THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 4/18

ARE YOU AN ENGAGED TEACHER?

INSIDE

Associate Professor Catherine Attard, Western Sydney University.

'The first job of a teacher is to make the student fall in love with the subject. That doesn't have to be done by waving your arms and prancing around the classroom; there's all sorts of ways to go at it, but no matter what, you are a symbol of the subject in the students' minds' (Teller, 2016).

Teller (2016), makes a powerful point about teaching and engagement, and how important it is that we, as teachers, portray positive attitudes towards our subject and towards teaching it. Do you consider yourself an engaged teacher? Are your students deeply engaged with mathematics, and how do you know? In education we talk about student engagement every day, but what do we actually mean when we use the term 'engagement'? When does real engagement occur, and how do we, as teachers, influence that engagement? In this article, I will define the construct of engagement and pose some questions that will prompt you to reflect on how your teaching practices and the way you interpret the curriculum, influences your own engagement with the teaching of mathematics and, as a result, the engagement of your students.

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FROM THE PRESIDENT

Michaela Epstein

The theme for this year's MAV conference in December is *Teachers Creating Impact*. We know from research – and just from stepping into a school – the great impact that teachers can have on students. Confusingly though, 'impact' is a term that has different implications for different people. What does it mean? In preparing for this column, I reflected on the question and at a surface level have defined it as: a meaningful change for others. Digging deeper, I have identified four aspects of teachers' work in which impact is created. These aspects are each valuable, although often are recognised to varied extents. Here they are:

First and most commonly acknowledged, is that teachers impact students' academic outcomes. Such outcomes can be measured concretely in terms of test scores (think NAPLAN, VCE), TAFE or university course admissions, or even jobs. However impact on academic outcomes is measured, it is fundamental to the work of the profession. But, it is not the only form of impact that matters.

The second aspect identified, is that teachers impact students' engagement and motivation. If education involved merely passing on content to passive recipients, the job would be far more straightforward. But students are interesting individuals (to say the least!), who enter the classroom with differing levels of readiness to learn. There is an undeniable importance to what teachers do in affecting both how students see themselves as learners and the curiosity they develop towards learning. Unlike academic outcomes, influence on engagement and motivation can be much harder to measure, although it is still valuable and can be long-lasting.

Third, teachers impact more than just the individual students in a classroom – influence also extends to the group of students as a collective. There is something to be said for a class environment that is supportive and positive – and these dynamics don't just happen on their own. It takes a deliberate set of actions to develop a class culture and help students realise that they are part of a community that is responsible towards and can learn from one another.

Finally, teachers impact one another. The complexity of teaching means that straight out of a university degree, the learning is nowhere near complete. While the education sector can provide experts from all walks of life, the expertise of peers and their ability to truly empathise with one another is second to none. By sharing knowledge teacher to teacher, impact is made beyond classrooms and beyond schools.

In just a few months, at MAV18 you can see and learn from all four areas of impact. It is an event for teachers that is primarily delivered by teachers. MAV conference is one of the biggest occasions on the Association's calendar, and it's a fantastic couple of days that shouldn't be missed. I hope to see you there!

REFERENCES

Hattie, J. (2003). 'Teachers Make a Difference, What is the research evidence?' Paper presented at the *Building Teacher Quality: What does the research tell us ACER Research Conference*, Melbourne, Australia. Retrieved from http://research.acer.edu.au/research_conference_2003/4/

2018 VIC MTQ

We were very pleased to receive 677 Victorian Maths Talent Quest investigations from 81 schools. The investigation topics were impressively diverse. Thank you to all teachers and volunteers who assisted with judging. It was wonderful to have the expertise of John West (WA) Sharon Portlock (NSW) and Jo Kellaway (SA) to assist our Victorian judges.

Well done to all the students who were chosen to represent Victoria at the National Maths Talent Quest. National winners, State High Distinction and Distinction winners will be announced at the awards ceremony on 18 October at La Trobe University. Congratulations to all schools and teachers who completed a MTQ investigation this year.

MAV PROFESSIONAL DEVELOPMENT

During Term 4 2018, 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
Algorithmics (HESS)	11/10/18	9-VCE	Georgia Gouros
GeoGebra in the classroom	18/10/18	7-10	Danijela Draskovic
Victorian Association for Gifted and Talented Children	23/10/18	5-10	Simone Zmood
The importance of developing children's counting skills: The move from rote to rational counting (webinar)	24/10/18	K-2	Catherine Pearn
HITS or Miss?	8/11/18	F-12	David Cook

If you'd like tailored professional development, contact Jen Bowden, jbowden@mav.vic.edu.au.

WELCOME DANIJELA

A rigorous grounding in STEM has led Danijela Draskovic to MAV as its newest secondary Mathematics Education Consultant.

While Danijela studied Science and Engineering at Monash University she turned to tutoring school students to support herself financially. This side business soon grew busy enough for her father to build her a small tutoring studio in the backyard. Danijela found a natural flair in teaching mathematics and got great feedback from her students who frequently encouraged Danijela to become a teacher. These suggestions planted a seed inside Danijela and awoke the curiosity about a teaching career. Just before graduating, Danijela began a career in science administration at DNA Solutions. She worked closely with the laboratory technicians and the customers in all matters of paternity testing, DNA ancestry and other genetic tests. Although Danijela thrived in this environment, it didn't take long for her to realise that science wasn't her passion – Danijela missed teaching mathematics.

Fast forward a few years and with a Master of Teaching under her belt, Danijela taught Year 12 physics and maths at Berwick Grammar school before making a tough decision to leave the school and travel to the UK.

While in the UK, Danijela taught secondary mathematics, 'Teaching in the crowded classrooms of the UK was a challenge. Regulatory pressure placed a huge emphasis on data collection and testing which meant that my autonomy as a teacher was stifled.'

Danijela returned to Australia and took up a post at St Margaret's School in Berwick teaching VCE physics and mathematics. Her UK experience helped her to view the Victorian Curriculum through a new lens, 'In comparision to the UK, I feel that the Victorian Curriculum allows more time for teachers to creatively apply themselves to the classroom. Personally, I love working with technology to enhance and support learning, and finding ways to allow students to explore concepts in engaging ways. I have always tried to cater to the individual needs of each student in my class. Using data to manage a student's progression of learning is becoming more important in Victoria, and I look forward to helping schools understand this data so that learning can be more personalised.'

Danijela is enjoying her new role at MAV. 'Having the opportunity – and the time – to explore best practice pedagogy is exciting. I want to make a difference in mathematics education and work with teachers who are striving to improve and expand their knowledge base.'

Danijela is available for in-school professional development on an ad-hoc or longer-term basis. If you and your colleagues are interested in a mathematics education consultant focusing on improving outcomes at your school, contact Danijela to discuss. Telephone 0423 189 240 or email ddraskovic@mav.vic.edu.au.

ARE YOU AN ENGAGED TEACHER?

Associate Professor Catherine Attard, Western Sydney University.

CONT. FROM PAGE 1.

STUDENT ENGAGEMENT: ON TASK VS. IN TASK

In education, engagement is a term used to describe students' levels of involvement with teaching and learning. Engagement can be defined as a multidimensional construct, consisting of operative, cognitive, and affective domains. Operative engagement encompasses the idea of active participation and involvement in academic and social activities, and is considered crucial for the achievement of positive academic outcomes. Affective engagement includes students' reactions to school, teachers, peers and academics, influencing willingness to become involved in school work. Cognitive engagement involves the idea of investment, recognition of the value of learning and a willingness to go beyond the minimum requirements

It's easy to fall into the trap of thinking that students are engaged when they appear to be busy working and are on task. True engagement is much deeper – it is 'in task' behaviour, where all three dimensions of engagement; cognitive, operative, and affective, come together (see Figure 1). This leads to students valuing and enjoying school mathematics and seeing connections between the mathematics they do at school and the mathematics they use in their lives outside school. Put simply, engagement occurs when students are thinking hard, working hard, and feeling good about learning mathematics.

There are a range of influences on student engagement. Family, peers, and societal stereotypes have some degree of influence. Curriculum and school culture also play a role. Arguably, it is teachers who have a powerful influence on students' engagement with mathematics (Anthony & Walshaw, 2009). Classroom pedagogy is one aspect of a broader perspective of the knowledge a teacher requires in order to be effective. The knowledge of what to teach, how to teach it and how students learn is referred to as pedagogical content knowledge (PCK). The construct of PCK was originally introduced by Schulman (1986), and substantial research has seen a strong focus on PCK in terms of mathematics teaching and learning (Delaney, Ball, Hill, Schilling, & Zopf, 2008; Hill, Ball, & Schilling, 2008).

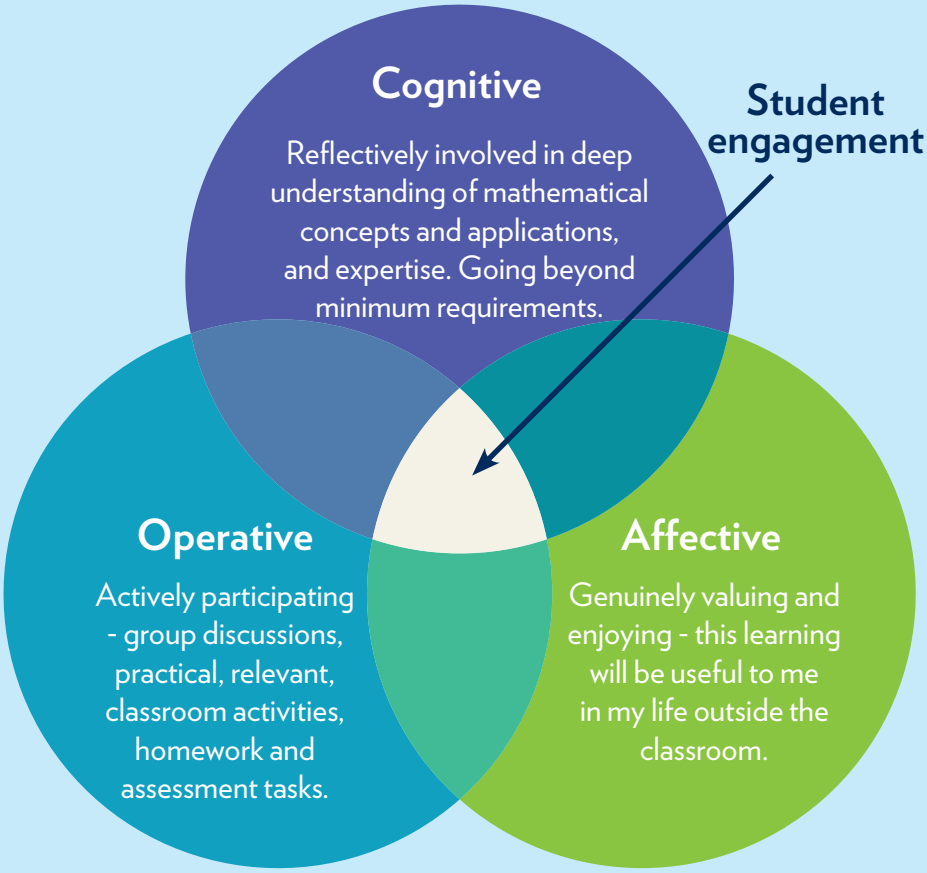

Figure 1. Engagement as a multi dimensional construct.

Although this research provides insight into the complex knowledge required to effectively teach mathematics, little attention is paid to how teachers themselves are engaged with teachers.

ENGAGED TEACHERS = ENGAGED STUDENTS

It makes sense that teachers need to be engaged with the act of teaching in order to effectively engage their students. If we take the definition of student engagement and translate it to a teaching perspective, perhaps it would look something like Figure 2, where teachers are fully invested in teaching mathematics, work collaboratively with colleagues to design meaningful and relevant tasks, go beyond the minimum requirements of delivering curriculum, and genuinely enjoy teaching mathematics in a way that makes a difference to students. In other words, thinking hard, working hard, and feeling good about teaching mathematics.

ARE YOU AN ENGAGED TEACHER?

Teaching is a complex practice with many challenges. Teaching mathematics has the additional challenge of breaking down many stereotypical beliefs about mathematics as being difficult and only for 'smart' people, mathematics viewed as black and white/right or wrong, and mathematics as a simply focused on arithmetic, to name a few. However, there are elements of our day to day work that we can actively engage with to disrupt those stereotypes, make teaching more enjoyable, and promote deeper student engagement. The following section provides some thoughts and questions for reflection.

Curriculum

How do you interpret the curriculum? Do you view it has a series of isolated topics to be taught/learned in a particular order, or do you see it has a collection of big ideas with conceptual relationships within and amongst the strands? How do you incorporate the General Capabilities and Cross-curriculum priorities in your

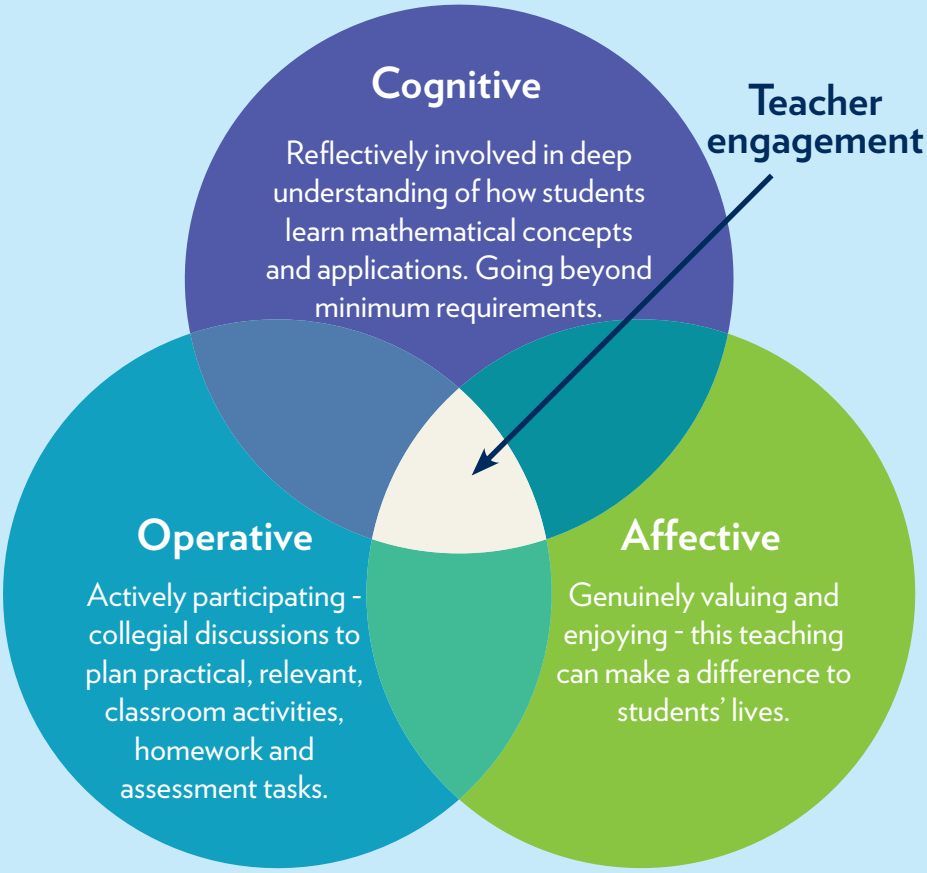

Figure 2. Conceptualising teacher engagement.

teaching? Do you make the Working Mathematically components a central part of your teaching?

Planning
How do you plan for the teaching of mathematics? Does your school have a scope and sequence document that allows you to cater to emerging student needs? Does the scope and sequence document acknowledge the big ideas of mathematics or does it unintentionally steer teachers into treating topics/concepts in isolation?

Assessment
How often do you assess? Are you students suffering from assessment fatigue and anxiety? Do you offer a range of assessment tasks beyond the traditional pen and paper test? Do your questions/tasks provide opportunities for students to apply the Working Mathematically components?

Tasks
What gets you excited about teaching mathematics? Do you implement the types of tasks that you would get you engaged as a mathematician? Do your tasks have relevance and purpose? Do you include variety and choice within your task design? Do you take into account the interests of your students when you plan tasks? Do you incorporate student reflection into tasks?

Grouping
How do you group your students? There are many arguments that support mixed ability grouping, yet there are also times when ability grouping is required. Is the way you group your students giving them unintended messages about ability and limiting their potential?

Technology
How do you use digital technology to enhance teaching and learning in your classroom? Do you take advantage of emerging technologies and applications? Do you use digital technology in ways that require students to create rather than simply consume?

Professional learning
How do you incorporate professional learning into your role as an educator? Do you actively pursue professional learning opportunities, and do you apply what you have learned to your practice? Do you share what you have learned with your colleagues, promoting a community of practice within your teaching context?

There are many other aspects of teaching mathematics that influence our engagement as teachers, and of course, the engagement of our students. Many factors, such as other non-academic school-related responsibilities, are bound to have some influence over our engagement with teaching. However, every now and then it is useful to stop and reflect on how our levels of engagement, our enthusiasm and passion for the teaching of mathematics, can make a difference to the engagement, and ultimately the academic outcomes, of our students.

REFERENCES

Anthony, G., & Walshaw, M. (2009). *Effective pedagogy in mathematics* (Vol. 19). Belley, France.

Attard, C. (2014). 'I don't like it, I don't love it, but I do it and I don't mind': Introducing a framework for engagement with mathematics. *Curriculum Perspectives*, *34*(3), 1-14.

Delaney, S., Ball, D. L., Hill, H. C., Schilling, S. G., & Zopf, D. (2008). 'Mathematical knowledge for teaching': Adapting U.S. measures for use in Ireland. *Journal for Mathematics Teacher Education*, *11*(3), 171-197.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualising and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, *39*(4), 372-400.

Teller, R. (2016) Teaching: Just like performing magic. Retrieved from www.theatlantic.com/education/archive/2016/01/what-classrooms-can-learn-from-magic/425100/?utm_source=SFTwitter

Catherine is presenting at MAV18, register online now at www.mav.vic.edu.au/conference. You can connect with Catherine via Twitter, @attard_c or online at engagingmaths.com.

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WHAT GOES AROUND DOESN'T ALWAYS HAVE TO COME AROUND

I'm delighted that I have been invited to join the distinguished list of speakers at MAV18 and I'm very much looking forward to meeting colleagues at what I hear is a most informative and enjoyable event. Looking back at last year's program I realise that what I have to say doesn't quite fit neatly into the four conference aims, but rather underpins them all.

Whatever year you choose, you can usually find a country that is rethinking the maths curriculum. It may be as part of a regular planned reform which takes place every so many years. It may be because within the policymaker community there is a dissatisfaction with international league table positions. Or maybe a new curriculum is thought to be needed because the political situation has changed, heralding a different educational philosophy or pedagogy. Whichever, curriculum designers, and the policy makers who usually instruct them, borrow content and structures from countries they see as successful in mathematics education to modify their curriculum and so, to a large extent, what goes around comes around.

At Cambridge we are designing something different. We are challenging the accepted content of the curriculum, which is largely the same now as it was when I studied maths at school a very long time ago. Of course, the essential building blocks of mathematics are the same the world over, but there are several factors which we think need taking into consideration. Firstly we know far more now about how students learn, and we believe that that knowledge should impact on decisions about how students might best experience the mathematics. Secondly, we have access to an ever increasingly sophisticated repertoire of digital technology – and we believe this should be incorporated into the curriculum where it adds value, and may, in some cases, fracture the accepted the progressions. Thirdly, mathematics, and its applications, is not a static body of knowledge. New mathematics and new applications are being discovered or invented continuously and there are aspects of that new knowledge that could and should be made accessible to students so that they appreciate what a dynamic and creative subject mathematics is.

However, these factors are necessary but not sufficient to ensure a coherent mathematical experience. We know that mathematicians are often frustrated when students experience mathematics as topics which seem unrelated to each other. For example, structures that connect content across mathematical themes are rarely included in curriculum descriptors, or the schemes of work that are based on them, and therefore not in text books or other resources upon which teachers and students may rely. In our Framework, we make connections within and between mathematical themes.

Our work is predicated on research findings or evidence from a range of experts. We record our decisions so that the reasons for them will be accessible to our users – and if there is no evidence, other than our team's own expertise, then we say so. This transparency and easy access to education research is a feature of our Framework that we hope will be of interest, and use, to our users. And we are capitalising on our research work by writing 'Espressos' . Designed for teachers, these not only show what research has been conducted on a particular aspect, but also suggest what are the implications of it for classroom practice.

One of the first issues that exercised us for a long time was in what form we should express the mathematics within the Framework. Most curricula describe the content in terms of learning outcomes - what a student should be able to know and do. Seeing this as restrictive we sought advice from curriculum designers and researchers around the world. We settled on a structure which sets the mathematics in context; it describes why this piece is important and how it fits into the general 'story'. The detail is based on recent work by the late Malcolm Swan, who has long been a hero of ours! Rather than learning outcomes we instead describe the content in terms of the different ways a student might operate on a piece of mathematics through several different actions - from performing it through representing to critiquing and making connections. We are gathering opinions on this structure through our external evaluation but so far so good...

We are incorporating all these ideas into our digital design tool, the Framework. We want it to be a structure that can facilitate teachers, policy makers, designers of curriculum, resources, assessment and PD in developing a shared understanding. We know that for a curriculum to be implemented effectively there needs to be what Oates calls 'curriculum coherence' and we think that the Framework will contribute to that.

How will they use it? There will be far too much content for any one curriculum so users will be able to choose the most appropriate pathways for their context. Ultimately, they will be able to connect any piece of mathematics learning to those that surround it, to the research that supports it, and to classroom resources, assessments, and professional development items. And if you'd like to see if it will be of use to you – well, join me at my keynote at MAV18!

Lynne McClure is the Director of Cambridge Mathematics, a joint project at the University of Cambridge between Cambridge Assessment, Cambridge University Press, and the Mathematics and Education Faculties. Lynne will present at the MAV conference in December, Cambridge are sponsoring her keynote presentation.

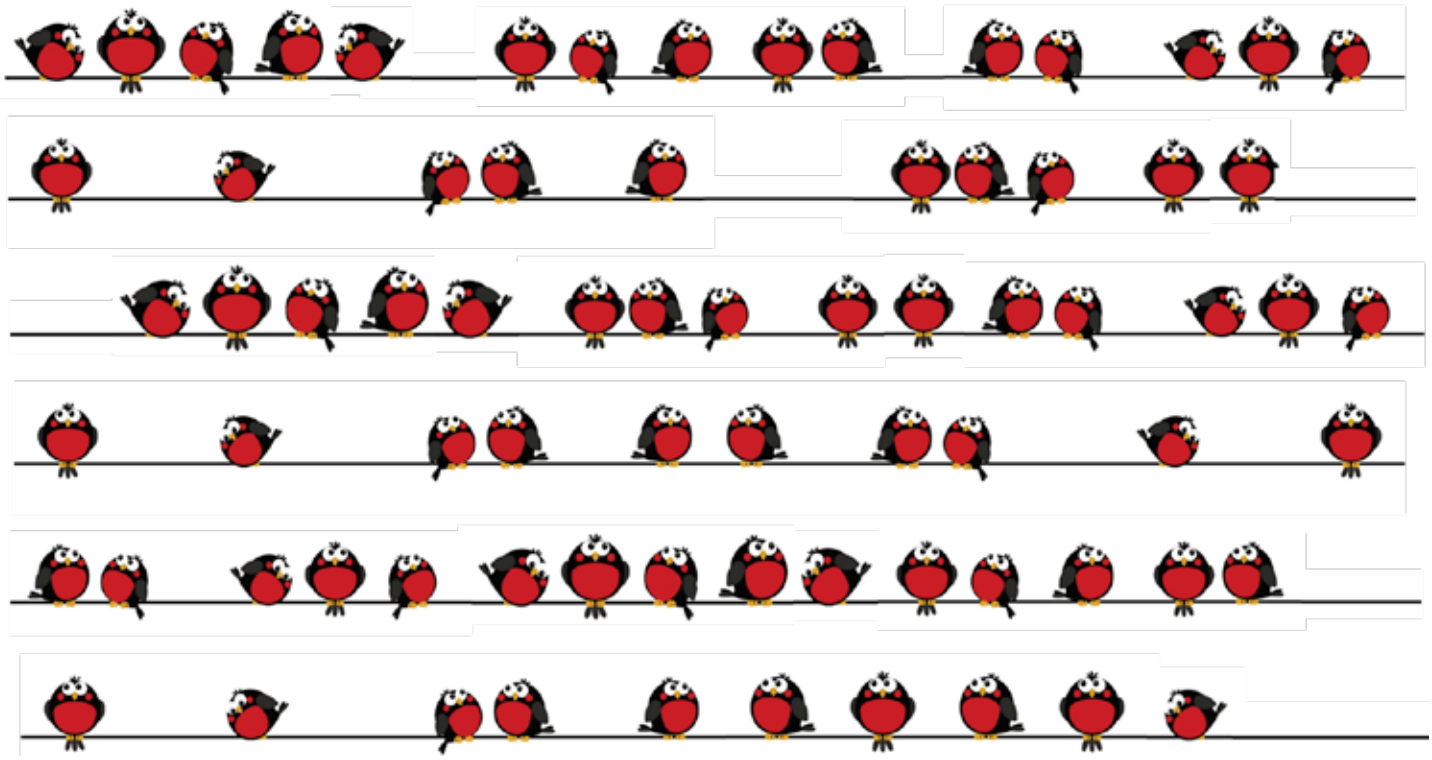
REFERENCES

www.cambridgemaths.org/espresso/

www.cambridgeassessment.org.uk/images/130106-tim-oates-paper-education-assessment-and-developing-a-comprehensive-qualifications-framework-.pdf

CREATING CHALLENGING TASKS

Pam Vilsten and Matthew Ferguson - South Yarra Primary School



Peter Sullivan's book *Challenging Mathematical Tasks* has been an inspiration to many teachers, it has become a part of teachers' resources set and referred to constantly in creating lessons and planning curriculum. Challenging tasks have become a highly regarded manner to differentiate and plan lessons that cater for the diverse range of learning needs in their classroom.

MAV's Education Consultant, Jennifer Bowden has worked at South Yarra Primary School to continue to build teacher capacity. During her time there, she a modelled lesson, explored pedagogy, planned and built curriculum.

Jen has worked with the teachers to create their own challenging tasks based on the framework and pedagogy the tasks created by Peter Sullivan. The teams used a purpose-built template to ensure all aspects of the tasks were considered in creating tasks. During intense workshops, the teachers adapted or designed tasks together, they then all taught the tasks and reflected on the impact of the lessons their teaching and learning practices.

The Foundation to Year 2 teachers share their stories and learning journeys. They adapted tasks based on well-known resources to create lessons that would suit their teaching and learning cohorts. Their stories are below.

HOW MANY BIRD'S -PREP

The Prep team adapted *Year 1 Skip Counting: How Many Birds?*, a reSolve classroom resource as a challenging task to uncover the counting strategies our students were familiar with and using.

During the challenging task lesson, we started with a number-based warm-up. We showed the bird sheet and demonstrated how long it would take to count the birds one by one. Each student was given a sheet containing 30 birds and encouraged to think of a different way of counting them. During our first few minutes of 'purposeful noticing' teachers walked around to see how students were approaching the task. Some were writing numbers above the birds, some were circling groups and others were using their fingers to point and count. Many students counted each line separately using one-to-one correspondence, then added each line, counting by 10's to 30. After this, teachers enabled some students to fold up the page and encouraged them to concentrate on only one line, or suggesting a new strategy they could try.

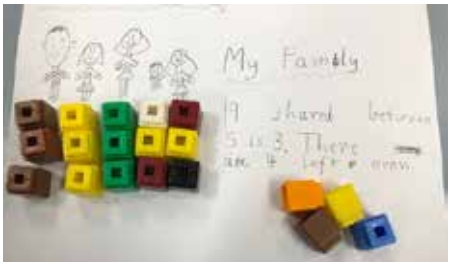
Other students were asked to explain their thinking and try another way of counting the birds. Those that had already showed this were given a different sheet, containing a higher number of birds to challenge them further.

It was interesting to see the different strategies used and hear the justification of why students chose these strategies. In the end, we found that the students impressed us with their counting skills and we should have designed an even more challenging task; not necessarily one with higher numbers but instead with more need for problem solving approaches and creative application of their number knowledge.

THE DOORBELL RANG -YEAR 1

Our task was to design and teach a challenging task for Year 1 students on division. We adapted the Maths 300 lesson *Cookie Count* to meet the needs of our students. Our activity was to share cookies between family members. We introduced the sharing task by reading *The Doorbell Rang* by Pat Hutchins. The teacher modelled the sharing strategy using magnetic counters on the white board. Students were then sent back to their tables to work individually to draw their own family

and share a number of counters equally, however, the number students were given ensured that there was a remainder. We posed the question 'what would you do with the remaining cookie?'



Enabling tasks weren't necessary as we had underestimated the student's ability to apply the concepts of sharing. Most students understood the concept that the groups must be equal and verbally explained that there was one cookie left over. Initially, one student was confused about what to do with the remainder and added it to a group. We were surprised that several students suggested cutting the cookie into equal parts using the language of fractions.

More challenging extending prompts were required and in one classroom, number families were discussed. We worked with Jen Bowden to plan this lesson prior to students completing the pre-assessment task for our unit on division. We discussed that perhaps we could use this activity as a pre-assessment for this unit in 2019.

24 CHOCOLATES – YEAR 2

We challenged ourselves to plan a challenging maths task to be reviewed as a team after the implementation of our unit on fractions.

Our warm-up task was to move around the room and clump into groups of ...4, 8, 3, odd numbers, etc. The warm-up was engaging and allowed for fluid change between groups. Students were already making the connections between what groups would be even and what groups would have remainders, and as a class we were then able to make predictions on whether or not we could make certain groups. Were there any remainders and what does that mean?

This was a great launch into making connections to the language of fractions such as equal, share, fair or divide.

Our main task was to share 24 chocolates into specific groups. This was an adaptation from Peter Sulivans task 'Arrays' from *Challenging Mathematical Tasks*. The 'chocolates' were counters, this was done as a floor activity with some students then modelling their ideas on the magnetic whiteboard.

Using magnetic counters as the 'chocolate' was a great entry point for the students. By moving the 'chocolates' and dividing the group in different ways allowed the students to see that there was not just one way to share it fairly. It allowed students to demonstrate their understanding of the concept and explain the strategies used.

We asked the students to choose their own objects to be shared, moving away from the 'chocolate' theme, at this stage still using 24 as our whole group.

Enabling task - All students were given the opportunity to choose to share their 24 objects between 4 or 8 people. How they did this was up to them. Using the think boards was a great idea, although explicit instruction and modelling an example are a must.

Having a focus group on the floor using Unifix blocks and counters as physical materials to move really helped to highlight misconceptions about sharing equally and dividing of the initial number (24). Some students were still confused with making groups of 6 (interpreted as putting 6 in each group). Targeting this teaching point with those students was also part of the enabling task.

Extending task - The stories were unique with students having the freedom to choose what objects would be shared in their story. Once students were competent with the initial problem, they were tasked with sharing an uneven number among even groups or visa versa. This was a challenge they were happy to tackle, with the use of concrete materials being integral for the concept of remainders to be introduced into the lesson.

Share time - The language of always/sometimes/never was brought into the session at the end with students sharing their stories and results to the class. This discussion was teacher driven, listing objects the students had chosen and asking if the objects themselves could be divided, much like a bar of chocolate can.

Linking the language of fractions to their understanding was a highlight of the lesson. Seeing the students grasp the idea that sharing into equal groups could be connected to fractions allowed a deeper affiliation with the concept to grow and lead into our unit of work.

SUMMING UP

We valued the process of creating our own challenging tasks, teaching the tasks and reviewing the lessons in our professional learning teams. Collaborating with colleagues is very important and we found using a template for our planning led to a consistent approach across our school. We could make changes and add suggestions for the specific tasks to be saved as a valuable teaching resource in our numeracy teaching. Having been through the process of planning for our challenging maths tasks, our teachers are more confident in working to embed these specifically targeted lessons within our numeracy program.

RESOURCES

reSolve Year 1 Skip Counting: How many Birds? www.resolve.edu.au

Maths 300 – Cookie Count
www maths300.com

Challenging Mathematical Tasks and *The Doorbell Rang* are both available from the MAV shop, https://shop.mav.vic.edu.au.

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

RESOURCE REVIEW:
WHAT THE LADYBIRD HEARD

Alicia Clarke - Foundation classroom teacher, St Mary's Primary School Whittlesea

What The Ladybird Heard is a beautifully illustrated picture storybook with a strong focus on locational language. The book tells the story of two thieves who plan to steal the prize cow from a farm. Unfortunately for them, the little ladybird overhears their plans and enlists the help of the other animals on the farm to stop the thieves in their tracks. To add to the fun, the story is full of rhyme, with the extra challenge to the reader to find the sparkly ladybird hidden on each and every page.

The mathematics within the story becomes evident as the thieves describe how they will steal the cow, using words such as *turn right*, *round*, *past*, *left*, *straight ahead* and *through*.

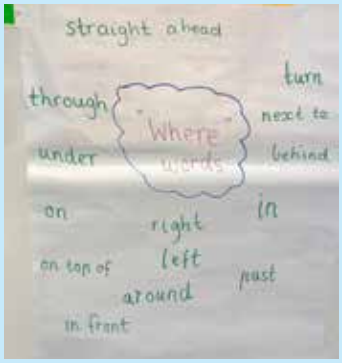
There is also a map (drawn by the thieves) which opens up some lovely possibilities for discussion about direction and location of objects on the farm.

Location comes under the strand of Measurement and Geometry in the Australian Curriculum. At the Foundation Level, students are expected to be able to 'describe position and movement'. At Level 1, students are expected to 'Give and follow directions to familiar locations'.

What The Ladybird Heard provides the perfect context within which to explore these content descriptors. This is an outline of a Foundation lesson using this book as a springboard for the teaching and learning of locational language.

This lesson was at the beginning of a unit on location for these Foundation students, the second session of the unit. The students had previously had some exposure to locational language, where they had positioned themselves on the playground and discussed where they were.

To begin this lesson, we read through the book, simply enjoying the story and predicting what might happen. We then went back through the text, focussing on the part of the story where the thieves described where they would go on the farm. From this page, we made a list of 'words that tell us where' (see below). Students were then able to add to the list from their experiences in the previous lesson.



As a class, we then made our own farm, with similar animals to the story, and used the thieves map to place the animals on the farm.

Students took turns to follow the directions given by the thieves to move a character around the farm. We then extended this, giving extra directions, and writing the location words on cards.

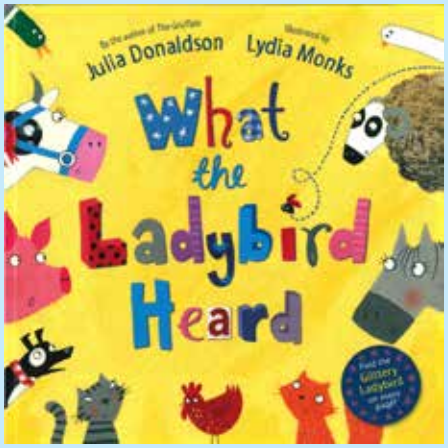
During this, the following prompting questions were used:

- Where is the cow?
- Where is the sheep?
- Where would the thieves go to get to the cow from the sheep? (etc).
- Can you place the duck beside the cow?
- Can you move the sheep around the pond?

Students then had a chance to draw their own map of the farm. They then used our 'where words' to tell the teacher something about the position of one of the items on their farm, and the teacher scribed this sentence on their work.

The above lesson was successful because the students were highly engaged – the picture storybook had given them a clear and interesting context within which to place their learning. The lesson was hands on – students were able to physically move the animals around the farm, allowing them to develop a deeper understanding of the meaning of each word. The final activity allowed me as a teacher to gather some information about whether the students could use locational language to describe the position of an object.

What The Ladybird Heard is an engaging way to immerse students in the teaching and learning of location. It is particularly appropriate for students in the early years, and the above lesson is just one of the many ways this book could be used in the classroom. There is a sequel to this picture book *What The Ladybird Heard Next* by the same author, which would be a fantastic way to extend and build upon this learning.



What The Ladybird Heard is available from MAV's online shop, http://shop.mav.vic.edu.au.

ALGORITHMICS (HESS)

Georgia Gouros - Mathematics and Algorithmics (HESS) teacher at Distance Education Centre Victoria (DECV).

Algorithmics (HESS) is a VCE study incorporating a structured approach to solving practical real world problems using computational methods defined as algorithms. The subject approaches problem solving in a systematic and structured way by using logical and mathematical methods.

Students learn about methods of analysis involving the identification and representation of important metrics and data relating to a problem, and how to construct abstract models incorporating data structures such as variables, lists, arrays and graph/networks used in combinations to represent the information in a structured way.

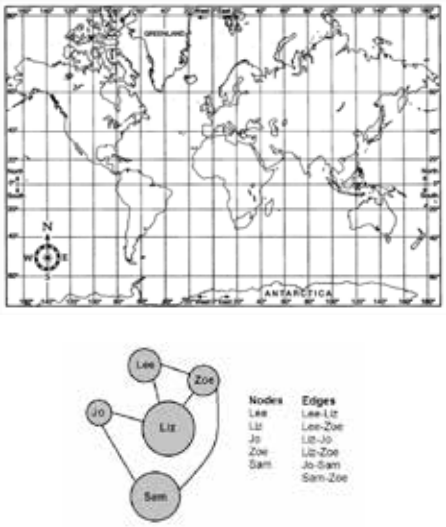


Figure 1. Examples of abstraction of variables and information.

Students learn how to create logic driven algorithms composed of processes and methods using pseudocode, and the implementation of the algorithms using programming languages such as SNAP/ Edgy, Python and Mathematica.

The emphasis of the study in Unit 3 is the reasoning and thinking that is required for the creation of the algorithm representing the solution to real-world information problems as a combination of the processes acting on the abstract data model. This can be understood, and implemented by people who can interpret pseudocode, into any programming language for an automated system of execution.

Example. A digital clock algorithm defined in pseudocode

```
set hour to 0
set minute to 0
set second to 0
Repeat forever
   set second to second + 1
   If second is more than 59, then
      set second to 0
      set minute to minute + 1
   End if
   If minute is more than 59, then
      set minute to 0
      set hour to hour + 1
   End if
   If hour is more than 23, then
      set hour to 0
   End if
   Display "hour:minute:second"
   wait for 1 second
End Repeat
```

Conditional logic using boolean algebra is defined in pseudocode for selecting and repeating certain actions, and in identifying the base case in the use of recursion to define operations and actions.

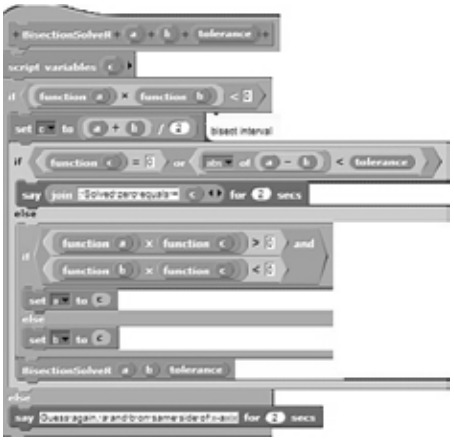


Figure 2. Implementation of a recursive Bisection Method algorithm to solve f(x)=0.

Several well known graph algorithms are studied in conjunction with the graph abstract data type.

Example. Applications of Breadth First Search (BFS) include

Exploring social networks, we can find people within a given distance *k*, where *k* is an integer, from a particular person, until *k* levels are reached.

For example: A friendship network/ graph can show friends and friends of friends. BFS can traverse this graph layer by layer starting at particular individuals and determine if two individuals have friends in common. G={V,E}, V={people}, E={friendship link}

In Unit 4 of the study, students learn about measuring the efficiency of different algorithms for solving the same problem, in addition to learning about deductive and reasoning methods for formally proving the correctness of algorithms.

Philosophical arguments are explored regarding the computability of certain types of problems, and the definition of what constitutes artificial intelligence.

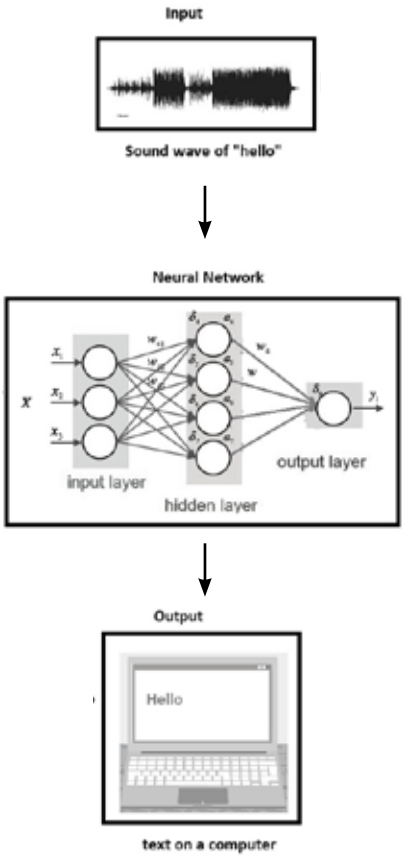


Figure 3. Neural network interprets sound as speech.

Broadly, the aims of the study as stated by VCAA in the VCE study design include:

- Use of symbolic abstractions to formalise real-world information problems.
- Design algorithms to solve practical information problems.
- Investigate the efficiency of algorithms through formal analysis.
- Determine the correctness of algorithms by use of deductive methods.
- Understand the mathematical foundations of computer science.
- Reason about the physical, mathematical and philosophical limits of computation and computability.

Algorithmics (HESS) was introduced into the VCE curriculum in 2015, following a pilot study conducted by Monash and Melbourne universities, with several participating schools. The motivation for the creation of the study was to encourage more students to study computer science, and impart the critical thinking skills, structure and concepts to students to enable them to participate as creators and contributors, rather than solely as consumers of computational technology and information systems.

Worldwide, corporations, research organisations and government authorities are seeking the skills of computer science graduates. In 2011, Google extended its Computer Science for High School (CS4HS) program, providing funds for Melbourne and Monash universities to run workshops over the 2011-2016 period for secondary STEM teachers. This initiative led to the development of the VCE Algorithmics (HESS) curriculum by the two universities, in conjunction with the Victorian Curriculum and Assessment Authority (VCAA).

The Algorithmics (HESS) course emphasises the computational thinking aspects for problem solving, taking a different approach to the VCE Software Development course, where the focus is on programming and implementation of software solutions.

The VCE study design for 2017-2020 exists as a Unit 3 and Unit 4 sequence, with a recommended prerequisite of Unit 1 and Unit 2 Mathematical Methods. The HESS stands for Higher Education Scored Study, and the subject contributes fully to student subject and ATAR scores, as well as earning first year semester credit for Computer Science at Melbourne and Monash Universities, and at other universities on request.

Information about tertiary credits available to successful students can be found at:
Melbourne University https://cis.unimelb.edu.au/schools/algorithmics/
Monash University www.monash.edu/it/future-students/vce-algorithmics

Schools offering Algorithmics (HESS) since its introduction into the VCE curriculum in 2015, have been steadily increasing, as STEM teachers, VCE coordinators and careers advisors are becoming aware of the existence, and aims of the subject, and the benefit to students in the development of analytical and computational thinking skills, together with the direct application of problem solving skills involving logic and mathematical reasoning. The computational methods covered in the course are applicable to many fields of study, in the sciences, mathematics, technology, commerce and the humanities. The tertiary credit that is available for the study in Computer Science is also attracting students to the subject.

Distance Education Centre Victoria have offered Algorithmics (HESS) since 2015. Students across Victoria are able to enrol with distance education if their school is currently not able to offer the subject. DECV students have enjoyed the challenges, and the rigour of the subject, with many introduced to formal algorithmic and computational thinking for the first time. Past students have gone onto study Computer Science at Monash, Melbourne, Deakin, RMIT and Swinburne universities, with the added benefit of a semester credit towards their tertiary studies.

If your school is considering offering Algorithmics (HESS) as a VCE study, there are extensive student and teacher resources available that were created as part of the pilot study in 2014 by Monash and Melbourne universities, which have been updated to meet the current study design. These resources are online at: www.alexandriarepository.org/module/information-for-prospective-teachers-of-vce-algorithmics/.

Algorithmic thinking workshops and sessions are regularly featured for all year levels at the annual MAV conference held at La Trobe University in December.

Based on personal experience in developing the online Algorithmics (HESS) course, and teaching the subject, I have written a textbook *An Introduction to Algorithmic Thinking – Algorithmics (HESS) Student Guide*, which is intended for students, and teachers new to the subject. The textbook covers the theoretical concepts within the course, using detailed examples to illustrate ideas and concepts. Each chapter has exercises and fully worked solutions to consolidate learning and understanding of the topics covered in the study.

OTHER RESOURCES

Free online resources supporting algorithmic and computational theory:
Computer Science Unplugged https://csunplugged.org

Khan Academy www.khanacademy.org/computing/computer-science

Openclassroom.stanford.edu https://online.stanford.edu/courses/soe-ycscs101-sp-computer-science-101

Bebras Australia www.bebras.edu.au

AMT Trust www.amt.edu.au

REFERENCES

VCAA Algorithmic (HESS) Study Design www.vcaa.vic.edu.au/Pages/vce/studies/algorithmics/algorithmicsindex.aspx

Cox, Richard & Bird, Steven & Meyer, Bernd. (2017). *Teaching Computer Science in the Victorian Certificate of Education: A Pilot Study.* 135-140. 10.1145/3017680. https://www.researchgate.net/publication/314294542_Teaching_Computer_Science_in_the_Victorian_Certificate_of_Education_A_Pilot_Study

Gouros, G (2017). *An Introduction to Algorithmic Thinking – Algorithmics (HESS) Student Guide* http://lulu.com/spotlight/algorithmics.

CODING@TGC

Margaret McArthur - eLearning coordinator and information technology teacher at The Geelong College

The emphasis on teaching coding to the generations of the future has seen significant growth in recent years. This particular strand of education offers various advantages to young, developing minds, including the strengthening of logic and problem-solving skills. In accordance with this focus, we launched the subject CODE IT for Year 8 in 2017, as well as a separate program for Year 2.

Year 2 students learnt how to code using OSMO block coding, which enhanced their understanding of the procedures required to create projects on devices. The next step of this process was to introduce the Year 8's and Year 2's to a shared classroom environment. Our Year 8 students imparted their knowledge to the Year 2 classes via ScratchJr in a one-off interactive lesson. A double period on a Wednesday allowed us to travel to the junior school and teach each class separately, without impacting any other subjects.

Once in the classroom, the Year 8 students found their confidence and effortlessly taught the Year 2 students.

Part of their action plan was to separate into small groups to better communicate with the younger students. The Year 2 pupils gained immense and valuable information from the 1:2 teaching ratios, and were deeply engaged in the activities. The level of programs they produced were outstanding and included dancing names, dancing characters and moving objects. Some even took the initiative to troubleshoot their own technical issues as the lesson progressed. A few students also got to experiment with our new OSMO Coding Jam, coding with blocks to make music.

This was a hit with the Year 2 students, and bonds were quickly formed between the students. At the end of the workshop, the younger pupils were reluctant to say goodbye to the Year 8's, and begged for them to stay and play all day. It was a lovely, positive morning spent learning and exploring. The Year 8 students were impressive in the patient and gentle delivery of their knowledge.

The feedback from both year groups was exceptional. From the Year 8's, we received comments such as, 'that was more fun than I expected', 'I was scared they would cry, but they really got into it' and 'the Year 2's really listened to me'. The Year 2 students' enjoyment also shone through in their reactions, saying 'can the Year 8's come down every week?', 'that was so much fun' and 'are we doing this again tomorrow?'.

Both year levels gained so much from this experience. For the Year 8 students, it was a chance to share the knowledge they had gained throughout the term and, most importantly, they synthesised these skills into lesson plans and delivery. The Year 2's connected with the older students, building confidence and excitement for their future progressions into middle school.

RESOURCE REVIEW: ONE MINUTE

Sarah McGregor - Derrimut Primary School

One minute can be the difference between catching the train and missing the train.

Our community of Year 1/2 teachers at Derrimut Primary School embarked on a unit focusing on time, from duration of events to reading the time on a clock to the nearest minute.

Our students are diverse both socio-economically and culturally with a large number from non-English speaking backgrounds. When we introduced the time unit, we began with finding out what our students already knew and what they would like to know.

WHAT DO WE KNOW ABOUT ONE MINUTE?

We launched with an investigation into the duration of one minute. Did students know what one minute felt like? We asked students to stand up and then sit down once they thought one minute had passed. It was interesting to watch when students sat. We discovered that most were able to estimate accurately the duration of one minute.

Students then explored tasks that they could complete in one minute. They were asked to estimate the amount of times they can do that task over and over again for one minute. Students were asked to estimate how many times they thought they would be able to do the activity and then they tested themselves. Some activities included

- writing your name
- running between two chairs
- singing Twinkle, Twinkle, Little Star
- Stacking unifix cubes, and
- Rolling a dice.

Students worked in pairs and were provided with tools such as one minute sand timers and iPads to time themselves. They compared their estimated number with the actual amount of times they completed the activity in one minute. Students were able to compare their results with their partners and came up with generalisations. One of the generalisations they came up with were people with shorter names wrote them more times than someone with a long name.

While students were completing their tasks, they were sharing their views on how one minute feels when completing specific tasks. For example, when jumping, a student remarked 'one minute feels so long' but when stacking unifix cubes, the student said 'one minute feels so quick'.

To summarise the lesson, we read *One Minute* by Somin Anh. This helped students consolidate their understanding of how long one minute is, how it can feel long or short and how different things can happen in one minute and the importance of one minute when catching a flight or train.

Students developed a deep understanding of the duration of one minute through their exploration and through the consolidation of their ideas by reading the picture story book. One minute is 60 seconds but it can feel very differently depending on what you are doing!

One Minute is available from MAV's online shop, http://shop.mav.vic.edu.au.

HAILSTONE SEQUENCES AND THE COLLATZ CONJECTURE

Katherine Seaton - Department of Mathematics and Statistics, La Trobe University

In a recent *Common Denominator* article (Nelson, 2018), a problem solving exercise based on the sequence 20-10-5-16-8-4-2-1 was described. This is a particular example of the hailstone sequences, so-called because, although they seem to fall eventually, they may rise as do hailstones during their formation. Often number sequences are named after a person (the Fibonacci sequence) or what they describe (triangle numbers), but the naming of the hailstone sequences is a lovely example of the use of metaphor in mathematics.

The hailstone sequences arise from the Collatz conjecture, the proof of which is an unsolved problem in number theory. One way to introduce it is by way of a pencil-and-paper game with these rules: Write down a positive whole number. If your number is even, halve it. If your number is odd, triple it and add one. Apply the same rule to your new number, and repeat (and repeat), to form the hailstone sequence of your original number. Pick another number, and try again – what seems to be happening? This game involves the mathematical process of iteration.

PLAYING HAILSTONES

Even better, play this with a group as a physical game that I call Hailstones in a workshop for Years 7-10. I do this in a room lined with whiteboards, first writing up the numbers from 3 to 36 (but not 27 or 31) leaving room for higher numbers to be added. The students each choose a different starting number. Applying the rules above, they work out their new number, write it underneath their starting number and then move around the room to the position of the new number, adding it on the wall if it has not yet appeared. I don't highlight mental maths in the game (though one could) so I encourage peer assistance and have calculators on hand. Then we iterate. Students are told to remember two things – where they started and the highest number visited (their maximum trajectory).

After a few rounds of the game, some students realise that if they reach 1, they become trapped in the loop 4-2-1... and they want to add a rule: when you reach 1, you are 'out', and I add another thing to remember: how many rounds of the game before you go out (stopping time). When the last student sits down, the students often say this person won. I propose an alternative winner – the person who reached the highest number. Advantages of playing this way is that we simultaneously observe many different sequences, and the variation in maximum trajectory and stopping time, and the up-and-down hailstone behaviour (quick diversion into meteorology to explain the name), experienced *kinaesthetically*, is striking.

NOTICE AND WONDER

We next represent what we have observed graphically by making plots, with starting number on the horizontal axis. Each student marks their stopping time on the vertical axis, and then on a separate plot, their maximum trajectory. They can plot individually the sequence that they followed – with round number on the horizontal axis and number at that round on the vertical axis. One discussion point can be whether it is appropriate to join up the points on these plots. What would it depict? What might it falsely suggest?

I ask the students collectively the two questions: What do you notice? What do you wonder? (Ray-Riek (2013) explains why these are good questions to ask at high school level.)

Some things that students notice are

- Numbers like 16 (or 8 or 32) don't ever go up, they just go straight down and have short stopping times. (Encourage them to name these numbers – the powers of 2.)
- You never get two odd numbers in a row, so you always come down straight after going up. (Why? Try to get the explanation that odd times odd is odd, and plus one makes even.)
- Some numbers are reached by two different routes e. g., 10 = 3 x 3 + 1 or 20/2.

Some things that students wonder are

- Why wasn't 27 included?
- Is there a pattern to the stopping times or the maximum trajectories?
- Do all numbers always reach 1?

This is exactly what Collatz wondered! The Collatz conjecture is that every hailstone sequence reaches 1, regardless of starting number. But although the conjecture is some 70 years old, and so easy to describe, it has proved resistant to the known methods of mathematics! Ask what would have to occur for it to be false. There are two possibilities. The first is usually mentioned – that one of the sequences grows more than it falls, and 'escapes'. You may have to prompt students to find the second, but point to 4-2-1 – what if, somewhere, one of the hailstone sequences contains a different cycle?

A different, and potentially beautiful, visual representation is to draw the various hailstone sequences as branches of a tree, which has 16-8-4-2-1 as its trunk, but then branches start to appear – since 16 could be preceded either by 5 or by 32. There are many depictions of this organism to be found online. (I particularly recommend the youtube Numberphile video with Alex Bellos, and http://swimmingthestyx.com/?p=447.) I have found the concept of mathematical art to be well-received by teenagers, but those who really don't want to draw seem to enjoy the challenge of generating the hailstone sequence that begins at 27. (It has 111 terms in its sequence and it goes as high as 9232!)

Up to this point, no symbolic representation has appeared. The idea of a hybrid formula (one form for some numbers, another form for others) may be new, but students who have done some coding are generally familiar with 'if' statements. A simple way to write the rule is, calling the current number n

$$\text{next number} = \begin{cases} \frac{n}{2} & \text{if } n \text{ is even} \\ 3n+1 & \text{if } n \text{ is odd} \end{cases}$$

Students may be ready to try to write a more sophisticated representation as a sequence labelled with the natural numbers, or to write the rule in a form that could be iterated in a spreadsheet.

No student in one of my workshops has ever wondered about beginning with negative numbers, which does give rise to cycles other than 4-2-1. However, they have noticed the shortcut that odd n can be followed by $\frac{(3n+1)}{2}$.

In the article mentioned above (Nelson, 2018), the numbers from the hailstone sequence of 20 were used by a Year 5/6 class to explore what rule could have generated them, with the assumption that it would be linear. (An extra piece of information also had to be assumed – that the hailstone sequence of 22 did not cycle.)

In this article, I have described activities from a workshop that I have run successfully with Years 7- 10 that also involves hailstone sequences. These activities, some of which are STEAM activities as they include technology and art, use a variety of representations of mathematics, they can consolidate use of mathematical language in an unfamiliar context, and they challenge student perception of what maths is. It isn't all already known; there are beautiful things left to wonder about!

REFERENCES

Nelson, M., Problem Solving with Rich Tasks, *Common Denominator*, Term 3 2018, p.10

Ray-Riek, M., *Noticing and Wondering in High School*, available at http://mathforum.org/blogs/max/noticing-and-wondering-in-high-school/, last accessed August 17, 2018

BRIDGING THE DIVIDE

Peter Maher - Penleigh and Essendon Grammar School

Earlier this year I took long service leave and toured parts of southern and eastern Africa. During a game park safari I encountered 'the big 5', saw Victoria Falls, Olduvai Gorge and the great wildebeest migration. However, the highlight of my tour came from a very unexpected source.

The tour company sponsor a school in the Arusha district of Tanzania. Located on the eastern edge of the Great Rift Valley, in the highland tropics of the country, is Kimandolu Primary School. I was staying nearby in accommodation at a coffee plantation, so I asked to visit the school and offered to teach and conduct a professional development session for staff. A phone call to the school's principal resulted in a warm invitation and so began a day's teaching I will never forget.

I was greeted by the entire school of over 500 students singing a Swahili song of welcome and then taken to the principal's office where he advised me of the school's curriculum and focus. Despite, by first world standards, the poverty of the physical structure of the school, he was justifiably proud of the opportunities that its children were afforded.

I met the Standard 7 teacher and his 12 and 13 year old students and was told that the day was mine to teach as I wanted. The students' first language was Swahili but they all had a rudimentary grasp of English, having learnt it since starting school.

There were 48 students in the class sitting in 14 wooden desks with an exercise book each and a shared set of pencils, both of which were only used for very special occasions. The classroom had plaster hanging from the ceiling, large cracks through the floor and walls and a split blackboard.

I began by writing on the chalkboard the first three terms of some arithmetic sequences and asking for what the next terms would be. The classroom teacher translated my instructions into Swahili and the students raised their hands with great excitement whenever they believed they had worked out the solution. It became very clear that the students had never been asked how or why they solved problems and my efforts to get them to justify their responses proved a major challenge.

Once I had the ability to assess the general standard of the class I moved on to playing maths games such as 'Guess my number' and '20 Questions'. The interest shown by the students, their respect, love of learning, joy and engagement were exceptional.

The PD session I conducted after school started with a question session where I was asked why I had wanted the students to explain how they came up with their answers and why some of the questions that I had posed had more than one possible answer. I used this opportunity to speak about the importance of thinking and verbalising and that learning should be a community activity rather than a solitary experience.

I focussed on tests for divisibility in the presentation and discovered that most of the staff had learned maths in a purely rote manner, some unable to say what number would come after 50 in the 5 times table, despite being able to count to 50 in 5's. I later discovered that only two staff members had been teacher trained with the majority of teachers being drawn from the local village. The staff thanked me for extending their knowledge regarding number theory and showing how mathematics is based on patterns and connections.

I took away a number of significant conclusions:

- Mathematics has the ability to effortlessly bridge cultural, linguistic and socio-economic divides.
- Student engagement is linked inextricably to challenge. New learning and new experiences lead to motivation.
- Well-being and happiness in students have little to do with material possessions. Teachers have no control over students' background. What we can control is the joy that they derive from their time with us. As mathematics educators we should try to ensure that our students are presented with engaging, challenging and relevant experiences.

MINI-MATHEMATICANS

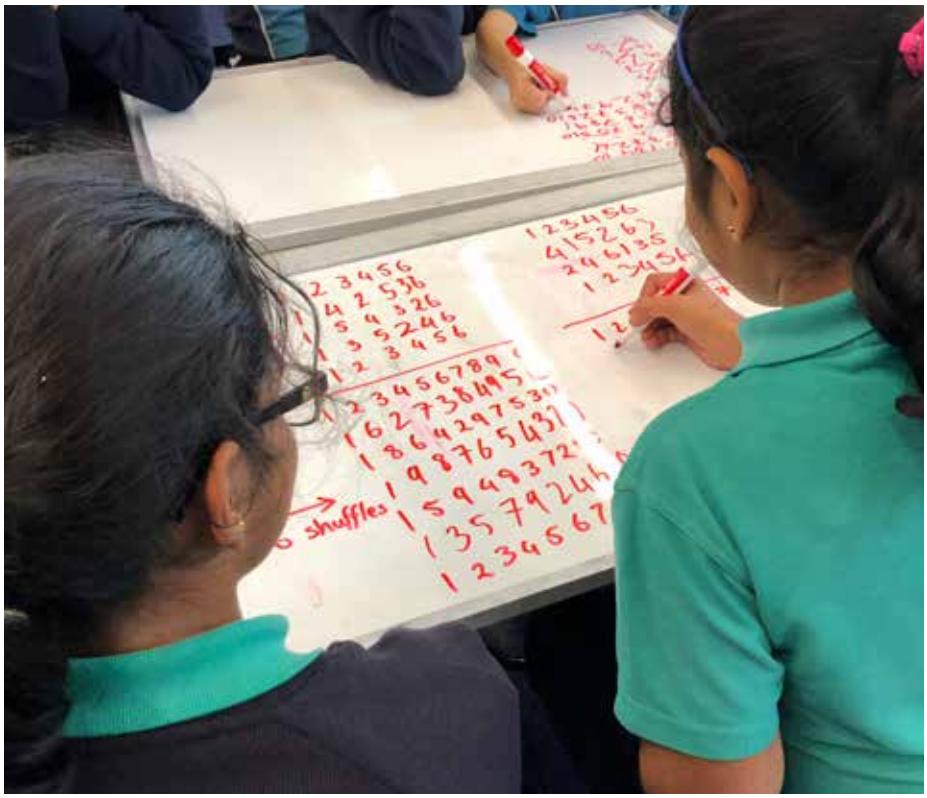
Luke Bohni - Head of mathematics and professional learning, John Monash Science School

ENCOURAGING PRIMARY SCHOOL STUDENTS LOVE OF MATHEMATICS TO MULTIPLY!

As mathematics educators, it is often our dream to inspire our students with the same interest and passion for the subject that we too have. It is unfortunate, therefore, that the prescribed curriculum often fails to provide us with the opportunity to explore and investigate the really interesting fields of mathematics that can hook students on mathematics. At John Monash Science School (JMSS), we are incredibly lucky to be able to provide students with opportunities to access some of these more abstract fields and we don't just stop there, we are now trying to extend these opportunities beyond our school to involve primary school students.

John Monash Science School is Victoria's first specialist school for science, mathematics and associated technologies. Open in 2010, a major component of JMSS' vision and goals is to empower and share all of the wonderful things that happen within the school with the broader community. We take our remit to share our teaching and learning and to generally build capacity in the Victorian education system very seriously. To achieve this, JMSS has a strong outreach team which focuses on a variety of programs to share the best of our unique curriculum with students from all over Victoria and increasingly interstate. One of our offerings is our Mini-Mathematicians program, which aims to provide primary school students in Years 5 and 6 with exposure to some of the really exciting and interesting fields of mathematics that they might not usually get to see in traditional maths classrooms.

In 2017, I led a small group of mathematics teachers at JMSS and together we designed a short course that explored areas of mathematics such as Infinity and logic, Card Shuffling, Code Breaking and Graph Theory. The result was a hands-on, highly engaging course that consisted of four one-hour sessions across a term. We then extended an invitation to local primary schools to send four or five students from their schools to take part in the program. In these sessions, the students would be exposed to all of these different mathematical ideas but the best aspect of all was that the course would be delivered by current and past JMSS students who also had a passion and interest in mathematics and, furthermore, had opted to give up their time to work with the primary school students.



The mentoring provided by the JMSS students was invaluable, it assisted greatly with their science and maths communication skills and gave them added confidence in their mathematical ability. It also provided them with a new level of 'empathy' for their everyday JMSS teachers. The primary school students loved being 'taught' by peers (not teachers) whom they could look up to, relate to and above all easily learn from. The passion that JMSS students had for mathematics was palpable and easily absorbed by both primary school students and teachers in the classroom. Primary school teachers were also encouraged to stay in the room with their students, so they could use this as a form of unofficial PD and take some of these ideas back to their own schools to integrate into their own curriculums or maths clubs.

This year Mini Mathematicians continues to grow. Every semester it is getting bigger and bigger with students from primary schools travelling over half an hour each way to come to JMSS on a Wednesday afternoon to study mathematics. We are proud of our achievements and think it is a great success but we aspire for the program to grow even further. We would love to pair up local primary and secondary schools to share this unique and engaging curriculum with schools across Victoria that are not in travelling distance to John Monash Science School. The students who participate in Mini Mathematicians get to go home with the secrets of public encryption keys, logical reasoning skills and card tricks but most importantly of all, they go home talking about mathematics and that is a big win in our books. When students are interested in and talking about mathematics they are on the path towards discovering how truly awesome mathematics is.

If your school is interested in getting involved in the project, or would like more information, please contact luke.bohni@jmss.vic.edu.au.

VCAL NUMERACY: APPLIED!

Jason Austin - qualified carpenter and mechanic, experienced VET Teacher, VCAL coordinator and manager of the Outer Northern Trade Training Centre, and Rachael Philp - inclusive classroom assistant at the Outer Northern Trade Training Centre.

HOW TRADE STAFF CAN ASSIST STUDENTS WITH THEIR NUMERACY?

Well before we know it our students are moving from middle years schooling into senior schooling and the obligatory worded outcomes and the associated pressure of accountability that accompanies these outcomes. When students are faced with challenges in senior schooling, particularly in regards to vocational pathways, we often see a deficiency in maths skills and their application.

One example of dealing with these maths deficiencies is finding some common ground with the students and then building on this.

Giving a recent example of roofing angles and measurements in the vocational setting of Building and Construction, I was faced with a number of challenges on how to find out, and work with, the student's base understandings.

SO WHAT DID I DO?

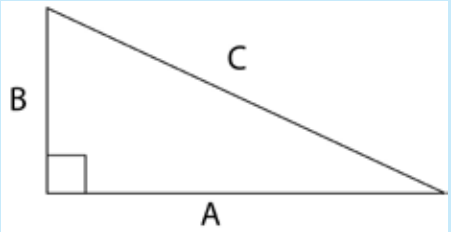
I asked a couple leading questions and had an example of triangle math formulas on the board.

As expected the usual negative responses of: 'I hate maths', 'Oh, not this again', 'I don't even know what trig means', 'Pythagoras' theorem! That's rubbish!' – or something to that effect. So once the dust settled I took them across to a 3D triangle roofing structure and said, 'All the things you don't like and don't understand allow us to build this structure!' 'Crickets chirping!'

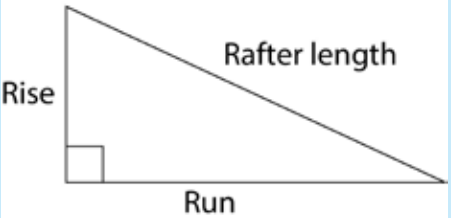
One quick question followed. 'Do you guys know about trigonometry?' 'Nah', the reply, and then, more silence. So the magic of Pythagoras was about to be applied and then made on the bench.

Reviewing the theory with the numbers 3-4-5 (used regularly in the building trades) I demonstrated the formula of $C^2 = A^2 + B^2$. 'Oh yeah I remember that', one student states. 'Great', I said.

That was the starting point and the common ground to working with key terms that match this simple 3-4-5 formula. Working from the little red book of roofing I again picked a table and showed them how this book works and how it's built on $C^2 = A^2 + B^2$.

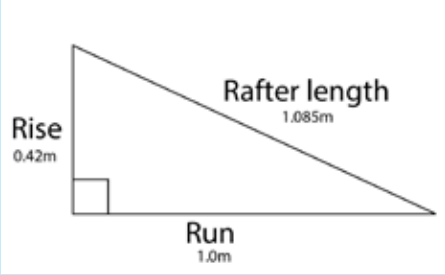


It is here that I got all students to do the formula with me for a roof pitch of 22°, a very common roof pitch for modern suburban homes.



I then gave them some numbers to work with from the roofing table 'red book'. Same theory, new names to the triangle and working with the common ground that was discovered.

The students worked the numbers into the formula and came up with the same answer as the book. Now they looked really surprised that they got the same answer and it was correct!



To follow up on their new discovery of an old theory that would have been diligently taught at an earlier stage in their learning, I then got them to calculate some new numbers and then look at cutting the rafters to the right length with the right angle. 'Ah.... angles!' you say!

So using the above diagram I explained it, in simple terms. This being, if I draw a line 1 metre long and then another line 0.42m long, followed by a line between these points, it's called the 'hypotenuse' and it is on the required angle. So how do I get them to reproduce this angle on timber?

I achieve this by drawing on the whiteboard the following: 42mm, then 100mm and then a line drawn between them. Then using a sliding bevel we adjust it to match the drawing and then put it to work on our timber. And to show them that they are right we double check our drawings with a protractor.

Although I'm probably telling you nothing new, I'm sharing a way of getting senior students that sometimes have little to no maths, the confidence to begin sawing and putting together basic roofing triangles. As the students practice this they are then demonstrating competence and meeting outcomes that they never thought they could.

HOW CAN EDUCATIONAL SUPPORT STAFF ASSIST STUDENTS WITH THEIR NUMERACY?

Having had the privilege of working with young people as a classroom assistant in a variety of vocationally based subjects that encompass numeracy, I have been able to support, create and share my experiences and strategies to help Education Support staff assist students with their numeracy outcomes within their vocational pathway.

I have seen the look of sheer panic in the eyes of young people when the words Pythagoras or Pi are uttered. Let alone lineal, square or cubic metres. I always tell them.... 'It's not that hard', because it isn't. It is important to not over complicate the mathematical process.

Working in vocationally resourced classrooms, staff have the advantage of being able to immediately apply the numeracy to a practical task, learn by doing and see maths in real life situations. This then gives reason as to why we need to know this. For example, we talk about how much cement would be needed to fill a hole to put in a fence post and then the reason why we need to know how to work out cubic metres becomes apparent, it then becomes relevant to our students. The same goes for square and lineal metres. Once it is related to a specific task or building method then

students become more engaged and willing to focus and are able to understand the steps involved in achieving the outcome.

Having simple visual aids in the classroom can also assist students with understanding the steps needed to work out the required numeracy tasks. Creating posters with a worked example has been a valuable tool in simplifying the process of many different numeracy tasks. These examples often become part of the classroom 'furniture' and knowledge is absorbed by the students. When it comes time to actually do a task they know the steps needed because they have been looking at them for a period of time and all of a sudden it's not as hard as they thought. As an example of this, students struggle with the concept of Pythagoras Theorem, 'It's just too hard!' However, students generally can manage to work with the 3, 4, 5 method to be able to make a right angled triangle and therefore ensuring their site set out is square.

A metric conversion chart can also come in handy to explain how many millimetres are in a centimetre or centimetres in a metre, and vice-versa.

Having students explain numeracy tasks to their peers is also a way of assisting students to learn. Peers have the ability to use language that they know their mates will understand. They use a less technical way in explaining and will teach the method that they understand. Often we find that the way students were taught at school is no longer the method that is taught these days and so students don't get confused by an unfamiliar method.

Working through a task as a group using the whiteboard is also a useful tool to visually explain a numeracy question. This invites input and class discussions around a topic and provides a better understanding of the maths at hand.

Education Support staff can further help their students by completing the set numeracy tasks, before the tasks are presented to students. By doing this support staff gain an understanding of the processes involved in completing the tasks and are then able to better help students while working through the questions. This also gives the support staff a 'cheat sheet' or answer sheet to check while we are assisting students!

If you teach VCAL Numeracy and would like to share your stories of success in the classroom, we'd love to hear from you.

Your story doesn't need to be word perfect, the editors can guide you through that process. If you are interested to learn more, email office@mav.vic.edu.au.

PUZZLES

Michael Nelson - Teaching and learning coordinator, Portarlington Primary School

LOWER PRIMARY

I saw the answers to a series of problems was 0, 5, 10, 15, 20. My teacher asked us what happened. I said the person was skip counting and my friend said they were adding. How can we both be right?

Describe, continue, and create number patterns resulting from performing addition or subtraction (VCMNA138)

Investigate number sequences, initially those increasing and decreasing by twos, threes, fives and ten from any starting point, then moving to other sequences (VCMNA103)

My teacher asked me to make 375 using MABs but he didn't give me any hundreds. Can I still make the number?

Group, partition and rearrange collections up to 1000 in hundreds, tens and ones to facilitate more efficient counting (VCMNA105)

MIDDLE PRIMARY

Is there any amount of money you can make more than one way without using the same coin twice?

Represent money values in multiple ways and count the change required for simple transactions to the nearest five cents (VCMNA137)

I went to measure the length of my pencils to buy a pencil case, but the ruler was broken and it started at 6cm. Can I still measure my pencil?

Use scaled instruments to measure and compare lengths, masses, capacities and temperatures (VCMMG165)

UPPER PRIMARY

I was looking over someone's shoulder who was using a calculator. I could see they hit the multiplication button but the digits did not change. However, the decimal disappeared. What did they do?

Multiply and divide decimals by powers of 10 (VCMNA216)

Your teacher buys a cupboard for her classroom library. It has shelves with an area of $2m^2$. Does it matter the order of the dimensions?

Calculate the perimeter and area of rectangles and the volume and capacity of prisms using familiar metric units (VCMMG196)

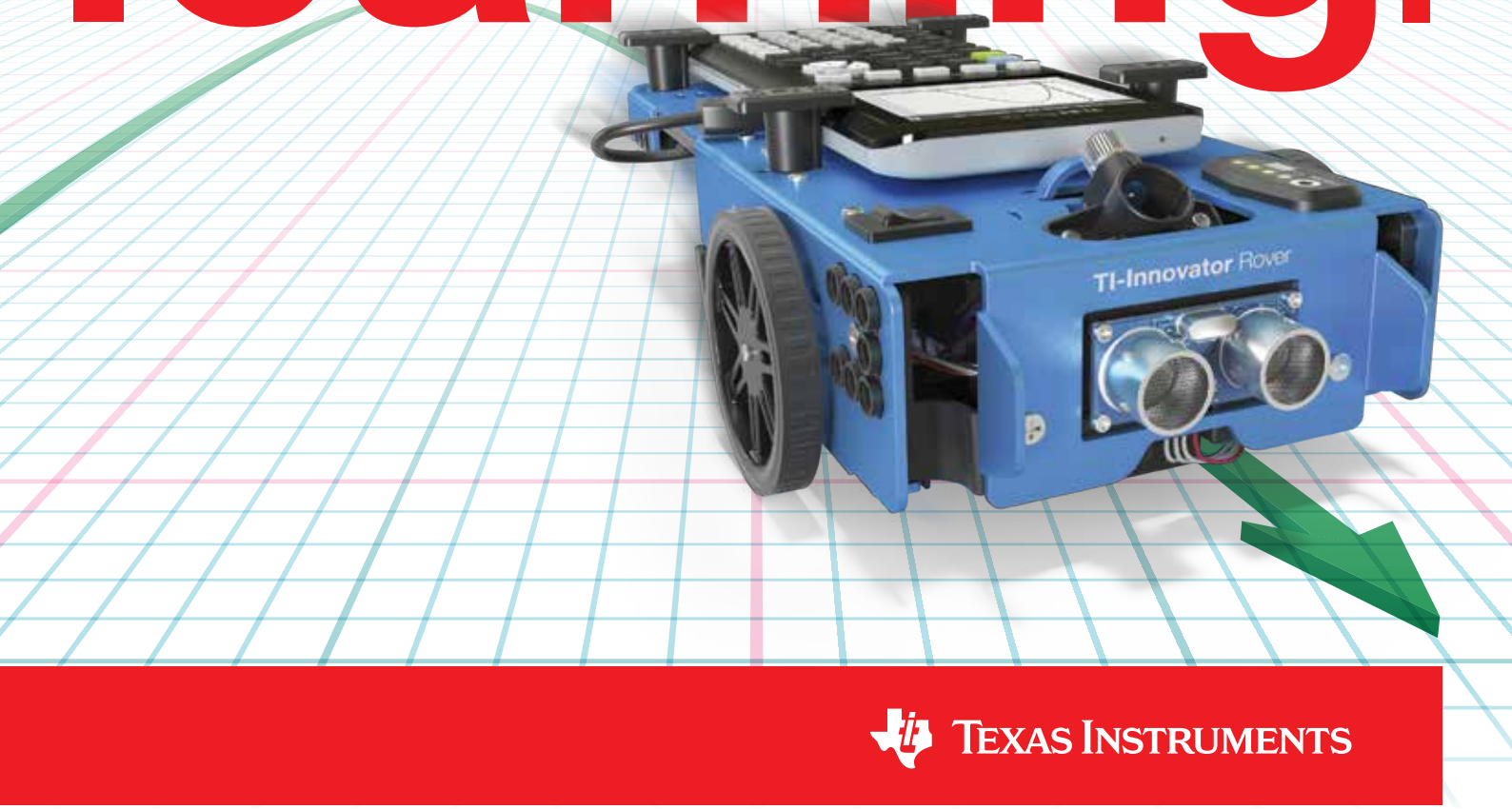
TM4U

Due to the substantial resourcing required to keep the Teach Maths for Understanding resource up-to-date, and the investment required to modernise any infrastructure used to deliver it for the future, MAV have decided to retire the Teach Maths for Understanding website at the end of 2018.

We apologise for any inconvenience caused by this change, and ask you to bookmark your favourite links elsewhere before the end of December.

MAV would like to thank Dr Ian Lowe for his continued support in creating and maintaining the content of the site over many years.

When the wheels are turning, the students are learning.



TEXAS INSTRUMENTS

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*TI-Innovator™ Rover requires a TI-Innovator™ Hub with TI LaunchPad™ Board and a TI-Nspire™ CX handheld or TI-84 Plus CE graphing calculator. Components are sold separately.

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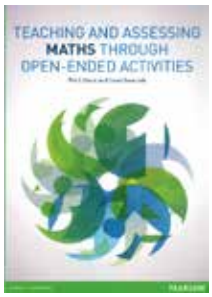
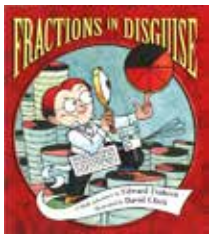


TEACHING AND ASSESSING MATHS THROUGH OPEN-ENDED ACTIVITIES

F–6

This book contains activities and real student work samples as a guide, to help improve student learning. It relates mathematical strategies to real life situations for students and caters for different needs, allowing for differentiated learning. Designed for teachers to help students practise investigation, conduct assessment and create reports.

$53 (MEMBER)
$66.25 (NON MEMBER)



FRACTIONS IN DISGUISE

3–6

When a valuable fraction goes missing, George Cornelius Factor (a.k.a. GCF) vows to track it down. Knowing that the villainous Dr Brok likes to disguise his ill-begotten fractions, GCF invents a Reducer - a tool that strips away the disguise, reducing the fraction and revealing its true form. Equal parts of action and humor add up to a wholly entertaining introduction to simplifying fractions.

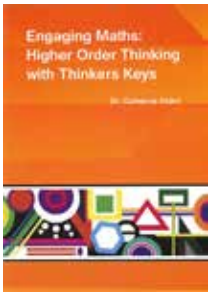
$12 (MEMBER)
$15 (NON MEMBER)

MORE PROBLEM SOLVING: THE CREATIVE SIDE OF MATHEMATICS

8–VCE

Be prepared to slice through cubes, lick stamps and limit the number of aliens allowed on a space ship and along the way spot the patterns, make conjectures, move towards a result and just maybe develop its proof. This book suggests different approaches to the solutions of a number of problems, such as the towers of Hanoi, tiling with polyominoes, an equi-probable dice game. Readers are encouraged to leave the text to do their own thinking and then return either in triumph or frustration! Accessible to most secondary students with a knowledge of number and some basic logic skills, this book provides lots of opportunities for problem solving and reasoning.

$42.26 (MEMBER)
$52.83 (NON MEMBER)



ENGAGING MATHS: HIGHER ORDER THINKING WITH THINKING KEYS

3–6

All students should be encouraged to engage with higher order thinking tasks. This book uses a critical and creative thinking tool called Thinkers Keys, adapted to be specifically mathematical. The keys indicate the kind of thinking needed to do the task: 'reverse' thinking, 'what if' thinking, 'invention' thinking, 'prediction thinking', even 'ridiculous' thinking. Could your students invent a calibrated measuring device to measure liquid? Or list reasons why a mental strategy might be better than a written strategy for a particular problem? A comprehensive table explains the different keys and gives an example activity. There are a number of carefully annotated student work samples. Engage your students with creative mathematical thinking!

$25.74 (MEMBER)
$32.18 (NON MEMBER)

ENGAGING MATHS: IPAD ACTIVITIES FOR TEACHING AND LEARNING

F–8

This book provides teachers with some professional learning in relation to using iPads® and other tablets to enhance the teaching and learning of mathematics in the primary classroom. There are unlimited and ever changing ways you can use technology in the classroom and it is impossible to have a definitive list of ideas. The goal is to promote the thoughtful integration of tablet devices in ways that enhance teaching and learning. Dr Catherine Attard draws on her own research into the use of tablets in primary mathematics classroom and her research on student engagement to provide a theoretical base for the activities and tasks presented. There are short tasks that can be used as lesson warm-ups, and extended investigations. The activities incorporate mathematics-specific applications, generic productivity applications and games.

$25.74 (MEMBER)
$32.18 (NON MEMBER)

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