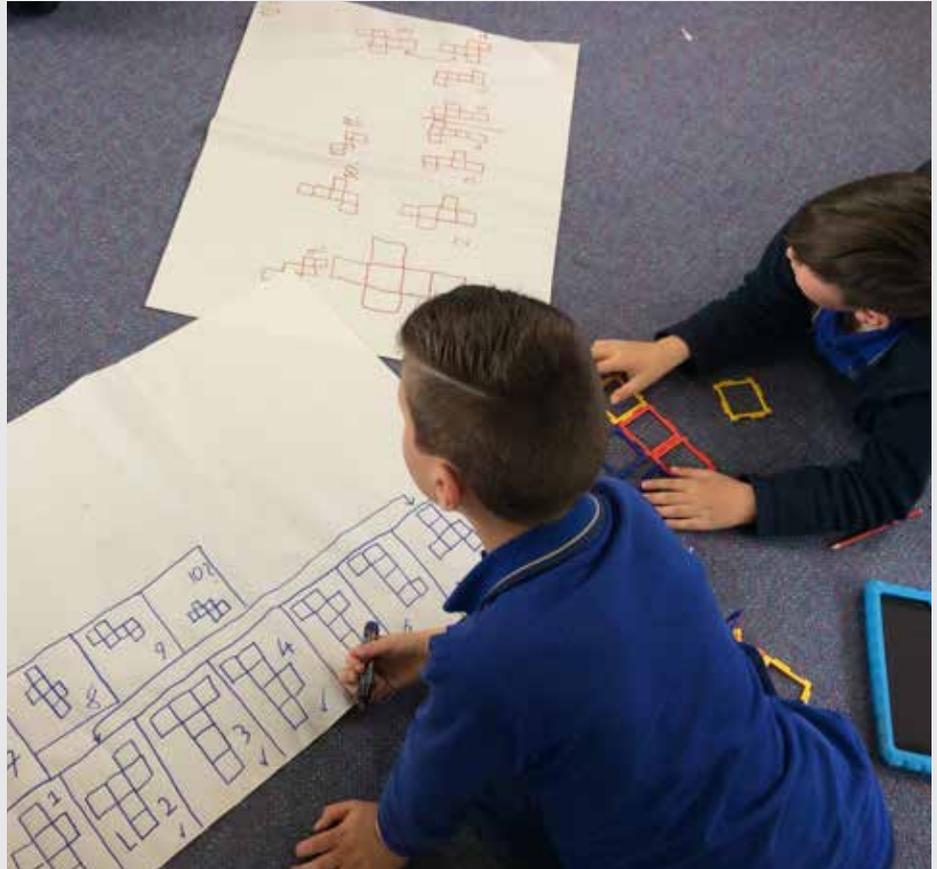
Ellen alternated between modelled lessons and observations and adapted to Derrimut Primary School's philosophy and language quickly. The project was very successful, Ellen established trust with the teams which allowed participants to critically reflect on their teaching and challenge themselves to try new things.

As the project came to an end, Derrimut Primary School was experiencing rapid growth and had a significant number of new teachers joining the staff – many of them being in their first three years of teaching.

We engaged Ellen to set up an ongoing partnership between MAV and Derrimut Primary to help us build effective structures, strategies and routines to improve mathematics outcomes for all students. Ellen was very flexible, ensuring her approach aligned with our philosophy and whole school goals. The coaching cycles allowed PLT's an opportunity to target their specific needs outside of our whole school professional learning structures.

Over the many coaching cycles that have now been completed, PLT's have refined their lesson structures, incorporated rich tasks for assessment, analysed data to design for targeted teaching, restructured learning spaces for more effective learning, and used resources such as Maths 300 and picture story books to enrich their programs.

Now, our whole school professional learning is focussed on developing the big ideas in mathematics and applying the proficiencies through authentic experiences. Teachers are designing rigorous investigations and deep learning tasks which support students to identify patterns, make and test mathematical claims and solve authentic problems.



Student engagement in mathematics is high at Derrimut Primary School.

Our NAPLAN and PAT Maths results have followed a steady upward trend for three years and teacher capacity to design and deliver high quality learning experiences in mathematics has increased significantly. In 2016, the most exciting change has been applying our learning from STEM in authentic contexts to introduce rich investigations as a leading pedagogy. We are also thrilled to have become a MAV Mathematics Active School, which will enable us to showcase our love of engaging primary mathematics with the wider community.

The partnership between MAV and Derrimut Primary has been successful on a number of fronts. Obviously we are very happy to see our NAPLAN and PAT Maths results trending upwards, but equally, I feel that our teachers have really benefited from having an external professional spend regular time at the school. It brings professional learning to the teacher – there isn't any need to arrange CRT or jump through other logistical hurdles.

Embedding Ellen's work into our existing framework meant that our staff were able to access a mathematical consultant on a consistent and regular basis and use her skills and knowledge to apply to their specific class and teaching methods.

I'd encourage other numeracy leaders to explore the options of learning partnerships, it has certainly been a rich and rewarding experience for us.

If you are interested in finding out more about learning partnerships and how they work, email Jenny Briggs, briggs.jenny.r@edumail.vic.gov.au or Ellen Corovic, ecorovic@mavvic.edu.au.

MAV LIFE MEMBERSHIPS

In December 2016, MAV President Jim Spithill awarded Simon Pryor and Doug Williams life membership to the MAV.

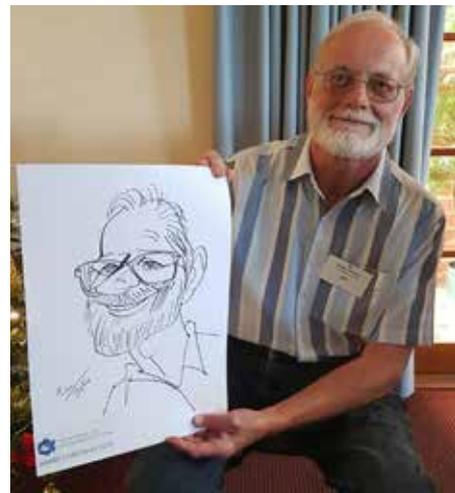
Simon was the CEO of the MAV for 14 years. These years were a critical and challenging time for mathematics education. In this period, despite it being a difficult period for other professional associations, the MAV survived under Simon's leadership and has remained as a dynamic and strong membership driven organisation, promoting its vision and mission of valuing mathematics in our society, and providing a voice, leadership and professional support for mathematical education across the state.

Doug Williams has had a distinguished and important association with the MAV over more than 40 years. He has been a MAV councillor, vice-president, president and editor of *Vinculum*. Doug was also the driving force behind the expansion of MAV membership to include primary teachers and schools.



He realised that if the MAV was to be attractive to primary teachers they needed to see something tangible.

About 1975, together with Betty Paine, Doug inaugurated *Set Two* as a publication dedicated to the teaching and learning of mathematics in primary schools. He also helped to ensure that options suitable

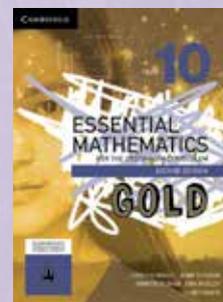
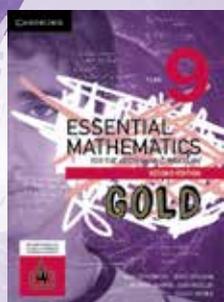
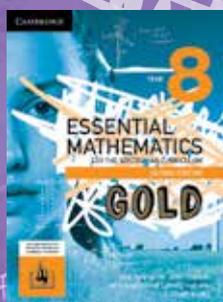
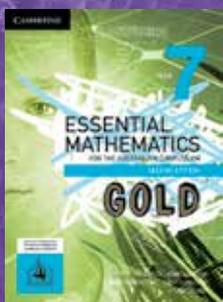


to primary mathematics educators were featured at the Annual MAV Conference.

Both Doug and Simon were awarded the life membership at MAV's end of year function. Simon is pictured here with his award and Doug with a (very accurate!) caricature of himself.

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MAV CONFERENCE REFLECTIONS

The 2016 MAV conference was a huge success and here are some reflections on the event. We'd love to hear your thoughts, post on our Facebook page (www.facebook.com/mathematicalassociationofvictoria).

It was wonderful to see teachers of various teaching experience demonstrating educational leadership by presenting their, or their school's, learning journey. From university leaders, school leaders and aspiring leaders; each had something unique and inspiring to offer.

I delivered a presentation on differentiation and made links with many new schools to whom the messages of 'teach for understanding' and 'differentiation' are the signals for change they have been waiting for.

I loved the high quality resources! Finding resources that promote mathematical thinking including those available through the Resolve project, the Picture Puzzles from the team at Mathematics Centre and the many teacher resource materials presented in sessions.

It's reaffirming to see so many teachers committed to improving student learning through reflecting and adapting on the way we teach.

MAVCON was a great opportunity for teachers to meet, talk and share ideas about excellence in mathematics education. With the recent focus on Australia's falling performance in TIMMS and PISA, it is essential that teachers talk about the issues and look for solutions. I heard many conversations about student performance and how best educators at all levels can improve outcomes for our maths students. Maths is essential for our students; it opens opportunities for them, is used everyday in their lives, and underpins our future success as a society.

One of the best aspects of the conference is the opportunity to reconnect with friends and colleagues.



In response to the news that standards of maths learning are falling (by international comparisons), it is encouraging to see so many teachers who really do want to make a difference to the learning in their schools, and are coming to MAV PD-fest to help them find out how.

Janette Bobis' keynote, *Drawing, Gesturing and Talking*, reaffirmed my passion for teaching children in the early years and allowing students to use drawing to explore mathematical problem solving and connections.

Planning for the 2017 MAV conference is already underway. Save the date: Thursday 7 and Friday 8 December.

If you have questions about the conference, contact Jacqui Diamond, jdiamond@mav.vic.edu.au.

THE MATHS BEHIND GAMBLING

Oliver Lovell - Sunshine College

WHY DEVELOP FREE VCAL RESOURCES ABOUT GAMBLING?

Never before has gambling been so heavily promoted and accessible. This makes it feel more normal and harder for students to recognise the potential harm. We want students to develop healthy and informed attitudes and with this in mind the MAV partnered with the Victorian Responsible Gambling Foundation to produce three units of work for VCAL Numeracy available at www.lovethegame.vic.gov.au/resources.

These units were launched by the Minister for Consumer Affairs, Gaming and Liquor Regulation Marlene Kairouz in late 2016 and are based on a previous MAV study that trialled the integration of gambling education in the curriculum. The trial resulted in improved student understanding of the long-term outcome of random events and the illusion of control in gambling, while the students' belief in luck decreased.

THE PROJECT'S SCOPE

These three units build on this MAV study and address the topics:

- budgeting and interpreting data
- sports and race betting
- pokies.

Written by experienced MAV writers Ian Lowe and Robert Money, along with VCAL teachers Jamie Gray (Peter Lalor Vocational College) and myself (Sunshine College), the idea was to produce hands on, classroom ready resources that would be accessible to both maths trained and out of field VCAL numeracy teachers. Included student self-assessment sheets allow both students and teachers to reflect upon how students have gained an understanding of the mathematics behind gambling through their engagement with the resources.

Each of the units contains between three and four parts or lessons (ranging from approx. 50-100 minutes). These lessons follow the predict, observe, explain cycle, fostering engagement in students as well as thoughtful reflection on the *why* of obtained outcomes. Units can be delivered independently or together, and in any order. Lessons can also be delivered in isolation, but in some cases teachers may find that the progression of lessons in a given unit

provides good scaffolding for students with respect to the more complex ideas introduced in that unit's later lessons.

A glossary of terms and teacher notes aids the teacher to possess the necessary background knowledge to deliver these units of work with confidence.

MAKING THE UNITS ACCESSIBLE

A big focus for the writing team was to ensure that lessons were accessible to all students in a VCAL class (low threshold, high ceiling). In order to achieve this, the worksheets associated with each lesson (excluding introductory lessons) are differentiated into three levels, this was modelled partly on the Sunshine College differentiation approach.

These worksheets allow a teacher to conduct a whole class activity (such as a simulation horse race, or pokie simulation) and have students simultaneously analyse the situation, but at three varying levels of difficulty. These levels are mapped to the outcomes associated with each of the three levels of VCAL Numeracy: foundation, intermediate, and senior. This being said, teachers are encouraged to allow students to choose (or teachers assign) worksheets based primarily on achievement level rather than VCAL Numeracy level enrolment.

Trialling these resources in my own class, I found that this differentiated approach facilitated the highest level of both learning and engagement for students, and I simultaneously ran all worksheet levels in my intermediate level numeracy class.

A LOOK AT ONE OF THE UNITS: THE REAL WINNERS.

My favourite unit (but I'm biased as this is the one that I played the biggest part in writing!) is the pokies unit, entitled *The real winners*. Over four parts, this unit gives students an understanding of some of the key concepts in gambling. The first part, *Chance has no memory*, introduces students to the fact that there is no way to predict the outcome of a random event (e.g., coin toss or card picked from a shuffled deck) and calculating the payout associated with a wager made amongst friends.

By bringing four students up to the front of class, getting them all to pay a token into a prize pool, then determining a winner based upon the suit of a card drawn from a pack of 52, students are able to see how a wager in the absence of a betting agency could work. This activity is then extended to a larger number of rounds and students record and represent the data in graphical form

Part two, *Who are the real winners?*, introduces the key distinction between a wager with and without a betting agency. By employing a similar activity to part one, the teacher demonstrates that by a betting agency taking a cut, players always end up with less money than was paid into the prize pool, and the house always ends up making money.

Part three, *Setting limits*, introduces students to the idea of a pre-commitment (a way in which a player can decide beforehand how much they are prepared to lose in a gambling session). Then, through the use of an exciting whole class simulation, it clearly shows that irrespective of the size of a player's pre-commitment, if they continue to play, they will spend their entire pre-commitment. Higher level worksheets encourage students to compare the dollar per minute cost of gambling to the dollar per minute cost of a movie and reflect upon the relative value of each activity.

The final part, *Pokies*, in the predict phase of the lesson students are asked: 'If each of ten players played 10 games on the pokies, betting \$1 per game, how many of them do you think would have won money by the end of the 10 games?'. Through the use of another interactive simulation, students discover the answer (usually approximately three people).

They are then asked the same question for 100 games, and 1000 games, after which students discover that perhaps one of the ten people will end up winning money after 100 games, whereas it is highly unlikely that anyone will end up on top following 1000 games.

In the explain section at the culmination of the unit, students are asked: 'A relative comes back from an afternoon at the pokies and tells you that they have just lost \$100. They suggest to you that they weren't lucky today, but if they play more they might

UNIT SUMMARY

Lesson	Learning outcomes	Activities and links to assessment	Resources
1. Chance has no memory (50–100 minutes)	<p>F, I, S: Students will understand that chance has no memory; outcomes are impossible to predict.</p> <p>F, I, S: Students will be able to explain that previous outcomes do not affect subsequent ones.</p> <p>F,I,S: Students will understand that there is no strategy that can reliably predict future results in a gambling game.</p> <p>S: Students will understand that for equally likely events, after a very large number of outcomes, the results tend to even out.</p>	<ul style="list-style-type: none"> • Whole class simulation • Spreadsheet demonstration • Use of appropriate levels of worksheets • Final discussion 	<ul style="list-style-type: none"> • A pack of cards • Student worksheets 1, 2 and 3 • Access to Probability Simulator Deluxe on MIT's Scratch website • Card sharp spreadsheet • Student reflection activity • Self-assessment record
2. Who are the real winners? (100 minutes)	<p>F, I, S: Students will understand that all gambling games provided by gaming venues and betting agencies are designed to make a profit at the expense of players.</p> <p>F, I, S: Students will recognise how money is deducted by the gaming venue because the long-term winnings are less than the long-term losses.</p> <p>S: Students will be able to calculate the probability of winning and the 'bet-to-payout ratio'.</p> <p>S: Students will recognise how money is being deducted by a gaming venue when the bet-to-payout ratio is greater than the probability of winning.</p>	<ul style="list-style-type: none"> • Whole class simulation • Spreadsheet demonstration • Use of appropriate levels of worksheets • Final discussion 	<ul style="list-style-type: none"> • A pack of cards • Student worksheets for levels 1, 2 and 3. • Student reflection activity • Self-assessment record

Each unit contains a detailed unit summary (extract above) and curriculum links.

win all of their money back. Based on the exercises above, what would you say to your relative?

CONCLUSIONS

It was a great joy to write these lessons in partnership with Ian, Rob, and Jamie. It was a challenge and a valuable learning experience to trial lessons that others had written in my own class, to see how students received them, then to take these reflections back to the writing group and make improvements as a team.

Equally valuable was having other teachers teach my lessons and provide feedback from their perspective. It gave me a great insight into the value that can come from a team writing process inclusive of feedback, reflection and iteration.

I'm really proud of these lessons and feedback from my students indicated that these were some of the most fun and memorable lessons of the year.

These resources can be found at www.lovethegame.vic.gov.au/resources

2016 VCE MATHEMATICS EXAM: TIPS AND HINTS FOR GETTING AHEAD IN 2017

Helen Haralambous - Mathematics education consultant, MAV

PREPARING FOR THE VCE EXAMS

When this article hits your schools many of you may not yet have had your first Year 12 maths class for 2017 so why an article on preparing for 2017 VCE exams? You will finish your course at the end of Term 3 and many schools run trial exams during the Term 3 holiday break. Whilst the exams should not be *the* focus of Year 12, preparing for these should start day one of the term (if not during your previous years head start program). There are many tips, ideas and approaches to this and many resources available to both teachers and students. This article outlines a few ideas as we note some of the questions members have brought to our attention that students had difficulty with in the 2016 VCAA exams.

Rather than wait until the trial exams, start making your students familiar with VCAA exam type questions from the beginning of the year. This may be through short tests – at the end of each area of study

Or it could be chunked up, for example, on the dot points of a particular key concept after you have covered that key concept of the area of study.

This does not have to be additional work, just use the relevant questions from the 2016 VCAA exam. It also doesn't have to eat into your class time, make it a homework task as part of students ongoing revision.

We have all become very good at incorporating a short (maximum 10 minute) warm up question at the junior maths level, if you haven't already done so why not use this strategy at VCE? It could just be one multiple choice question per week or per double lesson (again use the relevant questions from the 2016 VCAA exam). This can lead to valuable discussion regarding common misunderstandings, especially once the examiners reports are published or you have attended a MAV Meet the Assessors workshop which highlight these.

Place copies of the examiners reports or sections of the Meet the Assessors Powerpoints on the digital shared platform you use with your VCE class. If you want instant feedback on student understanding download *ParticiPoll* (www.participoll.com), allowing you to add multiple choice questions within PowerPoint. If your students have laptops in class they can answer the question directly and you will have instant (anonymous) responses and a bar graph of response breakdown allowing you to quickly identify misunderstandings.

The following are a sample of some of the questions students had difficulty with in the 2016 VCAA exams.

MATHEMATICAL METHODS WRITTEN EXAM 2

Exam 2 consists of 20 multiple choice questions (Section A) and 4 short answer questions (Section B).

2 hours is allowed for this exam and it is a CAS exam. Many students ran out of time and did not complete the exam because they worked sections of the exam by hand rather than using their calculator.

Advice: spend time during the year teaching or reminding students to use their calculator efficiently to minimise the amount of algebra to be completed.

Section B, Question 4b

$$\text{Let } f: R \setminus \{-2\} \rightarrow R, f(x) = \frac{2x+1}{x+2}$$

i) Find the rule and domain of f^{-1} , the inverse function of f .

MAV suggested solution

$$f(x) = \frac{2x+1}{x+2}$$

$$\text{Let } y = \frac{2x+1}{x+2}$$

Inverse swap x and y .

$$x = \frac{2y+1}{y+2}$$

$$y = \frac{-3}{x-2} - 2$$

Range of f is $R \setminus \{2\}$, domain of f^{-1} is $R \setminus \{2\}$

$$f^{-1}: R \setminus \{2\} \rightarrow R, f^{-1}(x) = \frac{-3}{x-2} - 2$$

Question 4d

$$\text{Let } g: (-k, \infty) \rightarrow R, g(x) = \frac{kx+1}{x+k}, \text{ where } k > 1$$

d. Show that $x_1 < x_2$ implies that $g(x_1) < g(x_2)$ where $x_1 \in (-k, \infty)$ and $x_2 \in (-k, \infty)$

MAV suggested solution

$$g'(x) = \frac{k^2-1}{(k+x)^2} > 0 \text{ for } x \in R, k > 1$$

Hence $g(x)$ is a strictly increasing function.

OR

$$\text{Let } x_2 > x_1 > -k, k > 1$$

$$g(x_2) - g(x_1) = \frac{(x_2 - x_1)(k^2 - 1)}{(x_1 + k)(x_2 + k)}$$

$$x_2 - x_1 > 0, k^2 - 1 > 0$$

$$\text{If } x_2 > x_1 > -k \text{ then } -x_2 < -x_1 < k$$

$$\text{Hence } k + x_1 > 0 \text{ and } k + x_2 > 0$$

$$\text{Hence } g(x_2) - g(x_1) > 0$$

So $g(x)$ is a strictly increasing function.

OR

$$g(x_1) = k - \frac{k^2-1}{x_1+k}, g(x_2) = k - \frac{k^2-1}{x_2+k}$$

$$\text{If } x_1 < x_2, \frac{k^2-1}{x_1+k} > \frac{k^2-1}{x_2+k}, k^2-1 > 0, k > 1$$

$$\text{Hence } k - \frac{k^2-1}{x_1+k} < k - \frac{k^2-1}{x_2+k}$$

$$g(x_1) < g(x_2)$$

Question 4e

i. Let X be the point of intersection of the graphs of $y = g(x)$ and $y = -x$. Find the coordinates of X in terms of k .

MAV suggested solution

Solve $g(x) = -x$ for x .

$$x = -k + \sqrt{k^2 - 1}$$

$$y = k - \sqrt{k^2 - 1}$$

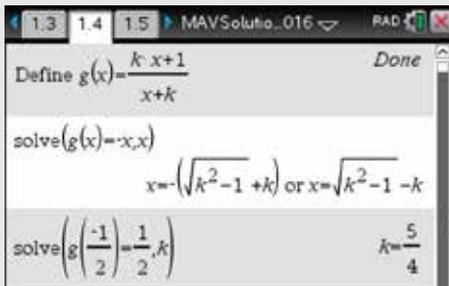
$$X(-k + \sqrt{k^2 - 1}, k - \sqrt{k^2 - 1})$$

e.ii. Find the value of k for which the coordinates of X are $(-\frac{1}{2}, \frac{1}{2})$.

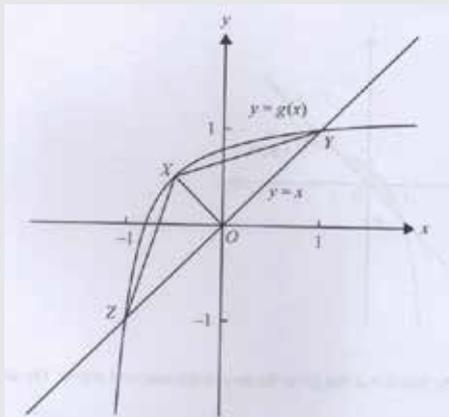
MAV suggested solution

Solve $-k + \sqrt{k^2 + 1} = -\frac{1}{2}$ for k .

$$k = \frac{5}{4}$$



e.iii. Let $Z(-1, -1)$, $Y(1, 1)$ and X be the vertices of the triangle XYZ . Let $s(k)$ be the square of the area of triangle XYZ .



Find the value of k such that $s(k) \geq 1$

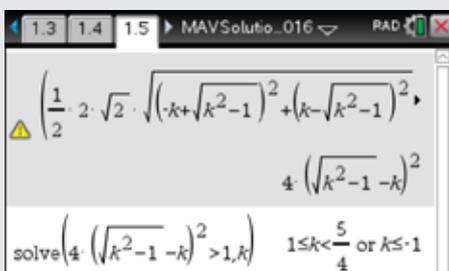
MAV suggested solution

$$YZ = 2\sqrt{2}$$

$$s(k) = \left(\frac{1}{2} \times 2\sqrt{2} \times \left(\sqrt{(-k + \sqrt{k^2 + 1})^2 + (k - \sqrt{k^2 + 1})^2} \right)^2 \right)^2$$

$$= 4 \left(\sqrt{k^2 - 1} - k \right)^2$$

Solve $s(k) > 1$, $1 < k \leq \frac{5}{4}$



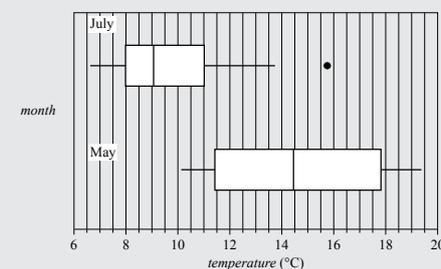
FURTHER MATHEMATICS WRITTEN EXAM 2

Students had difficulty with questions that required a worded answer.

Advice: A lot of practice is required with this type of question.

Core section: Question 2b

The boxplots below display the distribution of maximum daily temperature for the months of May and July.



i. Describe the shapes of the distributions of daily temperature (including outliers) for July and for May.

MAV suggested solution

The distribution shape for July is positively skewed with one outlier. The distribution shape for May is symmetric without outliers.

iii. Using the information from the boxplots, explain why the maximum daily temperature is associated with the month of the year. Quote the values of appropriate statistics in your response.

MAV suggested solution

The median maximum temperature for May is 14.5° which is different to the median maximum temperature in July which is 9.1° .

Consequently, the maximum daily temperature is associated with the month of the year.

Recursion and financial modelling: Question 5d

Students found difficulty in writing rules.

Ken has opened a savings account to save money to buy a new caravan.

The amount of money in the savings account after n years, V_n , can be modelled by the recurrence relation shown below.

$$V_0 = 15000, V_{n+1} = 1.04 \times V_n$$

d. The amount of money in the account after n years, V_n , can also be determined using a rule.

i. Complete the rule below by writing the appropriate numbers in the boxes provided.

$$V_n = \begin{matrix} \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \end{matrix} \times \begin{matrix} \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \end{matrix}$$

MAV suggested solution

$$V_1 = 1.04^n \times 15000$$

Students found writing recurrence relations challenging.

Question 6

Ken's first caravan had a purchase price of \$38 000. After eight years, the value of the caravan was \$16 000.

b. Let C_n be the value of the caravan n years after it was purchased. Assume that the value of the caravan has been depreciated using the flat rate method of depreciation. Write down a recurrence relation, in terms of C_{n+1} and C_n , that models the value of the caravan.

MAV suggested solution

b. Using flat rate method of depreciation, the recurrence relation is:

$$C_0 = 38\,000, \quad C_{n+1} = C_n - 2750$$

SPECIALIST MATHEMATICS

Students need to focus on understanding sampling distributions and hypothesis testing.

MAV publishes solutions to the VCAA exams. The resource contains answers and fully worked solutions to the 2016 papers. This resource comes with permission for the purchasing institution to reproduce copies for its students. You can purchase the solutions online at <http://shop.mav.vic.edu.au> or by contacting MAV on 9380 2399.

For further details on VCE resources and professional learning programs contact Helen Haralambous hharalambous@mav.vic.edu.au.

DESK MAP: THE SAME TASK TWO WAYS

Sarah Ferguson - Clairvaux Catholic School

This task comes from the department website. The task asked students to draw a map of their desktop to scale. It is intended that students will learn about scale and mapping through completing this task (look at the activity on page 13 for exact purpose). What follows is two possible ways to teach this task and some likely outcomes from these two different approaches.

WHAT IS SCALE?

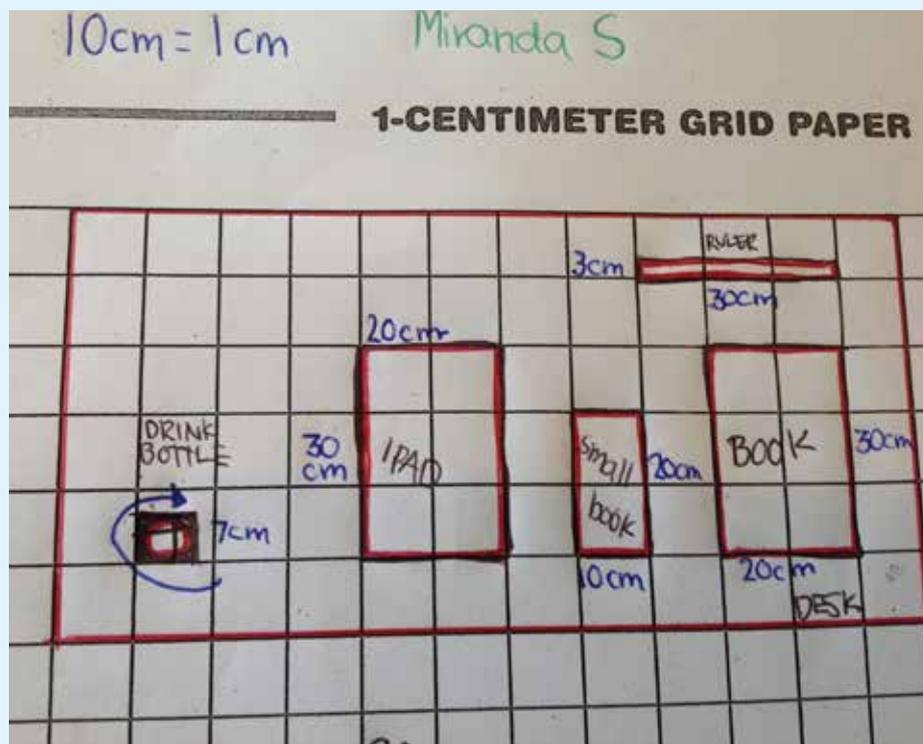
Teacher A plans to use this task with a Year 5/6 mixed ability class as part of a sequence of lessons about scale. Teacher A opens with a question on the board for the students to consider 'What is scale?' The teacher invites students to offer what they knew about scale. The discussion progresses slowly - expect many students not to participate and some to appear confused about the term.

When a student suggests an answer, the teacher will not comment except to say 'thank you. Does anyone else have anything to add to Ben's comment?' The students may not offer much substance during this discussion but the teacher should allow silences and half thought out ideas. After a couple of minutes, the teacher shows the instructions to the desk map task.

Students should work with the person sitting beside them. The task is broken down into two parts. Decide on a scale for your desk map and secondly draw the map of your desktop using this scale. Tape measures, rulers and paper will be provided. Students are invited to begin. The whole introductory part of this task should take five minutes.

Teacher B could also use the task as part of a sequence of lessons about scale with a mixed ability Year 5/6 class. Teacher B begins by reading the task to the students from the board. Teacher B then asks 'so what do we have to do?' Students suggest 'draw a map of what is on our desk' Teacher B adds 'to scale. What does that mean, 'to scale?'' The students are likely to be silent for about 5 to 10 seconds. Teacher B begins to work through the task by firstly deciding on a scale of 1:10. The teacher says 'so every 1 cm on my map will be 10 cm in real life.'

The teacher then models measuring a stapler from the desk and says 'So if this is 12 cm, how big will I make it on my map?' The students will eventually suggest 1.2 cm.



An example of a desk map using a 1:10 scale.

The teacher would write 'divide by 10' on the board. The teacher draws the stapler on the board using a ruler. Teacher B instructs the students to work with the person beside them and draw their desk using the scale 1:10. Teacher B would remind students to use a ruler or tape measure 'so that the drawing is accurate'. Students are invited to begin. The whole introductory part of this task would take 15 minutes.

THE DIFFERENT APPROACHES

As each class works through the task, students will be observed engaging in very different behaviours. In Teacher A's class, there is likely to be discussion, debate and talking. Teacher A will be very busy moving around the room and questioning the students as they work. About half the students will be drawing their desk map free hand without using a tape measure or ruler.

Teacher A should ask students if they have completed the first part of the task, deciding on a scale, some students will not have decided on this. Teacher A will ask questions like 'then how do you know if all these are the right size? In real life, does that folder take up about half the desk? Then on your map it should take up about the same size on your drawn desk as it does in real life.'

If students cannot decide on a scale the teacher could ask 'in real life if that folder is 25 cm long, how long will you make that on your map?' Most pairs of students will probably need to start again as their maps won't be to scale. Pairs that have decided on scale should write this on their map. There will be many different scales as the students work, prepare for one of those scales to be 1:1, that is, life sized.

The students in Teacher A's class aren't likely to have finished their desk map at the end of the 40 minute session, due to having to start over again. Teacher A should instruct the students to keep their maps and continue with them in the next lesson. It's estimated that the desk map activity would take 3 x 45 minute lessons to complete, including time for Teacher A to lead a discussion about the different scales used and the relative sizes of the desk maps.

In Teacher B's class, the students would likely work fairly quietly measuring at their desks with their partners. Teacher B would move around the classroom reminding students to measure carefully and to divide their measurements by 10 and to draw the measurements on their maps. Students would ask questions about dividing by 10.

At the end of 30 minutes students should have completed their desk maps. Teacher B would ask them to discuss the maps with another pair and compare their measurements. Some errors in measuring or dividing are sure to be discovered and students should correct these. The task would take one lesson to complete in Teacher B's classroom.

SAME TASK: WHY THE DIFFERENT OUTCOMES?

Let's examine the differences between Teacher A's and Teacher B's approach to implementing this task. Firstly, in terms of cognitive demand Teacher A's students are involved in 'doing mathematics' in that they would conjecture, use trial and error, and grapple with content.

Teacher B's students would be reproducing the teacher's method and following instructions or a procedure without connections being made to the concept of scale using a low level of cognitive demand. Considering work flow, Teacher A's class certainly seems bumpy in terms of the confusion and activity particularly during the first session.

With all the students able to choose their own scale, Teacher A has less predictability in what students would do and might need.

The students in Teacher A's class need a longer time to complete their maps though finished at different times. Teacher B's class had a smoother work flow in that it was relatively ordering and quiet. By assigning a scale, Teacher B could predict what student responses would be. The students all finish the task in one session and at about the same time.

RECONCEPTUALISE WHAT THE TEACHER'S ROLE IS

Should the teacher protect students from struggle or confusion or offer challenge within a supportive environment?

Is teaching modelling and explaining then having students replicate or offering challenges and supporting students to work it out for themselves?

Is the teachers role to know exactly what will happen and control this as much as possible or be open to surprises and surrender control to the students more?

Some teaching attributes that seem so natural and familiar, such as modelling and explaining, can actually reduce the thinking students need to do so that they are practising the teachers strategy instead of devising their own.

With a future we cannot predict, our students need practice in solving problems themselves and not have to rely on others to provide strategies for them. They need to practice what it feels like to struggle, to be confused, to grapple with a problem but then to think, to try and fail and try again so that they solve that problem themselves.

If you decide to teach the Desk Map Activity in your classroom, we'd love to hear your experience.
Email office@mav.vic.edu.au.

DESK MAP ACTIVITY

Students should make a careful scale map of some region, taking care with initial measurements, conversion calculations, and the final drawing. This map could be of an outside area or the classroom, but a quick and simple approach is to get students to make a 'map' of their desktop. This is a small area that can be measured quickly and accurately, and it is likely that there will be very few difficult angles.

Get students to place three or four objects on their desk. The map will be easier if the desk is rectangular and most of the objects are oriented parallel to the edges of the desk. Students take relevant measurements to draw a map of the desk top. To make it simple to begin with, a 1:10 scale could be used, with 1 cm on the map representing 10 cm of the desk top. You can let the students choose an appropriate scale rather than tell them to do 1:10

To help students appreciate what the scale is doing and how the numbers are used in calculating, the teacher may give students a 10 cm × 25 cm rectangle of paper to be one of the objects on the desk. This gives students one object for which it is easy to work out what the scaled version is; they may be able to generalise this to their other objects with more awkward dimensions. A second map using a different scale could then be produced, perhaps 2 cm = 5 cm (which is 1:2.5).

If students work out how to scale the 10 cm × 25 cm rectangle they will be able to use the same calculations in general. Graph paper may help students in drawing their maps.

Having made the map, its accuracy can be tested by using the map to calculate a distance that hasn't actually been measured

before now, such as between the corners of two of the objects. Students should measure this on their map, convert this measurement to a real-world distance, and then check by measuring on the desktop itself.

Students could also check each others' maps in this way.

ACTIVITY CAN BE FOUND AT:

www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/continuum/Pages/mapsscales475.aspx#a1

BLITZING VCAL NUMERACY

Grace Jones - Mount St. Joseph Girls' College

As a maths and science teacher I am always looking for new ways to engage and encourage students who do not particularly enjoy the beauty of mathematics.

Due to the changing landscape of education, we have seen a continued increase in students choosing VCAL as their senior program. As a college, we have focussed on building the understanding of the VCAL program to ensure that our students and their families are able to make an informed decision when navigating senior pathways.

This has led to a steady number of students choosing VCAL with a range of different backgrounds, interests and ability levels. In order to interest and inspire all of these students, I first surveyed the students in terms of areas they would like to learn more about. These areas ranged from understanding their time sheets at part-time work, knowing how to set up their own bank accounts and how to save money.

The majority of our VCAL students have achieved limited success in mathematics during their schooling, so we first worked to refine their basic skills before each project. To best prepare students to retain their skills and understanding, we regularly practiced common conversions and problem solving at the beginning of each lesson.

When I was given the opportunity to teach VCAL Numeracy, I aimed to develop a range of projects that catered for students with multiple entry levels and opportunities for success. I ensured that students had a range of options available in order to demonstrate the elements of each outcome so that they could continue to improve with each new project.

Due to the flexibility of the VCAL Numeracy curriculum, I was able to design the following key projects which have proved successful in both meeting student learning outcomes and catering to their different learning styles.

Students have really enjoyed and shown personal growth in their completion:

- Moving out of home
- Backyard blitz
- Criminal intelligence



Grace Jones and two of her students with their backyard models.

MOVING OUT OF HOME

This project focuses on getting students ready to move out of home and become independent. As part of an integrated program, students are given the opportunity to apply for jobs, attend mock interviews, decipher pay slips and prepare their own budgets.

This allows students to demonstrate elements of personal development skills, work related skills and literacy as they prepare for interviews, write professional letters and practice in groups. Students are encouraged to see the big picture in numeracy by exposing them to utility bills, transport costs, rental forms, phone contracts and costs of food and drinks.

In doing this, we also link back to the average incomes earned in their chosen industries, highlighting the challenges they will face in budgeting and saving. Students were not only able to budget, project income and personal costs but to also decide on the need for other expenditure such as trips and luxury items.

The final part of this project was to find a suitable vehicle that students would like to purchase when they move out of home.

Students researched all features of the chosen vehicle, the costs in purchasing, registering and insuring the vehicle plus maintenance and licensing required. This allowed students to begin making plans for their own futures in terms of how much they need to save and prepare themselves for.

BACKYARD BLITZ

Students are given the task of designing, planning, sketching, budgeting for and creating a model of a backyard for a family.

They are given a set budget, we head to Bunnings and the whole project comes together as a portfolio for the family.

This allows students to demonstrate their creativity while also showing their ability to manage time, money and use their measurement skills. In order to manage this task, students are required to complete this project in stages:

- research and inspiration
- drafting
- budgeting
- planning
- designing
- modelling
- presentation and final report.

By separating a large project into smaller and more manageable tasks, students were able to complete each stage to their own level and in their preferred order.

Some students were able to present a virtual model using computer programs while others were able to create solid, realistic models using timber, artificial turf and lego pieces.

CRIMINAL INTELLIGENCE

As a more exciting way to engage students with data collection, presentation and analysis, we completed a forensic science unit which focussed on not only collecting our own data, but also taking advantage of the data available through the Australian Bureau of Statistics.

Students investigated patterns in crime statistics over the past decade, analysed fingerprints, the handwriting of ransom notes, blood splatter patterns, characteristics of substances often found at crime scenes as well as solving a mock crime case.

In having a different focus such as forensic science, student engagement reached an all time high. Students were able to work outside creating and analysing blood splatter patterns, in the laboratory testing substances and examining fibres under microscopes as well as on their laptops creating spreadsheets, tables and graphs to present the information in the most effective way.

Current news stories were also able to be dissected, debated and analysed as a way to relate statistics to the real world. The forensic science focus proved to be the 'hook' required to gain student attention and maintain their interest and motivation.

These projects have engaged our students to look forward to numeracy lessons here



at Mount St. Joseph Girls' College. Our students are all able to achieve success and demonstrate their understanding in a creative and interactive way. We have also completed challenges such as comparing car loans, planning a trip around Victoria for a family and a spring carnival unit that focuses on probability.



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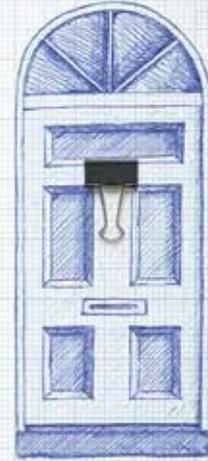
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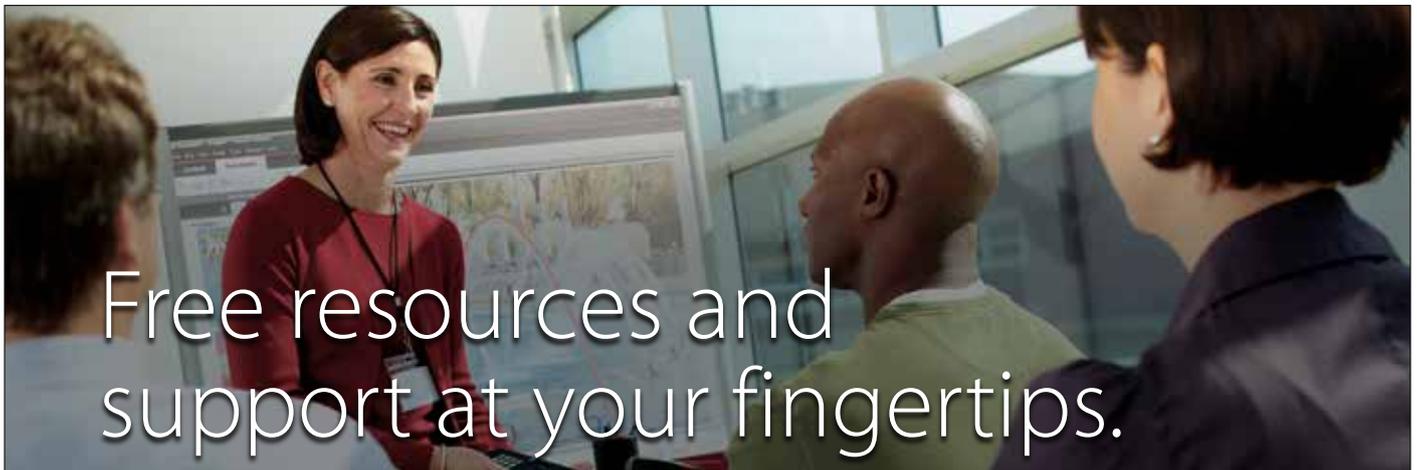
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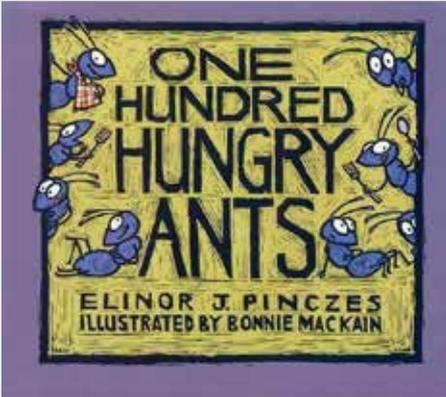


BOOK REVIEWS

Ellen Corovic - Mathematics education consultant, MAV (*One Hundred Hungry Ants*)

Josh Shuttleworth - Year 1/2 teacher, Derrimut Primary School (*Uno's Garden*)

ONE HUNDRED HUNGRY ANTS



I was quickly captivated by the roll of the rhyme and imagery depicted in Elinor J Pinczes' *One Hundred Hungry Ants*

It's a simple idea - 100 ants march to a picnic to get 'yummies for our grumbling tummies'. It demonstrates different ways to make 100 as a rectangular array. The 100 ants start marching in one row before the littlest ant exclaims that they are marching 'way too slow' and as such suggests that the ants march in two rows of 50 ants.

The ants scurry around to create the new formation... but are they simply wasting time? From one row of 100 ants to two rows of 50 ants and so on, they scramble until the ants marching in 10 rows of 10 to reach the picnic spot.

The story is catchy and repetitive in nature which enables children to quickly tune into the mathematical idea. The illustrations are vivid, whimsical and lively and a good visual representation of the mathematics.

This book could be a good introduction to arrays, ways to make 100 or division. It would be suitable for Preps through to Year 4 students depending on the mathematical focus. Either way, students will enjoy this story, particularly the way it ends!

USING THE BOOK IN YOUR CLASSROOM

Foundation

Use a variety of materials to make 100. Explore a range of ways to organise the resources for ease of counting.

Create a class chart using the sentence starter 'Clever counters...'

Level 1/2

Use a variety of materials to model the different grouping arrangements for 100. Record these 'groups of' statements. For example 10 groups of 10 is 100.

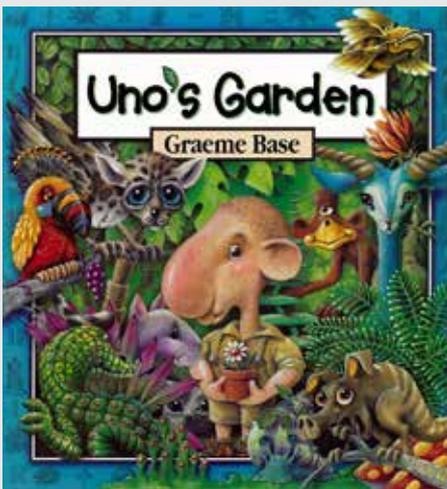
Alternatively use 12 and 24 and arrange these numbers into arrays and record using the groups of expression or the division version of shared between eg 24 shared between 4 groups is 6.

Level 3/4

Go on an arrays hunt. Locate and record the arrays that can be found around the classroom and or school. Take a photo of the array and record an appropriate number sentence using multiplication or division.

Investigate factor, factor, product relations. For example, explore a range of numbers and create a list of all of the factors for each number (product). Use hands on resources to support the investigation and recording.

UNO'S GARDEN



From the author of childhood favourites *Animalia*, *The Eleventh Hour* and *The Worst Band In The Universe*, comes Graeme Base's thought-provoking story, *Uno's Garden*. Set in a beautiful forest full of colourful flora and fauna, this tale explores the ideas of sustainability and environmental responsibility.

The story begins with Uno deciding to move into the forest, but it isn't long before others follow suit. As more people move into the area, plants and animals are gradually replaced with buildings and roads. It isn't long before the city is nothing but concrete and steel, with not a hint of nature in sight.

Uno tries to repair the damage by planting and tending to his own garden, but he grows old and dies (as does the recurring creature, the Snortlepig). Luckily, others within the community take responsibility for the garden, and the plants and animals slowly return to the area - except Snortlepig. The story ends with a message of hope that one day, this creature might return.

Uno's Garden provides a range of teaching opportunities across different curricular areas, with its exploration of narrative structure and patterns, alliteration, and Dahl-esque creation of words for literacy, links to sustainability for science, and numerical patterns and number facts for maths.

The book features a tally of animals, plants, buildings, and the Snortlepig on each page. They change over time in different ways, with some doubling, some looking at square numbers, and some increasing or decreasing by one at a time. This variation allows the text to be explored across different year levels.

The Snortlepig is hidden on each page, which also lends itself to exploring location-specific language. Is he under the tree? To the left or right of the house?

Overall, this is a book that students and teachers alike will love thanks to its detailed illustrations and relatable story. It should make for an engaging link to maths in your classroom.

One Hundred Hungry Ants and *Uno's Garden* are available from the MAVshop, order online at <http://shop.mavvic.edu.au>.

GAMIFICATION: IT WORKS

Gamification is the use of the elements found in games to engage learners in their learning. Some of the benefits of gamification are:

- allows a variety of learners to access to content
- is available on demand
- challenges the learner
- provides a supportive learning environment
- is non-judgmental
- interactive
- allows risk taking
- empowers the learner
- provides feedback
- provides coaching
- provides opportunities to engage with content in different contexts
- supports different forms of learning outcomes, social and academic

There are links between gamification and the requirements of twenty-first century learners. This exploration of this connection can be used a catalyst for rich conversations concerning best teaching and curriculum design.

Gamification is another tool at the teacher's disposal and one that requires thoughtful application for it to be effective. Making informed curriculum choices to achieve learning outcomes is critical. Teachers carefully plan how and when games, iPad's, tablets and other technology should be used in the classroom.

When asked about their mathematics experience students will often respond, 'We didn't do anything ... we played games!' The learning purpose when 'playing' any mathematical game should be an integral part of the experience, linked to the provision of effective feedback and fundamental to being engaged as a learner.
- David Cook

A great way to involve parents in students' learning through games is to host an family maths night at your school. MAV has developed a comprehensive resource full of games and activities so you can easily run a family maths night - all the planning has been done for you! Here are some sample activities to give you an idea of the rich tasks involved.

WHICH WAY HOME?

How many different ways can get home by moving along the lines and always moving up or to the right?

How can you record your moves? Is there a pattern? How could a pattern help answer this question?



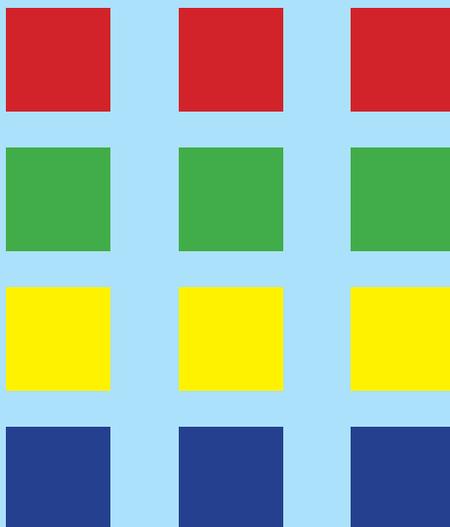
BLOCKS AWAY!

Read the clues below to work out which block was which colour.

Hint: Read all of the clues before you start

Directions:

- There is one blue between two yellows
- There is one blue under a green
- One green is between two reds
- Two greens are next to each other
- The yellows are to the left of the greens
- The reds are to the right of the blues
- There are only three piles
- Eight of the blocks are used



DOGS OR CHICKENS?

In the farmyard I saw some chicken and some dogs.

I counted 25 heads and 78 legs. Using the dog and chicken cards provided:

- How many dogs were there?
- How many chickens were there?

Explore different ways of finding the answer.

When you have found a different method use this new method to solve the question below.

In the next paddock I saw some sheep and some chicken.

I counted 12 heads and 40 legs.

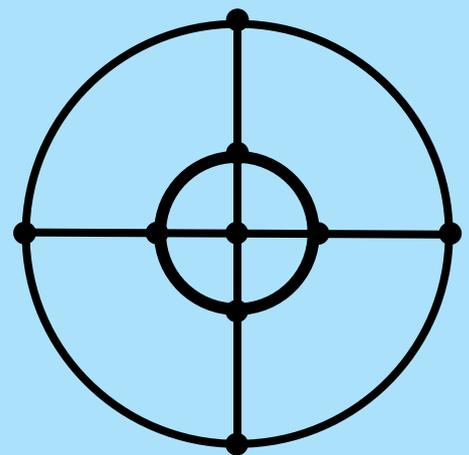
- How many sheep were there?
- How many chickens were there?

LAST PICK

Place one counter on each spot.

Players, in turn, remove one counter or two adjacent counters. 'Adjacent' means that they are connected by a line and there are no other counters in between.

The winner is the player who picks up the last counter or the last two counters.



The Family Maths Night Resource is available from the MAVshop as a downloadable PDF,
<http://shop.mav.vic.edu.au>.
If you'd prefer MAV to run your Family Maths Night, we recommend that you book now by emailing Ellen Corovic,
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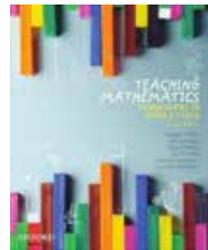
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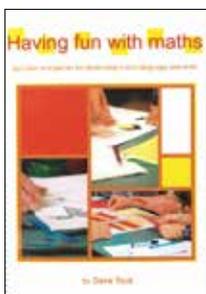


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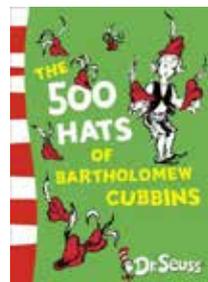


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6-
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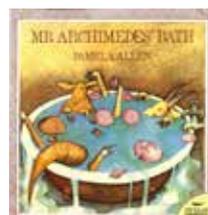


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1-4

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