THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR

4/17

MAKING AND BREAKING CONJECTURES

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One of the most fascinating things about loving mathematics is that hardly anyone has a clue what you do.

Think about that. If I say I love comics or camping or hiphop or opera or basketball or history or science, people have at least a vague notion of what I mean. But mathematics? So many people's last experience with maths was trying to memorise and apply formulas they didn't fully understand, to solve exercises they didn't care about, to pass a class they were forced to take. So if I rhapsodise about how mathematics powers the imagination by harnessing logic and is much about choice and creativity and freedom as it is about following rules - and in fact, that we choose to follow rules because the structure they provide gives us more power - well... I should expect to lose some people.

Continued on page 4

THE COMMON DENOMINATOR
The MAV's magazine published for its members.

Magazine 264, October 2017

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Print Post Approved
Publication No: PP100002988

FROM THE PRESIDENT

Michaela Epstein

The team at MAV is gearing up for this year's annual conference, MAV17 held on 7-8 December at La Trobe University, Bundoora Campus. This two day event will bring together over 1,500 maths educators from across Australia and overseas. Since I first started attending four years ago, I've been thinking about what has kept driving me back.

The MAV conference is an event where you can settle into the familiar, seeing speakers you've heard at previous events or whose work has influenced your practice. It's not an event where you just walk in and out of sessions, as a passive recipient of information thrown your way. Instead, the conference environment and many of the sessions themselves encourage interaction and continued discussion long after it's over. I keep going back each year to see how people's ideas are evolving. For the teacher who'd started with a new program or teaching technique and presented on it last year, how are they faring? What new ideas do they have? What have they reflected on and changed?

I know that when I'm at the conference, I will catch up with people who share a passion and deep curiosity for maths education. Each year I return, there are people whose approach to their craft I completely admire.

And because there are so many speakers, from all walks of the education community, I know that I will always be surprised.

While it's easy and tempting to keep going back to the familiar, with such a colourful menu of around 350 session options, why limit yourself? Last year, I found myself in Professor Joanne Mulligan's keynote on understanding pattern and structure for early learners. As someone with a background in secondary teaching, this was not the usual forum for me to be in.

However, listening to Joanne describe her research on the capabilities of young children gave me rich insights into the trajectory of student development. Joanne's presentation highlighted how the questions we pose can limit the extent to which students can express their mathematical understanding, or they can allow students to flourish. From the talk, I reflected on my own assumptions and left with new ideas for the work I do with much older students.

So at MAV17 this year, in addition to heading to presentations by known favourites, I am committing to go to new sessions, and dabble in the unknown. And for you, I encourage the same. Take a chance with a new name or topic. Who knows what surprise or new perspective it will bring?

If this is your first MAV conference, then all the better! Take the time to enjoy the exhibition hall; linger after sessions and dive deep into conversation with a presenter; hang around for networking drinks on Thursday to make new connections; and share some moments from your conference experience on twitter, via #MAVCON. It would also be remiss of me not to suggest you wear comfortable shoes. This isn't one of those conferences where you will be sitting inside a stuffy room all day, slowly falling into a slumber from lack of movement. By sly design, the MAV17 experience comes pumped with short spurts of walking between sessions and breaks, keeping your mind active and alert throughout the day.

Be prepared for a professional learning event that will get you invigorated for 2018. See you there!

REFERENCES

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

ARE YOU A PUZZLER?

The MAV is looking for a few teachers to contribute puzzles to each edition of *Common Denominator*. These could be worded problems, stimulus images, numerical problems, diagrams, crosswords - anything really!

Each puzzle would be accompanied with a relevant link to the Victorian Curriculum.

If you are interested in finding out more, contact Darinka Rob, office@mav.vic.edu.au.

PROFESSIONAL DEVELOPMENT

During Term 4 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
It's called number **and** algebra: algorithmic thinking across primary years (webinar)	12/10/17	2-6	Tim Colman
The importance of developing children's counting skills: the move from role to rational counting (webinar)	26/10/17	F-4	Catherine Pearn
MAV17 - MAV's annual conference	7-8/12/17	All	Various

MAV MEMBERSHIP

Your Mathematical Association of Victoria membership is your gateway to the mathematics education profession. The MAV is proudly 'by mathematics educators, for mathematics educators' and we are committed to advocating for and promoting the profession in Victoria.

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- In-school consulting
- Annual conference
- Primary conference
- Student activities
- Newsletters and journals
- Publications and resources
- Advocacy, representation and professional advice

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

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Visit www.mav.vic.edu.au/conference to view the full conference synopsis and register to attend.
Sessions fill up fast, so register as soon as you can.

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TEXAS INSTRUMENTS

MAKING AND BREAKING CONJECTURES

(CONT FROM PAGE 1.)

Dan Finkel - Math for Love

Some time ago, my partner Katherine and I started to formulate structures that would entice people to join in the mathematical experience; to become doers and thinkers when it comes to math, in other words, rather than bystanders. The original formulation of these were our *Five Principles for Extraordinary Mathematics Teaching*:

1. Start with questions.

2. Give students time to struggle.

3. Refuse to be the answer key.

4. Say yes to student ideas.

5. Play!

I loved, and still love, this formulation, with its emphasis on questions, curiosity productive struggle, understanding, and play. Still, it feels like there was more do to when it came to distilling the process of mathematical thinking itself. What do mathematicians actually do with themselves when they sit down to work?

This question led us to develop a new framework: *Making and Breaking Conjectures*. This, I believe, makes even clearer the process by which mathematical thought occurs, and mathematics, as a field, progresses.

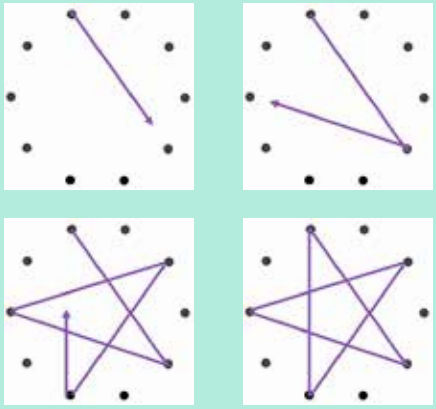
STEP 1. BEGIN WITH AN ENTICEMENT, NOVEL SITUATION, OR PROVOCATION.

It's a new environment to play around with! Explore, observe, and follow your instincts to observations and questions.

Mathematics starts with playing or pondering, and it's the most natural thing in the world. We just need a good prompt to stimulate our curiosity.

For example, I sometimes doodle by drawing dots in a circle and connecting them up with straight lines. Here's a picture of 10 dots, evenly spaced. If you were to place your pen at one dot, and draw a straight line to every fourth dot, I wonder what would happen.

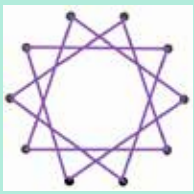
Only one way to find out!



Connecting the dots four steps away.

The fact that connecting to every fourth dot until I returned back to the beginning created a five-pointed star feels like a surprise to me, but it's a delightful one. I wonder what other shapes I could make! I wonder, too, if I could connect up all the dots if I connected them using a different rule. So, I play some more. What if I connect the dots three steps away instead of four steps away?

This design is even prettier! What's more, I think I understand what's happening: when I connect dots an *odd* number of dots away, I hit all the dots; when I connect dots an *even* number of dots away, I don't.



Connecting the dots three steps away.

For many students, this is where things end: they cry, 'I found the pattern!' Then the teacher has to step in and tell them if they are right or not.

But for us, it's just the beginning.

STEP 2. MAKE CONJECTURES

> *Conjecture. A mathematical hypothesis. An educated guess based on patterns, behaviors, or data we have observed so far.*

Conjectures are central to mathematics. What's particularly important about them is that they are often wrong. This doesn't bother me, though, so I'll go out on a limb and state my 'answer' as the conjecture it really is.

My Dot Conjecture. *If I connect the dots in a circle using an* odd *skip rule (i.e., connecting every third dot), then I'll connect every dot. If I connect the dots using an* even *skip rule (i.e., connecting every fourth dot), I'll connect only half the dots.*

Stating my conjecture does two things. First, I've now got skin in the game. I've staked a claim, and I want to know if it turns out to be true or not. Second, I've recognised that the 'answer' I thought I had ('I found the pattern!') is really just a guess at an answer. The process of thinking isn't done yet.

In fact, I teach my students that whenever they see a conjecture, their first instinct should be to break it.

STEP 3. BREAK CONJECTURES.

Mathematicians use a wonderful tool to prove each other wrong, and it can be used with students of any age. This miracle-tool is called a counterexample.

> *Counterexample. An example that proves a conjecture (or 'fact') false.*

For example, someone might tell you that any 2-D shape with four equal sides is a square. Seems reasonable. But it's not true! There are all variety of rhombuses that aren't squares.

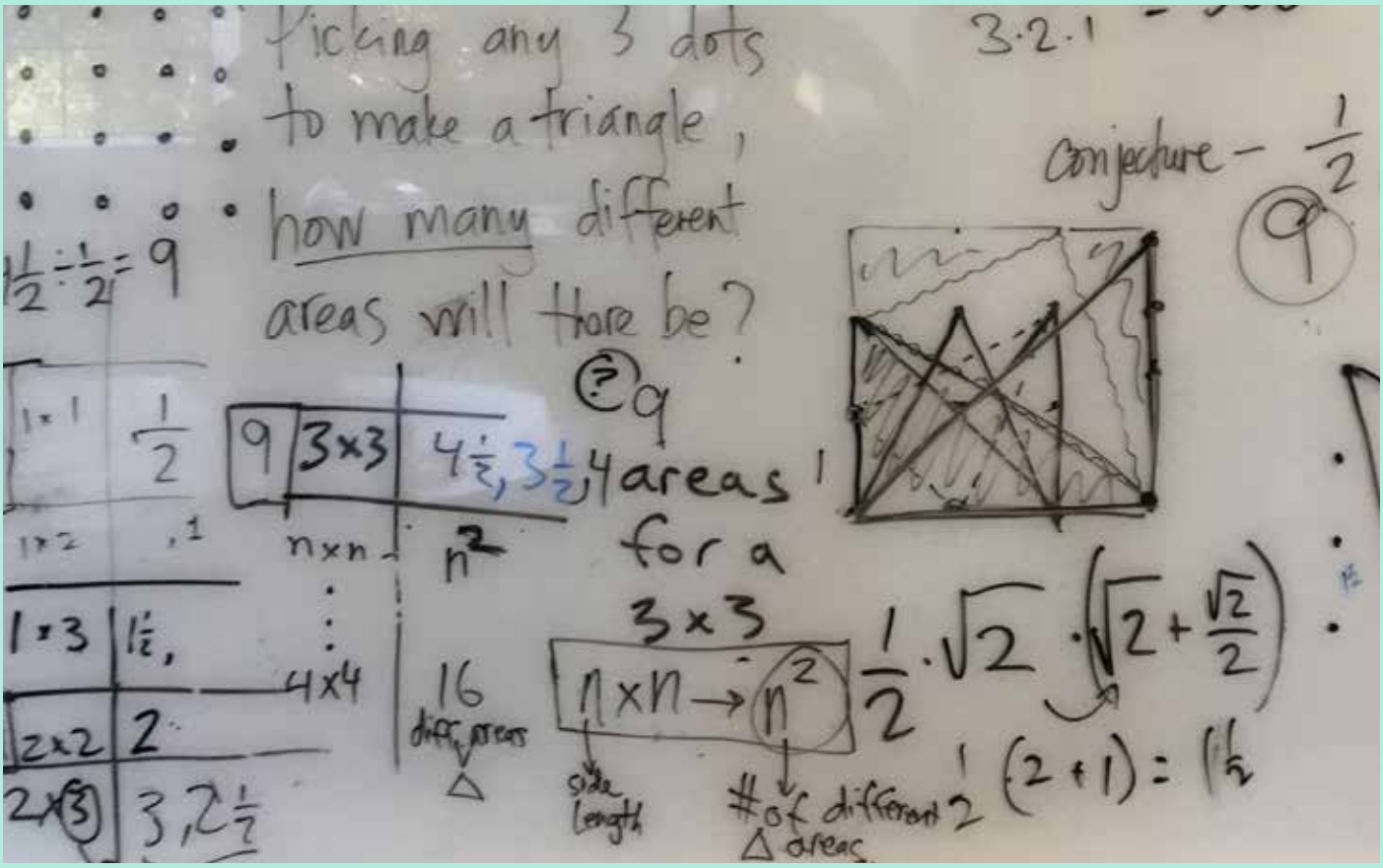
Four equal sides, not a square.

Or you might think that multiplying always makes numbers bigger. This, too, feels very reasonable, and I'd wager that many students (and adults) are walking around assuming that it's true. But watch:

Conjecture. *If you multiply two numbers together, you always get a product that is larger than either of the numbers you started with.*

The moment we state our intuition as as a conjecture, we have effectively painted a bullseye on it. Instinctively, I want to break it.

Can I find a counterexample, or is it actually true? There is motivation now to explore, to push into strange cases you haven't considered before, and determine whether the conjecture will hold up as we put it through its paces.



A whiteboard records the rich mathematics one group explored while making and breaking conjectures.

My Dot Conjecture, then, is just the first step of a mathematical adventure. Someone can show me that I'm wrong ('What if you connect to the dots five away?') and I, first, can see that I was wrong, and second, can refine my conjecture to make it better ('Obviously the conjecture won't hold in the case that I'm connecting to a dot exactly halfway around the circle. That's a special case.')

PART 4. REFINE YOUR CONJECTURES, AND BREAK THEM AGAIN. REPEAT.

And this is begins a cycle or conjectures and counterexamples that lead to, eventually something approaching the truth, and by the time we find it, we want, more than ever, to be able to convince ourselves that it is actually true. It's a truth we worked for, so we value it, it means something to us, and it is far more robust that the 'truths' we inherit from well-meaning teachers and promptly forget.

Depending on the age and proclivity of the students we work with, we may be able to move into deeper mathematical arguments and proofs. But even if we don't get all the way there, this cycle of exploration by way of conjecture and counterexample is the stuff mathematics is made of. When I say I love mathematics, this is the kind of experience I'm talking about, and the reason I love it is because it is such an adventure. As soon as I look closely enough at some novel situation to make a conjecture, I find myself on a journey where I'm inevitably surprised, bewildered, and enriched. I'll be wrong many times, of course, but I'll be stronger for it, just like getting lost in the woods is the best way to learn your away around.

There's so much to recommend the process of making and breaking conjectures. It demonstrates to students the value of being wrong, and how to learn from mistakes. It does wonders for motivation, and lets students delight in proving each other - and the teacher - wrong, towards a good end. It makes us hungry for tools and strategies that will let us explore in more organised and creative ways. It also leads to robust understanding.

But more than anything, making and breaking conjectures is where the real process of mathematics begins. We can do it at any age, and by making the process central in our classrooms, we invite students into the process of authentic mathematical thinking.

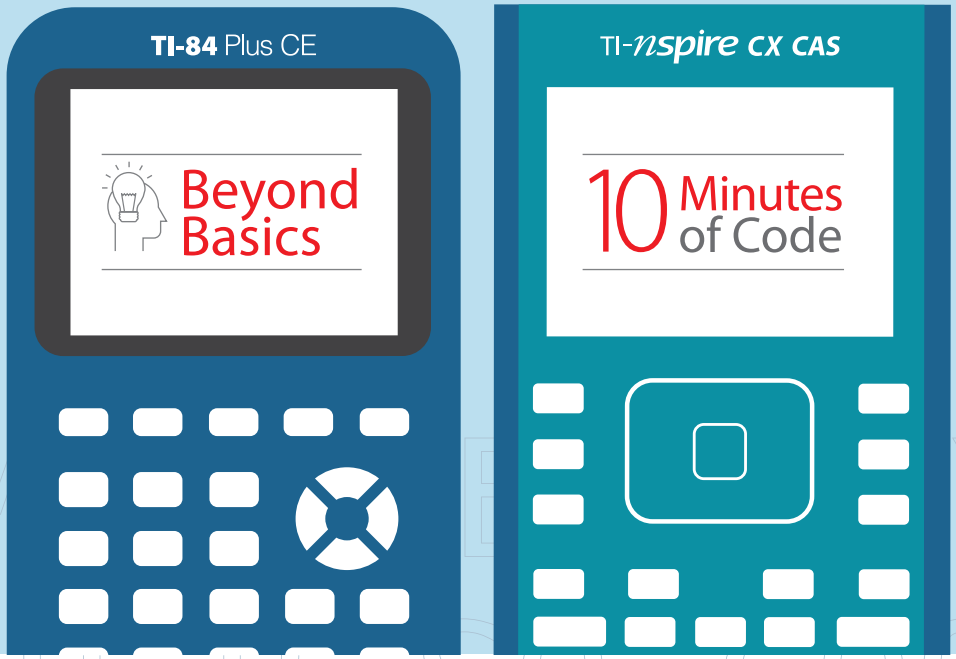
This, I claim, is what mathematics is really about. But if you can prove me wrong, I'd love to hear your counterexample.

Dan Finkel will present keynotes at MAV's annual conference, MAV 17. His first keynote will focus on further exploring the topic of making and breaking conjectures. His second keynote will look at how students can often get lost in the technicalities of mathematics. Dan will also present a workshop on playful exploration to deep questions.

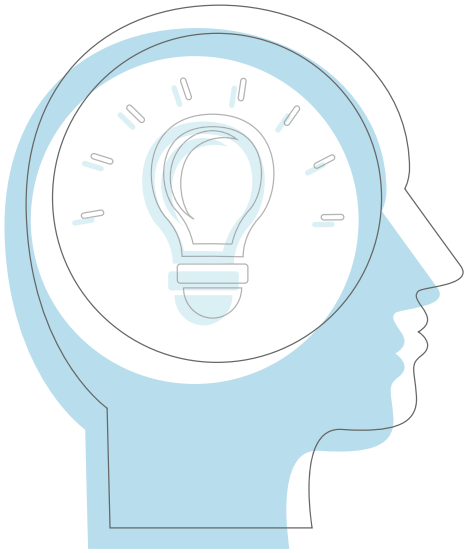
Dan's presence at MAV17 is supported by Maths Pathway.

TI Codes

Introduce students to the basics of coding, a critical skill for 21st century careers in science, technology, engineering and maths (STEM).



Encourage students to explore basic programming using the TI-Nspire™ or TI-84 Plus technology they use every day.



TI Codes offers:

10 Minutes of Code
Engage students in short activities that build understanding of maths concepts, programming logic and coding skills.

Beyond Basics
Encourage students who have some coding experience to build on their knowledge with these innovative activities.

Teachers' Lounge
Find resources to help students develop the foundational logic and mathematics of programming.

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CODING IN MATHS

Matthew Atanasovski - Year 2 teacher, Bell Primary School

The teaching of digital literacy in the modern day classroom is a global education trend on the rise.

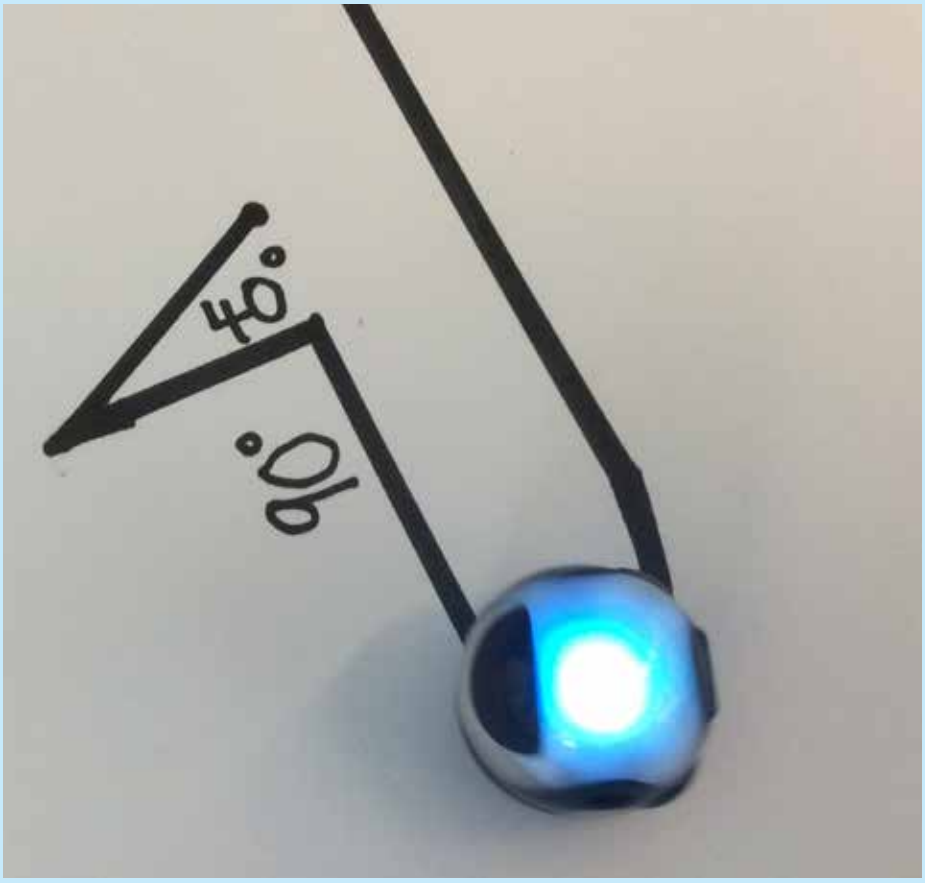
The inclusion of coding – the algorithmic language of computers – in school curriculums around the world exemplifies a shift away from the focus on instructing children how to use computers, applications and programs towards teaching them about how computers are built, how they work, and how to instruct their function and behaviour through coding. By teaching coding from an early age, it is widely believed that children will acquire the skills necessary to create, design and adapt technology to meet future requirements.

Digital technology supports students to develop their ability in problem solving, critical thinking, creativity, expression and communication. One of the ways they can do this is through algorithms. The word 'algorithm' may not seem relevant to students, but the truth is that algorithms are all around them, governing everything from the technology they use to the mundane decisions they make every day. Algorithms are fascinating and, although some are quite complex, the concept itself is actually quite simple.

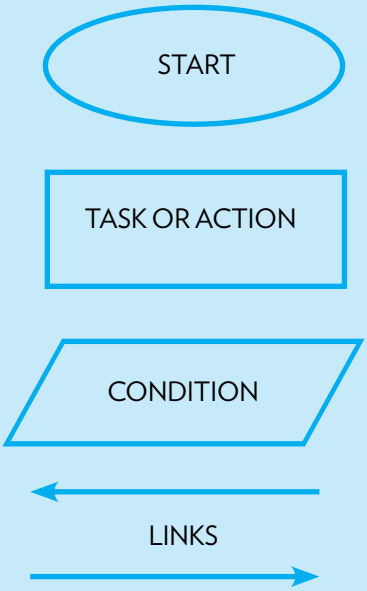
An algorithm is a detailed step-by-step instruction set or formula for solving a problem or completing a task. In computing, programmers write algorithms that instruct the computer how to perform a task. When you think of an algorithm in the most general way (not just in regards to computing), algorithms are everywhere. A recipe is an algorithm, the method you use to solve mathematical problems is an algorithm, and the process of folding a shirt or a pair of pants is an algorithm. Even your morning routine could be considered an algorithm!

Algorithmic thinking, or the ability to define clear steps to solve a problem, is crucial in subjects like numeracy and science. Students use algorithms without realising it all the time, especially in numeracy.

Kids can strengthen their algorithmic thinking skills (with or without digital technology) by completing coding activities. As an example, students can create simple yes/no flowcharts about how to perform basic numeracy operations, for example, how to do subtraction. The types of information can be categorised and represented with shapes. The oval being the start, the rectangle representing a task or action, the parallelogram a condition and the arrows a link between concept. This simple task is a very easy way of introducing the concept of algorithms.



Ozobots are an excellent way to teach and demonstrate angles.



BEE-BOT

Bee-Bot is a unique and versatile classroom resource, which will delight and engage children in a wide variety of cross-curricular learning activities. Bee-Bot is the ideal support for helping you teach early computing and programming. With a simple child-friendly layout it's a perfect starting point for teaching control, sequencing, directional language and algorithms.

Bee-Bots help students understand what algorithms are; how they are implemented as programs on digital devices; and that programs execute by following precise and unambiguous instructions.

They are a perfect tool to use in early years classrooms to help students describe position, direction and movement, including whole, half, quarter and three-quarter turns.

They also promote the use of mathematical vocabulary to describe position, direction and movement, including movement in a straight line and distinguishing between rotation as a turn and in terms of right

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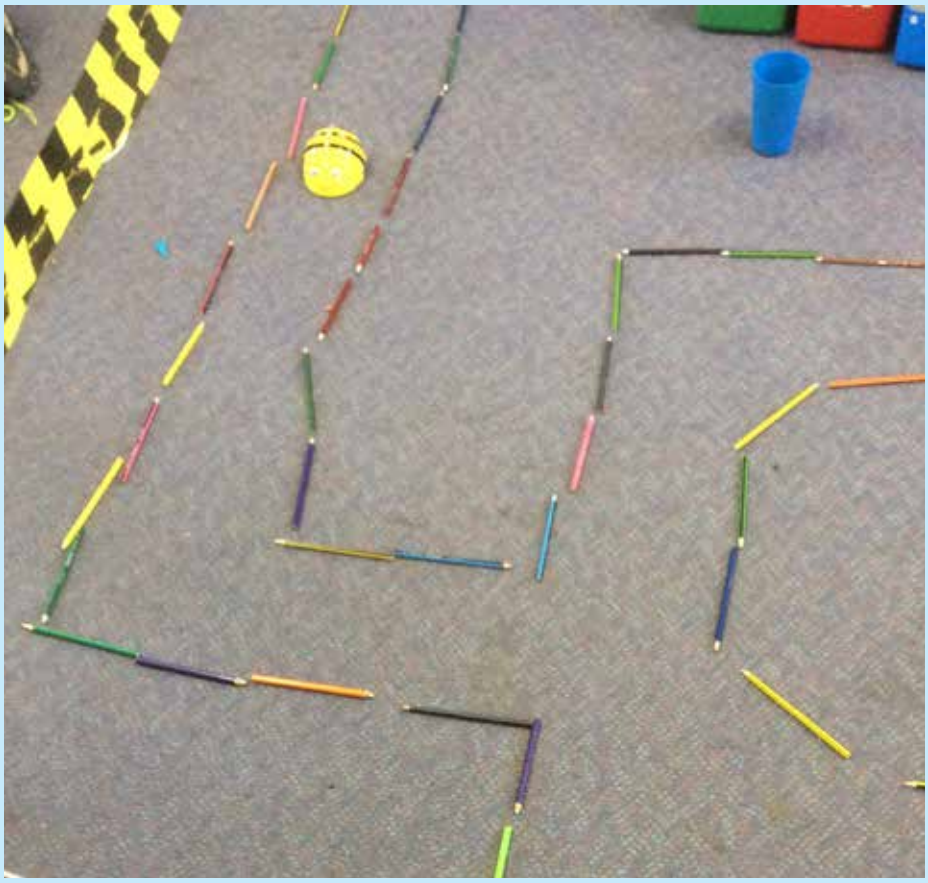
CODING IN MATHS (CONT.)



Students using their directional skills and language to navigate self made tracks with Bee-Bots.

angles for quarter, half and three quarter turns (clockwise and anti-clockwise).

Simple hands-on activities can be set up, for example writing simple algorithms for the Bee-Bot to manoeuvre around certain tracks or obstacles.

OZOBOT

An Ozobot is a small and smart line following robot. It uses precise movement and sensors to follow and react to colors on a page or screen. This simple form of communication and programming allow children and adults of all ages to create and send Ozobot through an endless array of mazes, maps, and racetracks.

If your students have never used Ozobots before, give them time to explore with them. I shared how to calibrate them using the black dot and also modelled how to use the markers to draw a track for them. Partner the students up and give them a piece of white paper for them to draw a track on. Then let them go explore! Some of the students may draw a track and some may create an Ozobot race.

It's a fantastic way for students to tap into their creative side and see all of the different things that are created for the Ozobots.

Ozobots are perfect to incorporate into shape lessons. In early years, students can a track, incorporating draw two-dimensional shapes. Angles can also be explored through the use of Ozobots. Students can draw a track for the Ozobot to travel on, however write a set of expectations.
For example:

- Draw four angles for your Ozobot to travel on
- Label the angles
- Using the angles, create a track for your Ozobots
- Add some colour codes (colour codes make their track more interesting as it can make the Ozobot go in turbo mode, turn around, spin etc.)
- Have fun!

Provide students with a piece of paper, a protractor and an Ozobot. It works well when students first draw their angles and then connect the angles to make their track.

SCRATCH JR

ScratchJr is an introductory programming language (available on iOS and Android) that enables young children to create their own interactive stories and games. Children snap together graphical programming blocks to make characters move, jump, dance and sing.

CONCLUSION

Digital technology is here and it is here to stay. As educators, it is our job to equip 21st century learners with the skills that will ultimately see them flourish in life. Digital technology should not be feared, nor the digital technologies curriculum. I hope I've introduced you to a few simple ways that you can incorporate digital technology and coding into your mathematics classes.

For more information on a MAV professional learning program centred around algorithmic thinking or coding, get in contact with Jen Bowden, jbowden@mav.vic.edu.au.

DEVELOPING FLUENCY: CARDS VS DICE

James Russo - Belgrave South Primary School and Monash University

Players engaged in a game of Cards-vs-Dice.

This simple card and dice game provides students in Foundation to Year 2 with opportunities to reinforce their knowledge of doubles facts. Through engaging in the game, students are exposed to helpful back-up strategies – such as counting by 2's, counting on and bridging through 10 – which can be applied when either a doubles fact is unknown, or a student is only somewhat confident in their response.

Applying these back-up strategies allows students to build their conceptual understanding of how doubles facts are constructed and calculated (e.g., representing a doubles fact on a bead frame, and then counting by 2's), whilst the repetition in the game provides opportunities to build fluency in accurately and rapidly recalling this important set of number facts. The game can be modified for older students to expose them to more sophisticated mental computation strategies (e.g., number splitting), as well as to support the learning of times tables (e.g., four times tables).

MATERIALS

Gameboard. Any sort of gameboard with a track which includes a beginning and an end is potentially suitable. If a gameboard is not available, you can instead use a hundreds chart, with players beginning at 1 and ending at 20.

Cards. Picture cards are removed, while the tens are kept in the deck.

Dice. A 20-sided dice is preferable. Alternatively, two 10-sided dice can be used instead and summed together (see modifications and extensions).

Counters. One counter per player.

Bead Frame. This supports students with applying back-up strategies if they are uncertain about particular doubles facts. Students can represent the doubles fact on the bead frame.

HOW TO PLAY

The game is suitable for two players, although a third player can be introduced (see modifications and extensions)

Player 1 uses the cards. The deck of cards is shuffled and placed face down. Play begins by Player 1 turning a card over. Player 1 then needs to double the number on the card, with the answer to this doubles fact serving as their score for that round. For example, if the student turns over an Ace, their score will be 2 (1 + 1 = 2); if they turn over a 6, their score will be 12 (6 + 6 = 12); if they turn over a 10, their score will be 20 (10 + 10 = 20). The student uses a bead frame (and a relevant back-up strategy) to check the doubles fact if either they are unsure about the fact, or Player 2 disputes their initial calculation.

Player 2 uses the dice. After Player 1 has performed their calculation (and Player 2 has concurred), Player 2 rolls the dice. The number rolled represents Player 2's score for that round.

Whoever rolls the higher score advances their counter one space on the gameboard. The first player to the finish is the winner. After the game has been completed, get players to switch roles.

SUPPORTING THE MATHS

If students do not know their doubles facts fluently (particularly the more difficult facts such as 6 + 6, 7 + 7, 8 + 8 and 9 + 9), they should be encouraged to use an efficient back-up strategy. The substantial repetition in the game (if play continues until the deck is depleted, each doubles fact would have appeared on four occasions) enables students who initially used a back-up strategy opportunities to attempt to recall the doubles fact when they encounter it again on subsequent occasions.

If a student is unsure of a doubles fact:

- In the first instance, students should be encouraged to represent the doubles fact on a bead frame. For example, if required to represent double seven, students would ensure there were seven beads on both the first two rows (see Figure 1).

Students can be encouraged to use a preferred back-up strategy. Students should be dissuaded from counting all the beads by ones. Instead, they should be supported to either:

- Count the beads by twos (e.g., 2, 4, 6, 8, 10, 12, 14).

Count-on, beginning at the second row on their bead frame, ie, count on from the first number (e.g., 8, 9, 10, 11, 12, 13, 14).

- Use their knowledge of a related doubles fact. For example, the student may realise when constructing the doubles fact on the bead frame that because double six equals 12, double seven must equal 14, because one more has been added to each row.

- Use another efficient mental computation strategy. For example, the student may bridge through 10 when calculating double seven. They may reason that if we added three more beads to the top row and took three away from the bottom row, this would change the doubles fact to 10+4, which they may know to be 14.

MODIFICATIONS AND EXTENSIONS

1. A third player could be introduced to the game. This player could be given two 10-sided dice, and required to sum these two dice together. This provides an opportunity to expose students to additional mental computation strategies. For example, if this third player rolled an eight and a seven, they may choose to add the dice together using bridging through 10 (8 + 2 + 5 = 15), or the near doubles strategy (7 + 7 + 1 = 15).

2. Younger students (Foundation) being introduced to the game could initially play with a reduced deck of cards (Ace to five), and a 10-sided dice, rather than a 20-sided dice. Additional playing cards (i.e., doubles facts) could then be gradually introduced, and the dice modified accordingly. For example, once the students are ready to introduce sixes to the deck of cards, Player 2 can play with a 12-sided dice.

3. Older students, or students requiring a more challenging version of the game, could play with additional dice, which Player 2 would be required to sum together (e.g., two 20-sided dice or four 10-sided dice). The game would proceed as outlined above, except Player 1 would be required to 'double double' the face value of the card. For example, Player 1 might turn over an eight, which they would double to 16, and then double again to 32. Player 2 might roll a 19 and a 12, which they would sum together to be 31. As Player 1 has achieved the higher score for that round (32 vs 31), they would advance their counter one square.

This adaption could be used to reinforce more complex mental computation strategies (e.g., number splitting strategies), and introduce students to a strategy for calculating their four times tables (i.e., double double). Obviously the game could then be further adapted by introducing even more dice (e.g., four 20-sided dice), and requiring Player 1 to 'double double double' the face value of the card (with an opportunity for students to make connections with their eight times tables).

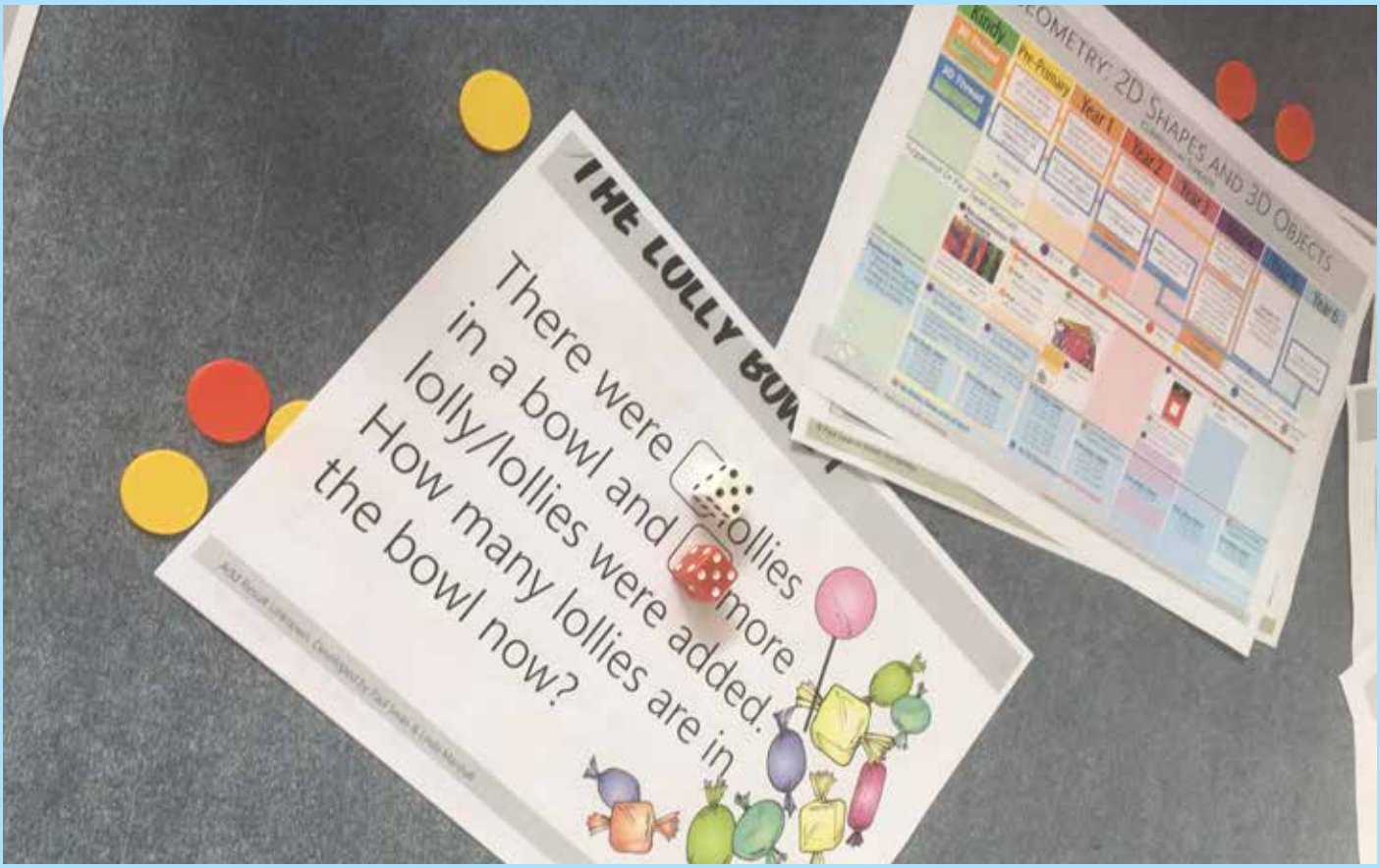
Figure 1. Does double seven actually equal 14? The first student (top) uses counting bytwos as their preferred back-up strategy, whilst the second student (bottom) counts on.

CONCLUDING REMARKS

Although the game outlined above is extremely simple, it has been offered as a vehicle for teaching doubles for three reasons. Firstly, it has proven engaging to students, at least in my classrooms. Secondly, its simplicity allows the teaching emphasis to be on students applying efficient back-up strategies when a doubles fact is unknown. Promoting efficient back-up strategies supported by an appropriate representation on a bead frame helps facilitate conceptual understanding of doubles. Thirdly, the repetition in the game helps leverage this understanding into fluently recalling doubles facts. I hope you find it useful in your classrooms.

LITERACIES AND PROFICIENCIES

Jennifer Bowden - Mathematics education consultant, Mathematical Association of Victoria



Part, part, whole task.

MATHEMATICAL LITERACIES, THE VICTORIAN CURRICULUM PROFICIENCIES AND FUN PROFESSIONAL DEVELOPMENT WITH DR PAUL SWAN

The MAV prides itself on our professional learning offerings, covering best practice teaching, relevant curriculum links and engaging tasks that challenge our teachers and school leaders. In July we were in the fortunate position of hosting Dr Paul Swan as he ran a variety of professional learning workshops for schools, teachers and our Mathematics Active Schools.

Paul challenged our thinking around mathematical literacy and the routines we use with children to engage their mathematical thinking and reinforce their understanding of concepts. Paul has a great resource online based on a variety of *Mathematical vocabularies routines*. We were fortunate to see these modelled as it is extremely important that teacher work with those routines they are familiar with and are best suited to their personal and schools learning pedagogies.

Our first day was spent with the entire staff at Black Rock Primary School. The MAV has spent time working with the teachers and students at this school and they were already well acquainted with many of Paul's excellent resources and approaches towards number fluency. The day started with the infamous game of LuLu. It was wonderful to be a participant and experience the depth of understanding involved in the games and different directions Paul took teachers as he explored the concepts.

Paul worked through a variety of activities and resources from his *Mathematical vocabularies routine menu,* engaging teachers in tasks and activities that challenged their thinking. The teachers worked in teams, utilised their school curriculum and discussed the implications of the professional learning on their school's teaching and learning program, making a direct impact to their planning.

The MAV also hosted a professional learning workshop where 24 classroom teachers had the opportunity to take part in an intimate workshop that explored a range of fluency games and activities along with language activities, specifically around the use of worded questions. In this workshop, many teachers enjoyed working on Paul's updated *Check the Clues* tasks. The tasks require students to work together in a team to solve problems using *Polya's Problem Solving* through a process of understanding worded statements and excluding items until they finally solve the problem. The teachers thoroughly enjoyed these highly engaging tasks and were very excited to find a bank of these resources available on Paul's website along with books with similar tasks for sale at the MAV Shop. Teachers felt the *Check the Clue* routine was adaptable to their personal teaching context and the three different strands of the Victorian Curriculum.

The MAV held an exclusive workshop for its Maths Active School members. This workshop, hosted at Fintona College, was an opportunity for our experienced Maths Active teachers to engage in a range of Paul's tasks and activities, explore with their colleagues and teachers from other Maths Active Schools the impact such resources

Dr Paul Swan demonstrating a place value task at Black Rock Primary School.

MAV Education consultants working on a master class with Dr Paul Swan engaging in his latest research and activities.

Hands-on tasks at Beth Rivkah Ladies College.

could have in their schools. It was wonderful to observe the collegiality brought on by teachers from different schools working together to solve and explore tasks.

Paul's last stop was at Beth Rivak Ladies College. Beth Rivkah has a longstanding partnership with MAV and are extremely active in participating in school-based teacher professional learning. Teachers from Beth Rivkah enjoyed spending time working with Paul to explore many of the pedagogies task and challenges the MAV had previously work through with them in greater depth. Whilst many of the activities Paul worked with were new, it was also fantastic to see the teachers deeply exploring ideas they had already been introduced to and had trialled with their students with the educator who wrote and created these tasks.

Personally, the highlight of my week was Paul's masterclass at the MAV with our mathematical consultants. The MAV has a very strong partnership with Paul and we are extremely appreciative of his outstanding resources and tasks. In his masterclass, Paul gave us the opportunity to discuss the research and resounding behind his activities and the breadth and depth the tasks can be explored across the curriculum.

The MAV are extremely grateful to Paul's generosity and time, not only while in Melbourne but continuously updating MAV with his resources and research. This knowledge has enhanced our own professional development offerings and support to schools. From classroom activities and planning to hands-on tasks at family maths forums his resource and activities are always challenging and enjoyable.

For more information about Dr Paul Swan's resources drpaulswan.com.au

To discuss how a MAV Education Consultant can enhance your school's professional learning or teaching and learning program contact Jen Bowden jbowden@mav.vic.edu.au

Dr Paul Swan led a professional development day for teachers at Surfside Primary School. Staff participated in a range of games and activities that can be used in all classes across the school. There was a particular focus on helping students solve worded questions, looking at maths vocabulary and broadening the problem solving process in lessons.

Paul's style was interactive and engaging, he had staff act out a problem to solve how to get everybody across the river in the quickest time possible - this helped bring the mathematics to life.

Staff also looked at planning documents, examples of materials and assessment techniques. Staff found they day engaging, practical and clear, and the gained some valuable learning for teaching mathematics.

- Linda Patterson, Surfside Primary School

FAMILY CONNECTIONS: GAMES NIGHT

Alissa Willan - Numeracy Leader and
Cathie Devery -FSP and Student Wellbeing Leader, Christ the King Primary School, Braybrook.

Have you ever wondered how to close the gap between families' perceptions of maths and what is being taught in the classrooms? At Christ the King Primary School (CTK) we puzzled over this conundrum, and created a very successful maths experience for our whole community. We needed to drop some assumptions: that something won't work and that some parents haven't been engaged in maths in the past so why would they be interested now?

In Term 2, we had a very successful and highly engaging Maths Day, which included a shared PLT involving staff and parents, followed by an exciting Family Maths Games Night.

80% of our school families have English as their second language, an even higher percentage have culturally diverse backgrounds, and many are new arrivals to Australia. The predominant culture is Vietnamese, with a growing number of Burmese families, and smatterings from many countries across the globe. Our students engage in extracurricular tutoring programs for mathematics, literacy and their family's first language.

Staff were finding it increasingly difficult to move from procedural to conceptual understanding of mathematics in the classroom. We believe that many students are caught in a vice that complicated what we are modelling in the classroom with the structures that they are being taught during their tutoring sessions. We don't want to compete with the tutoring sessions, we want to supplement and support them. How to do this?

The initial meeting between our family engagement leaders, and the numeracy team was to probe the question of how to engage families in the school through numeracy. Our best option was to hold a Maths Games Day for the whole school. All curriculum areas and interventions groups would be postponed for the day so that all students and teachers could participate with various classes. This opened up children's perceptions from teachers being confined to one area of interest or expertise. We planned games activities that would engage all aspects of numeracy while being open enough for all students to access at their own level of ability. We invited the support of Jen Bowden from MAV who suggested we have five rooms of numeracy games; a building room for Geoshapes, one each for board games, dice games and card games, and Planks.

Our very tall Year 3/4 teacher needed a step ladder to continue her construction!

Preparing the activities was the easy part compared to the logistical tetris of attempting to ensure the day ran smoothly. As we began working through the daytime organisation we realised that the best way to address our initial problem of engaging families in maths at CTK, was to extend the Maths Day into the evening and invite families to participate.

We drew on the success of previous evenings where family engagement had been high, and began imagining the most exciting evening we could. We investigated supplying a meal to our families, having a small family prize and having interpreters so that all families could access the activities and the information being shared. At the same time as engaging the help and support of Jen from MAV, we also wanted to use her expertise for the teachers own professional development, mindful that the aim of the event was for family engagement and to build relationships. Our solution was to plan for a joint PLT with families and teachers.

MATHS DAY

The Year 5/6 classes were allocated the challenge of timetabling. They created the groups, allocated teachers, developed the the rotating timetable for the day and calculated the time available for each session; real life maths! Teachers found that students needed a lot of time to work through the problem of rotating all groups fairly, and developing and demonstrating their understanding of elapsed time.

With anticipation, excitement, a sense of uncertainty, some admissions of anxiety from students for whom maths generally highlights a sense of inability, the day got underway smoothly. The children were split into five groups with 50 children in each group. The groups rotated through classrooms to experience each activity.

Students had a simple age appropriate reflection sheet to complete at the end of each session, responding to growth mindset questions about what they learnt, what they did well, and what they needed to practise. Prep to Year 2 students rated their learning with emoji faces.

A social element was incorporated, where students, teachers, learning support officers and family members ate lunch together. There was an atmosphere of engagement and fun, there was much happy chatter and conversation about the day.

JOINT PLT - TEACHERS AND PARENTS

We invited teachers and parents to a joint PLT at 3.30pm, which was presented by Jen Bowden from MAV. The planned activities were to highlight the different strategies that we teach children to calculate numeracy problems, and to illustrate and recognise the validity in the variety of responses. We had Burmese, Vietnamese and Chinese interpreters at the PLT to facilitate access to all our families. We offered babysitting for all children while the parents attended the PLT, and were thrilled with the attendance of more than 20 parents who joined the staff. The positive comments related to the learning was great feedback.

Students eagerly getting stuck into Rowco and Combo card games.

MATHS FAMILY GAMES NIGHT

Families were invited to attend a Maths Family Games Night. To encourage participation in as many activities as possible, there was a competition where students and their families completed the games and had a passport signed for posting in the prize box at the end of the night. This indicated that 80 families had attended the night, a great participation rate for our school, biggest attendance ever for an extracurricular school activity. All families, teachers and students shared a joint evening meal at the beginning of the event and then the games began. It was engaging, energising and FUN! Our Principal had to make five announcements to finish up the night as no one wanted to leave - a sure sign that this experience was valued by students and their families.

CONCLUSION

There is huge potential to engage families in maths. We could continue the momentum into an annual experience which would further bridge the gap between home maths and school maths. Giving parents the opportunity to have insight into what the child is learning in the classroom should result in students being supported mathematically in both school and home settings. This will make maths a holistic learning experience. The enthusiasm and buzz for maths learning has never been higher.

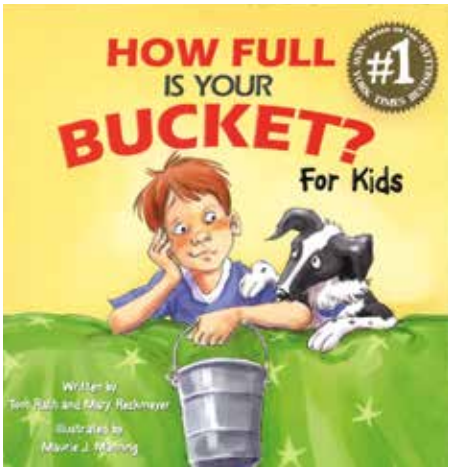
At the beginning of the Maths Day, a Year 6 student explained to her teacher that she didn't want to participate due to her fear and anxiety of not being good at maths. At the conclusion of the Maths Night, I was so excited to overhear this same student tell her father 'I love maths!' - this change of heart demonstrates how powerful a fun approach to mathematics can be.

The MAV can assist your school to run a Family Maths Night, or you can purchase *Family Maths Night - school support resource*, this is a downloadable PDF which contains a bunch of activities that can be photocopied, along with a listing of all materials required, hints and tips for running the evening.

Visit http://shop.mav.vic.edu.au and search for 'Family maths night'.

HOW FULL IS YOUR BUCKET?

Mel Lowndes - Three year old kinder educator, Windsor Children's Community Centre



Picture books are full of an amazing range of teaching and learning opportunities. While some may be written for explicit teaching purposes of mathematics, others may have concepts embedded or perceived throughout the text. *How Full Is Your Bucket?* can be used throughout a child's education to discuss concepts such a relationship and a growth mindset. It is also a great way to scaffold mathematical understandings of measurement.

Here is a reflection on how I utilised the book with my three year old class at Windsor Children's Community Centre to explicitly teach social skill whilst embedding concepts of measurement.

Introducing the kindergarten children to *How Full Is Your Bucket?* has provided an opportunity for collaborative and engaging discussions for both children and educators. The story, which can gauge emotional capabilities of readers, is an effective tool translating the concepts of kindness, gratitude and positive social interactions and the benefits of these intrinsic values.

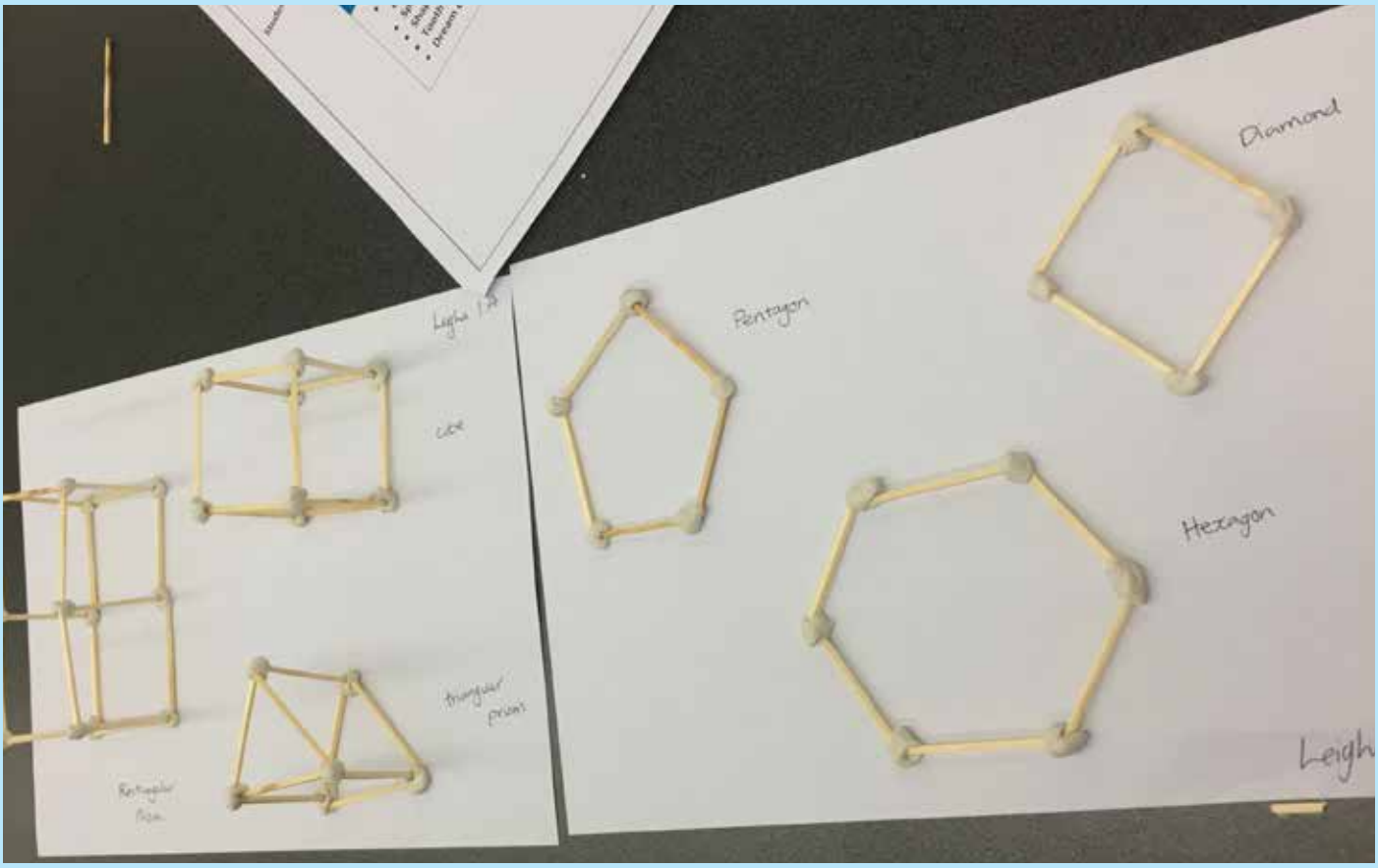
The children were able to absorb the ideas shared and question their own understanding throughout. Questions like, 'what colour is your invisible bucket?' and 'how can I fill your bucket, Mel?' The illustrations amplify the concept as the kinder children could see the levels increasing or decreasing, explicit mathematical concepts around measurement, which can also show the variations in emotional states.

What we learnt as a small community is that we all have a bucket and that our emotions are what makes us human. Having a child come and tell you how they have filled another peers bucket on their own accord, confirms that this piece of literature is relevant and can reinforce positive view points for all involved. Children have the capacity to care and empathise and this material is needed in our early childhood sector. Having positive stories creates children who ponder, wonder and allow all to belong.

How Full Is Your Bucket is available at the MAVshop, http://shop.mav.vic.edu.au.

CHOOSE YOUR OWN ADVENTURE

Gabrielle Panozzo and Rachel Villani - Peter Lalor Vocational College



Constructions of two and three dimensional shapes using toothpicks.

Faced with the quandary of how we could engage our Intermediate VCAL students quickly and meaningfully at the start of term three, we developed a week long set of numeracy based activities.

For the set of activities, the 'Choose Your Own Adventure' project, we chose to focus upon the VCAL learning outcome of design. The reasons were twofold. Firstly, we wanted to start back for the new term with an engaging and interesting curriculum that would excite and ignite the students, and also set up a strong and positive work ethic for semester two. Secondly, other projects offered to date had not directly focused upon design, so this presented an opportunity for us to champion all the elements of the design learning outcome in a succinct package of activities.

Here, we should remind VCAL Numeracy teachers that unlike VCAL personal development strand units, whereby all elements within each learning outcome must be met in the one assessment task, it is not expected, for VCAL Numeracy units, that all elements for an outcome can be assessed within a single task. This then provides teachers with the opportunity to observe students demonstrating competency on more than one occasion and through different mediums to ensure that assessment is consistent, reliable, fair and as equitable as possible.

The design-based activities were broken down into three groups. The first group was a set of six hands-on learning tasks, of which the students were made to select at least three. This provided the students with the opportunity for choice and thus a degree of ownership over their learning. This student ownership, in our experience, directly correlates to the level of student buy-in with the task. We have found that the more invested students are in their learning, the more likely it is that you find the desired higher levels of student motivation and engagement in the classroom.

The six tasks offered to students were toothpick constructions of two-dimensional and three-dimensional shapes, an exploration of the shapes found in their VET subject, making 'pictures' from seven geometric pieces (tans) cut from a square, constructing a cuboctahedron, drawing hypotrochoids and epitrochoids using a Spirograph (geometric drawing tool) and designing a dream catcher. Interestingly, it was observed that choices seemed to be made along the lines of personal interest and not the normal social groups, and also that students willingly shared constructional insights amongst peers, who had similarly selected an activity. Even more interestingly, with identical tasks offered within three different classrooms, each room teacher reported different activities as being the most popular within their space.

The rooms were set up in separate areas, almost in the form of work stations. All the items required were available in each area for a particular task and students were free to choose which area, and therefore which task, they would work on. This choice element resulted in many students working with a much broader group of peers than would normally be the case.

For the first group of activities, the folio of evidence included records of teacher

CHOOSE YOUR OWN ADVENTURE (CONT.)

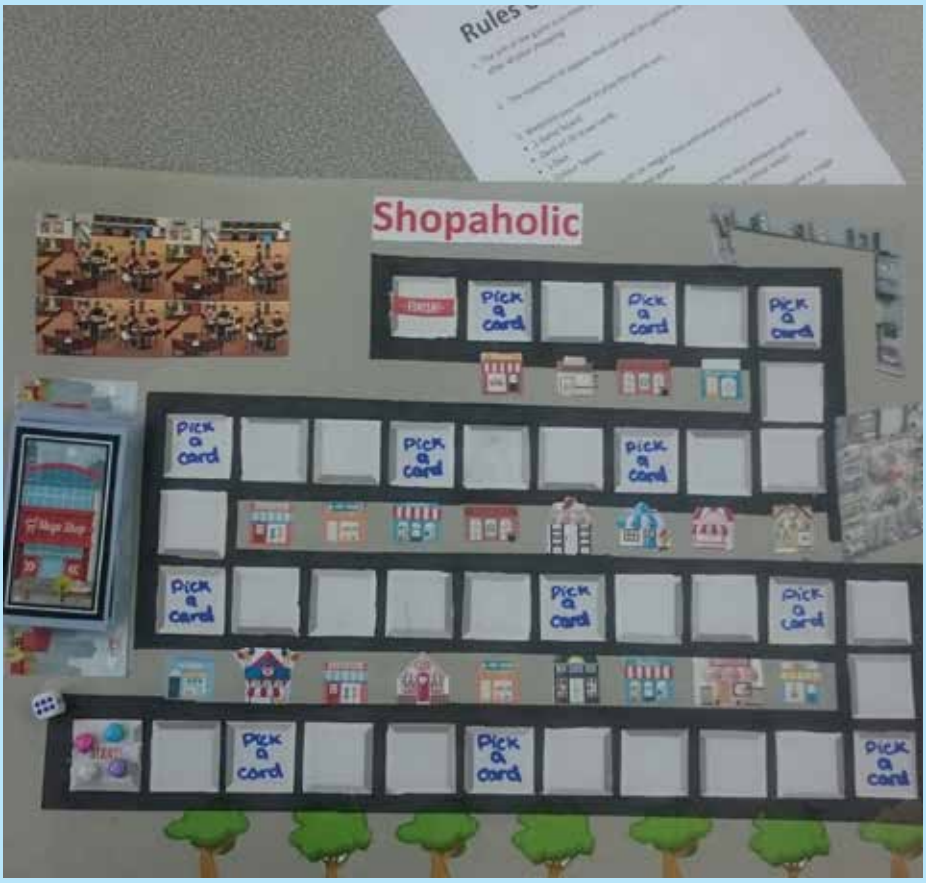
observations and student comments, photographs of the toothpick activity, tangrams, geometric construction, spirographs, dream catcher and VET shapes task. A written reflection of each of the tasks was also required.

The first group of tasks were very hands-on in nature and align well with the idea of VCAL being traditionally viewed as the 'hands-on' or 'applied' senior secondary pathway. However, it should be noted that hands-on activities are not the only component of applied learning. Since developments in the 1990's, the VCAA (2014: VCAL Information Sheet) has recognised that the definition needs to be broader, and 'advocates an approach that contextualises learning in a way that empowers and motivates students, while assisting them to develop key skills and knowledge required for employment, further education and active participation in their communities'

The second group of tasks aligned to this broader definition with its focus on transferable employability skills and in particular looked at communication, technology, and initiative and enterprise categories. These attributes are identified as skills needed by young people to apply in different scenarios as they transition from school to work and travel along their career pathway. More employers are identifying the need for young people requiring these 'soft skills' to complement the 'industry specific skills' they are learning via their VET (Vocational Education and Training) and SWL (Structured Workplace Learning).

The two tasks in the second group required the students to design a page for the year level yearbook and to design a recognition postcard, the most popular to be professionally printed after selection and used to send home to students and their parents/carers to positively acknowledge student efforts. These tasks required the students to incorporate both two-dimensional shapes and three- dimensional shapes into their designs and offered students an opportunity to be creative and expressive with their learning.

The third task was for students to create their own board game. In choosing the design of their product, students were



Shopaholi, a student designed a game, required application of both literacy and numeracy skills.

shown a variety of different board game templates. Students then crafted their own board and decorated it, while respecting a number of mandatory parameters. Students were required to design the game concept, components and rules, and create an instruction sheet explaining how to play the game. A literacy component was a key part of this task.

The teaching of VCAL at Peter Lalor Vocational College is via an integrated pedagogy model. Tasks where students can address outcomes across different streams provide an opportunity for one project to incorporate multiple elements and offer opportunities for students to locate an area within the project that meets their interests and/or strengths.

If we review the key concepts underpinning VCAL as identified by VCAA, the 'Choose Your Own Adventure' project can be seen to address each of them. Tasks are offered at various levels and therefore students are able to start where they are at. The curriculum is negotiated by the opportunity for student choice. Students are able to share their knowledge and interests with peers and teachers. Activities are designed to link with their VET and VCAL, thereby connecting with their real-life experiences. All students are able to experience success, a vital factor for the building of resilience and the development of increased confidence and self-worth. The learning is integrated across strands and within the experiences of students. A broad range of activities are offered, allowing for a diversity of learning styles. And finally, assessments are appropriate for the tasks.

We, as a teaching team, have identified the benefits of offering theme-based activities to our VCAL classes, where student choice and flexible delivery are the focus of the projects that are offered. Recognising there is no 'one size fits all' approach to implementation, we continuously support each other to modify the delivery or the tasks as required in our own classrooms, while keeping our approach to assessments consistent with our team moderation processes. After successful implementation of this project, we will investigate similar projects for our future curriculum delivery.

BEEP BEEP VROOM

Freda Vosko and Eleanor Di Felice - Albanvale Primary School

This book has provided a springboard for many fun activities for our Prep students. They enjoyed this simple book, identifying and making connections to the real world and their own families.

It was a fun, easy read. The language was catchy and the students happily joined in with the repetitive language. They enjoyed anticipating the text, and identifying the repetitive pattern of the language.

The book led to a myriad of activities beginning with investigating patterns all around us, and embarking on a pattern hunt around the school.

The students experimented with making simple patterns using a variety of concrete materials. Through play and exploration they copied, made and continued patterns made by their peers. Students were quick to pick up the repetition and errors in a modelled pattern. They even began using language such as, 'this is an ABAB pattern'.

The book was read and viewed many times with a different focus each time. The book was incorporated and used as part of our mini lessons. We were able to extend simple ABAB patterns to more complex patterns as was seen in the text. Each pattern was introduced and discussed separately, allowing time to investigate and explore.

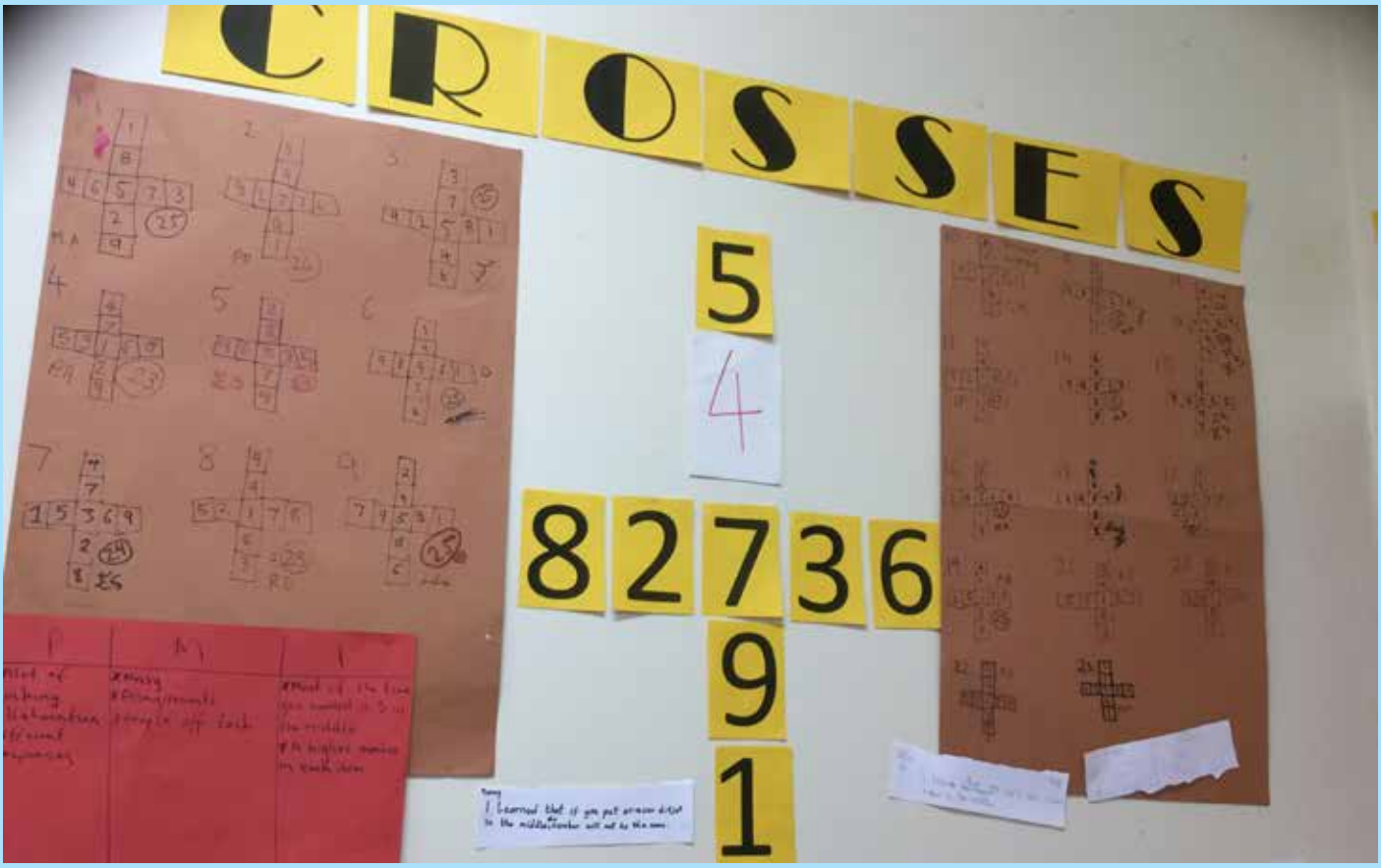
The students had fun searching for and talking about the patterns in the book and identifying the repetition in each pattern. They embarked on a variety of open ended activities which allowed for student differentiation. Some students made simple ABAB patterns while others challenged themselves to include and explore more complex patterns as seen in the book.

The students completed colour patterns using a repeating car template. They created their very own super patterned car and manipulated different car types to create a pattern. Students were encouraged to articulate their thinking and learning along the way.
They explored making patterns with words to accompany their visual patterns.
The story is also on YouTube allowing the students to view and enjoy the story in a different way.

The picture story book, *Beep, Beep, Vroom, Vroom*, was certainly instrumental in our approach to explicitly teaching patterns to students. We certainly had fun and will definitely use this book over and over again.

CROSSES FUN

Jane Lockwood - Year 4/5 teacher, Albanvale Primary School



This year, Albanvale Primary School subscribed to the Maths300 resource (available via AAMT). We wanted activities that, not only engaged the students in their maths learning, but also incorporated the critical and creative thinking curriculum. Activities in Maths300 catered for both. This article discusses how I used the *Crosses* activity in the classroom and the outcome of these series of lessons. After using a rich assessment task to ascertain where students were at in their understanding of addition and subtraction concepts and where they needed to go, I decided on the *Crosses* activity to develop these concepts.

DATA DRIVEN

After analysing a common assessment task, developed by the Year 3 - 6 professional learning community, I discovered the students understanding of addition and subtraction strategies was varied across the cohort. Some students used basic strategies like known facts and adding ten, while others could use the split strategy to add and subtract three and four digit numbers. With such a range of abilities, I needed a task that would cater for all the students in the classroom that would be engaging and thought provoking.

IMPLEMENTATION OF THE CROSSES LESSON

I decided on the *Crosses* lesson as it was open ended enough to cater for all abilities in the classroom. It has many entry points and covers a number of facts and properties of number.

LESSON ONE

I introduced the lesson to the whole class: 'Today we are going to do an activity called *Crosses*. I want the people who have my cards to come out here and place them in the middle of the circle in a big 'plus' sign shape. We might also call it a cross shape. We want the arms of the two crosses to add to the same number'

The students began to manipulate the tiles to add to same number. The whole class was involved as the students on the outside of the circle were giving advice to the ones with the tiles on how to manipulate them.

The students were placed in mixed ability groups, so more able students could model thinking and number strategies, and proceeded to manipulate their own tiles to come up with solutions. When groups found a solution they placed it on a class chart with their initials next to it, checking that another group hadn't already recorded the solution.

We reflected on this session by completing a PMI chart. What students found positive about the activity was:

- they had an opportunity to collaborate
- there was a lot of thinking involved
- there were lots of different solutions

The students were already beginning to hypothesise, because in the 'interesting' part of the chart there were responses like; 'most of the time you needed a three in the middle' and 'each arm had to have a higher number'.

LESSON TWO

We started by revisiting our solutions: 'Look at the solutions from yesterday, what do you notice that is similar about all the solutions?'

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SHRIRO

CROSSES FUN (CONT.)

After a discussion about lesson two, students noticed:

- lots of the answers have a three in the middle
- it is always an odd number in the middle
- most answers are 24
- always at least one tens fact in each line

Students were asked 'what are you wondering?' The had several hypotheses:

- does there always have to be a tens fact in each row?
- does there always have to be an odd number in the middle
- does it always have to be three?
- if the answer is 25, does it always have a five in the middle?

In small groups, students tested their hypotheses and added their findings to the class charts.

Using the sentence starter 'I learned....', students discovered:

- an odd number was always in the middle for it to work, usually three or five
- that when I had an even number it didn't work but when we put a three it worked
- today that the middle number has to be odd, because the group tested it out and it didn't work when it was even
- that the row or column doesn't always have to have a tens fact

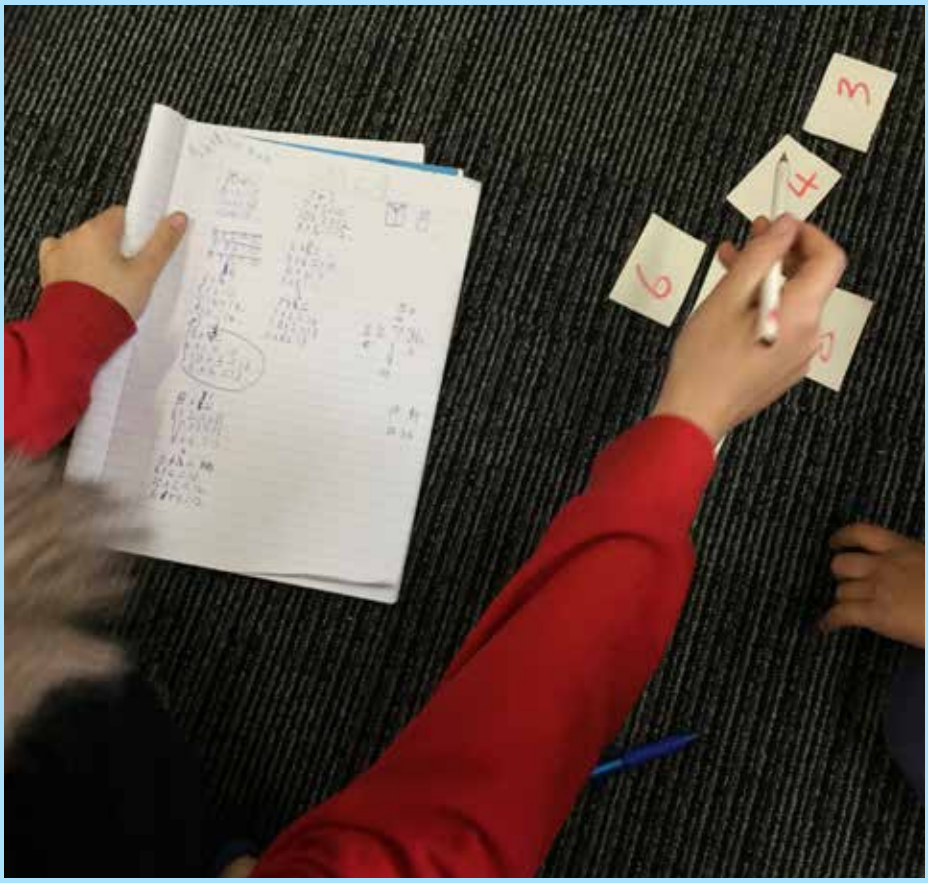
LESSON THREE

After our investigation the previous two days, and with what we now knew about *Crosses*, we wanted to find **all** the solutions. I introduced two main strategies:

1. break a problem into manageable parts (i.e.: different odd numbers in the middle)
2. test every possible combination

The strategies and explanation were explicitly explained on Maths300 and that is exactly what I used to introduce these strategies to the children.

'Following the odd-in-the-middle approach and considering how to arrange the remaining digits suggests:



Working together to investigate all the possible solutions.

- One in the middle
- One in the middle means the two arms will total 45 + 1 = 46 (since the one is counted twice). This means each arm must total 23. So, discounting the middle number (turning it over), the remaining four digits on an arm must total 22.
- The remaining digits are nine, eight, seven, six, five, four, three and two. What different combinations of four of these can be found which add to 22?

Note: Since the sum of all the remaining digits is 44, finding four that sum to 22 for one arm automatically means the four left must also sum to 22 and must be on the other arm.'

Students investigated all the possible solutions and discussed the strategies they used, adding to the class charts. Even though we didn't find all the solutions, the students were happy they found 194 over the three lessons.

EVALUATION

The *Crosses* activity proved to be a great success. The students were engaged during all three lessons and didn't want to stop when our maths lessons were over. It gave students the opportunity to work collaboratively and to articulate addition and subtraction strategies they used. It also opened up discussions around a great deal of number concepts and properties which were investigated in subsequent lessons.

The Maths300 resource has become an integral part of our maths program at Albanvale. During team planning, when looking for engaging, rich investigations that cater for a range of abilities we often turn to Maths300. The activities are comprehensively explained and meaningful, real life tasks which the students can relate to. Maths300 tasks are used on a weekly basis which students find engaging and thought provoking.

REFERENCE

www.maths300.com/members/m300full/112lcros.htm

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1-6

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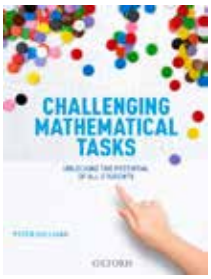

CHALLENGING MATHEMATICAL TASKS

K–6

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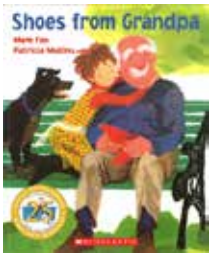

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