THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 4/21

BUILDING THINKING CLASSROOMS

INSIDE

Peter Liljedahl - Professor, Simon Fraser University, Canada

My work on *Building Thinking Classrooms* began in 2003 when I reached out to my network of teachers and administrators and asked them to recommend to me teachers that they had heard were good. I contacted these teachers and asked them if I could visit their classroom for a day. While visiting, I likewise asked them to recommend to me a teacher in a different school that they had heard were good. Following this thread of good teachers, I was eventually able to visit 40 different classrooms in 40 different schools. And because I followed this thread, there was a lot of diversity between the schools I visited. I was in low socio-economic settings and high socio-economic settings. I was in French-speaking classrooms and English-speaking classrooms. I was in public schools and private schools. And I was in primary classrooms and secondary classrooms. And everywhere I went I saw the same thing – students not thinking and teachers planning their teaching on the assumption that students either couldn't or wouldn't think.

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

Magazine 281, October 2021

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The Common Denominator is edited and produced by Louise Gray, Stitch Marketing.

Print Post Approved
Publication No: PP100002988

FROM THE PRESIDENT

Michael O'Connor

Two recent articles, one in *The Conversation* (10 September) and the other in *The Washington Post* (25 June) explored different aspects of the influence of COVID-19 on teaching and learning. In *The Conversation* the topic was assessment, specifically end of year and end of school. While the Post article talked mostly about the need to speak honestly with students about maths being hard, there was a sub-theme as well though, about the use of the chat window.

Remote teaching is a bit like going deaf or blind. Not sharing a physical space with students makes determining the impact we have harder. Finding ways to check for understanding becomes more complicated. Approaches to communication and assessment have both needed to change in the last two years. Fortunately technology too has advanced markedly in the last few years. The capacity now exists for us to observe an entire class at work at a glance, and compare student responses more easily.

As the year nears its end, I find myself reflecting on what I have been forced to do differently this year and what I want to incorporate into future practice.

ASSESSMENT

I remember hearing, decades ago, that teacher's assess what they value and students' value what is assessed. A more prosaic variant of the same idea is, 'Is this going to be on the test?'

This begs the question, what is it that we as teachers value? Computation? Application? Insight? The lion's share of end point assessment has been, and I venture remains, around computation.

However, the amount of time dedicated to marking such questions can now be reduced. Even a basic use of a Google form provides increases in efficiency and tracking of mastery development in formative ways.

Assessing the application of concepts in novel or non-routine settings is a mainstay at Year 12 but is not always included rigorously at lower year levels. Products like AMT's Problemo are making this easier to access though. What then of the third possibility – insight?

OBSERVATION AND COMMUNICATION

Assessing insight requires an engagement in dialogue and communication. Engendering an environment of dialogue, of safe questioning too has changed. The possibility of this was present before COVID but, as the author of the Post article notes, remote learning has provided the necessity for noticing its value. This can be especially valuable for students who are traditionally shy or reticent in speaking up in class. It also allows for the conversation to extend beyond the confines of a forty or fifty minute lesson.

What aspects of teaching through the pandemic will you incorporate into mainstream teaching?

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PD IN TERM 4

The MAV annual conference will take place on 2 and 3 December. The conference will be delivered virtually and provides a terrific opportunity for professional development for mathematics educators from early years through to VCE. Registrations are open now, visit www.mav.vic.edu.au/conference.

MAV's mathematics education consultants are available to assist your school with tailored virtual professional learning. To learn more about PD or student activities available in Term 4, contact Jen Bowden jbowden@mav.vicedu.au

CROSS CHECKS

Michael Nelson - Learning specialist, Drysdale Primary School

Success criteria

S: use an efficient strategy for solving my multiplication fact
L: explain my multiplication strategy using appropriate language
A: show my multiplication strategy using an array
T: use turn around facts for the facts I already know

Figure 1.

When assessing addition strategies, students need to be able to:

- verbalise the process
- not use counting on for anything other than 0, 1, 2, 3
- counting on may involve fingers, but mentally is preferred
- students should be able to identify when to use the strategy, not just use the same strategy regardless of the fact

Figure 2.

A key element of a great mathematics lesson is the collection of formative data. But a difficultly often discovered is how to collect the data. We want to be able to collect data as part of our regular lessons, not to have our students have to complete separate assessments all the time. Whilst these have their place, we can collect more meaningful data on an ongoing basis.

This article will look at a topic I discussed at the Australian Association of Mathematics Teachers Conference in 2019. Something that has been successful, both in my classroom and in other classrooms, is the use of cross checks during the lesson. I acknowledge that these can be used at a unit level to track student progress. For the purposes of this article, the focus will remain on using them as a formative assessment tool during a lesson.

CREATION OF THE CROSS CHECK

The creation of the cross check and its content is the most important part of the entire process. As teachers, we need to be aware of what we are looking for during the lesson. To be able to accurately assess student work, we need to understand what success looks like.

This does not necessarily mean it has to be too prescriptive, as students need freedom to show their understanding. But for example, when the curriculum says 'Read numbers to at least 10,000', it is crucial that we understand what that means and that if we are working as a team, that all members have the same understanding of what it means to achieve this standard.

As teaching and assessment should be seen as two sides of the same coin, we need to link what we are teaching to what we are assessing.

In Figure 1, the lesson's success criteria becomes the assessment criteria. It is crucial that the success criteria is clear, simple and directly related to the curriculum. It is not simply enough to copy and paste the curriculum content descriptor in. This is for two reasons. One, some of the descriptors cover multiple areas, such as 'Develop efficient mental and written strategies and use appropriate digital technologies for multiplication and for division where there is no remainder.' Within a single lesson, this is rarely, if ever, going to be covered in its entirety. The content descriptors act more as a unit focus.

Secondly, the content descriptor doesn't tell us what it actually looks like to achieve that. It is important to unpack, either individually or part of a professional learning community, what it looks like.

As you can see from Figure 2, a team I worked with discussed what the criteria was for achieving the standard they were assessing. This criteria becomes the success criteria and thus the purpose of the cross check. As the lesson success criteria should be differentiated, this will mean that the assessment is also differentiated.

COLLECTION OF THE DATA

Within a lesson, there is the potential to collect data on a range of different areas. Whilst we can do this, in reality it is cumbersome and is rarely effective and in most cases become completely overwhelming. This can be avoided by focusing only on the success criteria of the lesson. If the success criteria are not giving the data you need, then it is time to review what criteria was selected, and do we know what success would look like.

The purpose of cross checks to avoid needing pure 'assessment lessons'. When using cross checks in the class, I use a code system. This can be as simple as ticks and crosses (Figure 3) or by using letters to indicate areas of note (Figure 4). This is an individual process and should be adapted to suit your own needs. As you are roving or working with small groups, you are adding to the cross check.

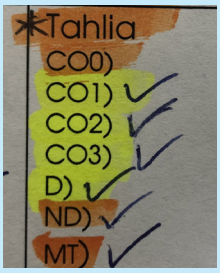

Figure 3.

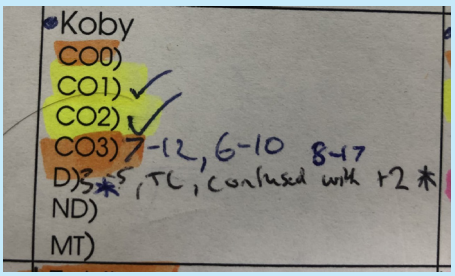

Figure 4.

WHERE TO NOW

The most important part of cross checks, and assessment in general, is what we do with it. Before introducing cross checks, you need to ensure you are committed to being reactive to the information you reveal.

The data can be used in many ways. It may to be inform your own practice, to show whether you have been effective in teaching the content. It may indicate certain students (or the whole class) need more work on particular areas of your topic. It may also indicate that some students have mastered the concepts being taught. In combination with flexible and responsive planning, cross checks allow educators to ensure they are targeting every student's point of need at all times as they are a 'live' form of data.

BUILDING THINKING CLASSROOMS

Peter Liljedahl - Professor, Simon Fraser University, Canada

CONT. FROM PAGE 1.

This is not to say that there wasn't activity. There was lots of activity. Students were listening to the teacher, taking notes, and answering questions. They were filling in worksheets. And in some cases, they were collaborating on activities. But none of these activities required the students to do any thinking – at least not in the way that we know students need to think in order to be successful in mathematics in the future. This is a problem. Thinking is a necessary precursor to learning and if students aren't thinking, they aren't learning.

At first, this realisation was just a sense. But subsequent research revealed that my sense was not wrong. Instead of thinking, students were slacking, stalling, faking, and mimicking (Liljedahl, 2020; Liljedahl & Allan, 2013) – none of which required thinking. Even deeper research into this phenomenon revealed that in typical lesson, only 20% of students spent 20% of their time thinking, while the rest of the students spent 100% of their time slacking, stalling, faking, and/or mimicking.

And these were students of teachers who had been recommended to me because they were known to be good teachers. And they were. These were dedicated and professional educators who knew their content, knew their students, and cared that their students got through the course. There were no students falling through the cracks in these classrooms. Yet, these teachers were teaching on the assumption that students either couldn't or wouldn't think.

They were stuck in a difficult situation. They had students who weren't thinking, and they had content to get through. In fact, many of the lessons I observed in these 40 visits were lessons lifted right out the Ministry of Education approved textbooks and resources. Interviews with these teachers revealed that, for many, this is not how they *wanted* to teach. Rather, it was how they *had* to teach. It was how the system was pushing them to teach. It turned out that students not thinking was not a student problem. And it wasn't a teacher problem. It was a systemic problem.

Building Thinking Classrooms is a reaction to this realisation. It began as a research project whose single goal was to develop teaching practices that could get more students thinking and thinking for longer. This research was organised around 14 core teaching practices:

1. What are the types of tasks we use?
2. How we form collaborative groups
3. Where students work
4. How we arrange the furniture in our classroom
5. How we answer questions
6. When, where, and how tasks are given
7. What homework looks like
8. How we foster student autonomy
9. How we use hints and extensions
10. How we consolidate a lesson
11. How we give notes
12. What we choose to evaluate
13. How we use formative assessment
14. How we grade

Each became a variable in my research. I was looking for how to enact each variable in such a way as to maximise the amount of thinking students do.

Over the course of 15 years and with the involvement of over 400 teachers this research eventually emerged an optimal thinking practice for each of these variables – each of which has been empirically shown to increase the thinking in the classroom. The sum of the research showed that it is not only possible to get students to think, but to think for long periods of time. Doing so, however, requires a radical departure from the institutionally normative structures that have permeated mathematics teaching practice for the last century. To build a thinking classroom we are going to have to change what teaching looks like.

You can read about the full details of this research and these 14 optimal thinking practices in the book, *Building Thinking Classrooms in Mathematics (Grades K-12): 14 Teaching Practices for Enhancing Learning* (Liljedahl, 2020). But I will share the first three here:

1. THE TYPE OF TASKS USED

If we want our students to think, we need to give them something to think about — something that will not only require thinking but also encourage thinking. In mathematics, this comes in the form of a task, and having the right task is important. The research revealed that we have to give thinking tasks. When first starting to build a thinking classroom, it is important that these tasks are highly engaging non-curricular tasks. As the culture of thinking begins to develop, we transition to using curriculum tasks. The goal of thinking classrooms is not to get students to think about engaging with non-curricular tasks day in and day out — that turns out to be rather easy. Rather, the goal is to get more of your students thinking, and thinking for longer periods of time, within the context of curriculum, which leads to longer and deeper learning.

2. HOW GROUPS ARE FORMED

Once we have given students something to think about, we have to give them someone to think with - we need to form collaborative groups. We know from research that student collaboration is an important aspect of classroom practice, because when it functions as intended, it has a powerful impact on learning (Edwards & Jones, 2003; Hattie, 2009; Slavin, 1996). How we have traditionally been forming groups, however, makes it very difficult to achieve the powerful learning we know is possible.

Whether we grouped students strategically (Dweck & Leggett, 1988; Hatano, 1988; Jansen, 2006) or we let students form their own groups (Urdan & Maehr, 1995), we found that 80% of students entered these groups with the mindset that, within this group, their job is not to think. However, when we frequently formed visibly random groups, within six weeks, 100% of students entered their groups with the mindset that they were not only going to think, but that they were going to contribute. In addition, the use of frequent and visibly random groupings was shown to break down social barriers within the room, increase knowledge mobility, reduce stress, and increase enthusiasm for mathematics.

3. STUDENT WORKSPACE

Once we have given students something to think about and people to think with, we have to give them a workspace to do that thinking. One of the most enduring institutional norms that exists in

mathematics classrooms is students sitting at their desks (or tables) and writing in their notebooks. This turned out to be the workspace least conducive to thinking. What emerged as optimal was to have the students standing and working on vertical non-permanent surfaces (VNPSs) such as whiteboards, blackboards, or windows. It did not matter what the surface was, as long as it was vertical and erasable (non-permanent).

The fact that it was non-permanent promoted more risk taking, and the fact that it was vertical prevented students from disengaging. Taken together, having students work, in their random groups, on VNPSs had a massive impact on transforming previously passive learning spaces into active thinking spaces where students think, and keep thinking.

PUTTING IT TOGETHER

If you enact these practices, along with the rest of the optimal thinking practices, you will see a huge improvement on the baseline data. Rather than 20% of students spending 20% of class time thinking, you will see upwards of 90% of students spending 90% of the class time thinking.

You will have a classroom that not only is conducive to thinking but also requires it. You will have a space that is inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion. You will have built a thinking classroom.

Students working collaboratively on vertical non-permanent services - an essential feature of the thinking classroom.

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Professor Peter Liljedahl will deliver a keynote presentation at MAV's annual conference in December.

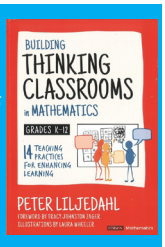
Peter will further unpack the research behind *Building Thinking Classrooms*.

The theme of this year's conference is *The capabilities in mathematics teaching and learning*. The program is packed with inspiring educators who will share their research, knowledge and ideas with you.

The conference will be delivered virtually and participants will be able to access every single session, so there are opportunities to continue learning long after the conference has ended.

Registrations are open now, visit www.mav.vic.edu.au/conference.

Professor Peter Liljedahl's book, *Building Thinking Classrooms in Mathematics* is available from MAV, visit www.mav.vic.edu.au/mav-shop.



FACILITATING GROUP WORK

Maria Long - St George Preca, Caroline Springs

I have been a classroom teacher for over 10 years and I have always wondered why group work is so important in primary school, besides the reason that it is fun and engaging for students. This article explains the theories behind group work in mathematics education and answers the following questions:

- Why is group work effective in the mathematics classroom?
- What are some ways that we can implement mathematics groups in our primary classrooms?

Vygostki (1978) who has had an enormous influence on education describes learning as something that is constructed through collaboration with others.

Similarly, learning has been defined by Barnes (1998, November) as a collaborative activity involving a small group of students who are working on a task with the same or a similar goal. Esmonde (2009) identifies group work as co-operative learning practices.

Therefore, there would be no surprise that experts in mathematics education would recommend group work in mathematics to allow students to use mathematical language amongst their peers. This all sounds great on paper, however through my experience as a primary classroom teacher and in discussion with my own colleagues, group work in mathematics can be challenging to manage and takes up a lot of our energy planning and organising (Barnes, 1998, November; Takeuchi, 2016).

I reflected on this issue, as I know group work in mathematics can be extremely effective. I analysed research that answered these two questions:

- Why can groups work be a challenging practice in mathematics classrooms?
- How can these challenges be addressed?

HOW CAN GROUP WORK BE IMPLEMENTED IN A PRIMARY MATHEMATICS CLASSROOM?

In research on power relationships and students' roles in cooperative group work, Barnes (1998, November), conducted a study which involved analysing how students worked in a senior secondary mathematics classroom, over 17 lessons. Power relationships are roles in which people naturally identify themselves in, which is usually influenced by society (Barnes, 1998).

In her research paper, Barnes analysed student discourse during a collaborative classroom investigation and a teacher led mathematics lesson. Within these lessons, Barnes analysed the common trends in the behaviour of boys and girls in the class and the different personality traits that students had and how it affected group collaboration.

Barnes found that the culture of the mathematics classroom influenced the way students worked collaboratively, as many students did not see the value in discussing how they solved a problem, rather, they were more interested in obtaining the correct answer and competing against other groups. This study clearly highlights the importance of teachers knowing their

students well, so that their personalities and talents can be utilised to their full potential when organising students into collaborative groups.

Takeuchi (2016) undertook a study on whether collaborative learning in mathematics is more effective when students work with their friends or are assigned in groups by a teacher. In a previous study, which had a similar goal, it was concluded that girls work better in groups with friends than boys (Kutnick and Kington, as cited in Takeuchi, 2016). Takeuchi hypothesised that gender may not be a factor, rather, the power-relationships within a group. She also explained that many teachers find group work overwhelming to facilitate as students have various personalities and backgrounds, which can cause an 'imbalance in learning opportunities'.

The research project took place in a large multicultural primary school in Canada. Video footage, over a year in two Year 4 mathematics classrooms, was used as data. Similar to Barnes, Takeuchi concluded that the teachers often assigned less capable students with mathematically competent students, however, this can have a negative impact as the less capable learners tend to contribute very little to group tasks. She also noted that students who worked with friends collaborated more as they felt more comfortable being involved in mathematical discussions. In her paper, Takeuchi suggests that group work in mathematics may be more beneficial when students are working with peers close to their 'zone of proximal development', as the study showed a positive correlation between friendship groups and cognition (Vygotsky, as cited in Takeuchi, 2016.)

HOW CAN THESE CHALLENGES BE ADDRESSED?

Boaler (2006) outlined that 'one of the most difficult challenges facing teachers of mathematics, is the wide range of students' abilities in their class'. She also explains that many teachers and schools are trying to eliminate this ongoing issue by using ability grouping practices, however, Boaler highlights that in a number of studies, mixed ability grouping has been proven to be more effective to increase students' mathematics results. Boaler explores a teaching strategy that significantly improved mathematics grades in an urban, low financed high school with high numbers of students from multi-cultural backgrounds, in California.

Firstly, the school adopted a culture in mathematics classrooms where students worked together, discussed tasks and supported one another. Students and teachers at the school also had a collaborative understanding of mathematics learning as a shared responsibility (Boaler, 2006). When students were placed into their assigned groups, they were allocated a role, such as, 'facilitator, team captain, recorder or reporter, or resource manager'. Boaler explains that when many schools encourage group work, students become reliant on the more capable students and tend to not participate, however, due to the culture at Railside School, the students took their roles very seriously. Boaler emphasises that adopting this strategy and a culture where all students are responsible for each others' learning, may be a way to help cater for the wide range of abilities in classrooms.

In addition to Boaler's (2006) suggestion to combat the issue of social equity when using collaborative learning in mathematics, Meyer (2014) discusses the use of the Reciprocal Teaching (RT) approach, adapted to facilitate group work in mathematics.

The RT approach, which was originally created by Palincsar and Brown (1984), is a reading comprehension tool, which involves students assigned to roles so that there is equal contribution in a group. These roles are 'predicting, clarifying, questioning and summarising' (Meyer, 2014, p. 9).

RT is a highly valued strategy, which has shown to be an effective reading comprehension approach in a number of studies (Palincsar & Brown, 1984; Meyer, 2010). Meyer (2014) outlines a number of studies where the RT approach was used in mathematics in the middle years classrooms.

Out of all the studies , only one showed no significant improvement in student performance. One study by Quirk (2010) used a five-stage process of 'see it, plan it, do it, check it' and the fifth stage, making connections to mathematical operations (Polya, as cited in Meyer, 2014, p.8).

With an efficient amount of research, which proves that RT provides critical thinking skills in literacy, it would make sense to adapt the strategy and use it in mathematics.

I trialled this when I was a Year 3 teacher as the strategy really interested me. To be able to use this method the students need to know their Reciprocal Reading strategies so they can bridge their learning across to mathematics. From my own experience, it does allow the students to really think about a worded problem rather than just rushing it and missing important information as we can all relate to this.

Esmonde (2009), who conducted research on group work in Canada, researched and compared two different approaches to analyse student equity, within a group, when working collaboratively. Esmonde used an ethnographic research approach to analyse three mathematics classes in a metropolitan secondary school. The first approaches studied was a group quiz; in which the groups were given a rubric where they needed to show that they worked together, all asked questions, explained their thoughts and each person needed to show their own working out to achieve the correct answer.

The final score was given to the whole group, rather than individual students. The second approach was to assign students to a role to help them work collaboratively so that they could all contribute to a presentation. The person who was presenting was to be picked moments before the presentation, therefore, all group members were accountable. I have used this strategy in my own classroom and it worked really well.

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A full list of references is available by emailing Jen Bowden, jbowden@mav.vic.edu.au.

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LEARNING VIRTUALLY

Anita Stibbard - Principal and mathematics instructional coach, St Joseph's Narrandera and Robyn Twyford - Assistant Principal, Templestowe Park Primary School

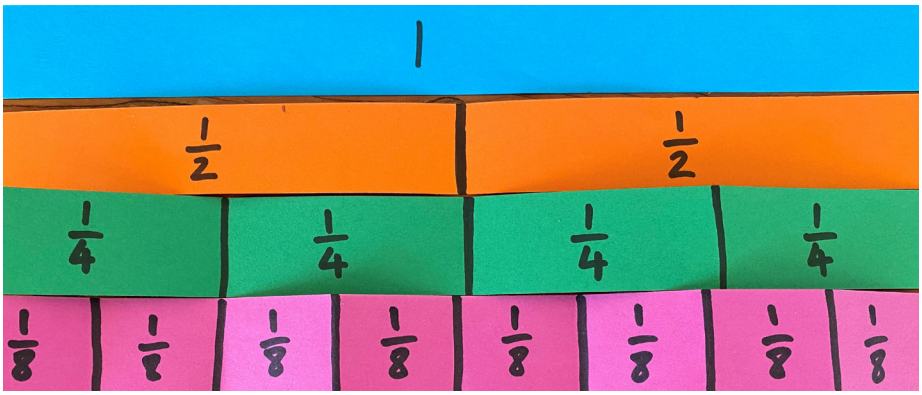
MAV's beloved annual conference looked a little different last year. COVID-19 meant that the conference was delivered virtually. Although it is wonderful to experience the conference in person, there were several benefits of the virtual delivery. Two teachers reflect on their experiences here.

ANITA'S REFLECTION

Access to quality mathematics conferences and professional learning is often difficult for me to source without hours of travel and precious time away from school and home. In 2018, I was lucky to experience the MAV conference first hand and benefit from many hours of professional learning. Disappointingly, this was not able to happen in 2019 and therefore it was with great excitement that I learnt of the virtual opportunity being provided by MAV for its 2020 conference. The opportunities that this opened up, especially for those living in rural areas was exciting.

The 2020 MAV Virtual Conference provided a great opportunity for me, and in turn, my school community, to access and take advantage of all of the presentations by a range of renowned scholars as well as those who had not previously been on my radar. This provided the opportunity to view a wide range of presentations over the year to take advantage of the elements that suited our professional learning agenda as a school, and also to develop my own professional knowledge. The format of the conference meant that I could watch many presentations live over the days of the conference as well as having the added benefit of being able to view every single presentation at my leisure. This conference access is definitely worth the investment of time and money.

One of the sessions that was incredibly useful to develop my own professional knowledge and as well as to use snippets with the teachers at my school was the session titled *Fractions: Engaging and extending Students' Conceptual Understanding*. This session was led by Dr Catherine Pearn, Carmel Mesiti and Kate Copping. The focus of professional learning over the last six months has focused on the conceptual teaching of fractions and decimals as well as developing teacher knowledge and confidence in order to



impact teaching. I was able to use this session in a variety of ways to further our whole school focus.

I watched the webinar by myself and looked at whether the learning imparted fitted with the approach we were taking towards the teaching of fractions and decimals. I then looked at how this professional learning would complement the work undertaken by my staff and how it could complement their knowledge and skills in teaching fractions. I used snippets of the professional learning with my stage 1, 2 and 3 teachers. We examined the way that we could implement the learning within our classrooms. We trialled using the fraction strips in our Year 1 and 2 classrooms as a way of developing the students' knowledge and understanding of equivalent fractions while focusing on the whole, halves, quarters and eighths. Each student made their own fraction strips (see image above) and were able to use these strips to begin to talk about the equivalence of halves and quarters as well as quarters and eighths. This has led to the students being able to add some simple fractions with different denominators, for example knowing that half plus two quarters is equal to one whole. The use of this webinar has worked in conjunction with our previous professional learning to extend our teachers' and students' knowledge of fractions and their equivalence.

The MAV 2020 conference provided me with a rich source of professional learning, which I continue to delve into and explore in order to develop my own knowledge and explore ways to support and enhance the professional learning of my staff. I am greatly looking forward to the 2021 Virtual Conference!

ROBYN'S REFLECTION

The MAV Conference is always something to get excited about, but if your school environment is anything like ours, the timing of it is difficult. There is always so much to attend to in early December at school and it is hard to justify the time away, let alone the expense of sending more than one or two people. Although the pandemic interrupted much of our world last year, it also resulted in some positives as well. The decision by MAV to make the MAV 2020 Conference virtual was outstanding.

By registering for both days prior to the event, I was able to assess closer to the actual day whether I would be attending live or not. As events panned out, the decision to go virtual meant the recordings were the only option. Having access to the recordings means there are 100 sessions and 10 keynotes that I can dip into. By registering, I have access to all the presentations for 12 months.

Workshops specific to what our school has been focusing on have been invaluable for presenting an expert view to support our direction. They have also helped to focus learning for individuals or teams of teachers who have been working on increasing their professional learning in particular areas such as maths talks. The 'anytime, anywhere' access has meant that I can use the platform for professional learning when it suits me – a definite advantage in our current times. It means that sessions can be revisited to clarify understandings. Instead of wondering whether the timing will be right to be able to attend the 2021 conference live, I will automatically register for both days, knowing that I am getting access to a plethora of rich learning opportunities for the next 12 months.

ONE MINUTE WITH AMIE ALBRECHT

I'M....

Amie Albrecht, an Associate Professor of Mathematics at the University of South Australia. I'm also the Dean of Programs in UniSA STEM responsible for degrees in science, technology and mathematics.

MY RESEARCH IS...

Primarily focussed on scheduling and control methods for railway operations and energy-efficient driving. Scheduling, like creating train timetables, is about making smart decisions that minimise some objective (like total delay or cost) while satisfying all the constraints (like arriving at destinations by certain times). Control theory is used for problems like deciding how you should drive (control) a train to minimise energy use and to arrive on time. My research is done in collaboration with others because complex problems require a range of different skills to solve them.

PROBLEM SOLVING IS...

In the words of Paul Halmos, 'the heart of mathematics'. Mathematicians – and mathematical advances – are driven by problems that are interesting, meaningful, perplexing, tantalising. A challenging problem requires us to bring to bear our curiosity, intuition, sense making, understanding, and reasoning. Through this lens, problem solving should also be at the heart of teaching mathematics.

MOST PEOPLE WOULDN'T REALISE...

That mathematics is a creative endeavour. I love the metaphor, from mathematician Reuben Hersh, that mathematics has a 'front and a back', much like the front and the back of a needlework. The 'front' is mathematics in its finished form, like in lectures and textbooks. What we don't expose much is the 'back' – the messy, tentative, part with all its knots and dead-ends. I wonder how many people's conception of their maths ability would change if they realised that uncertainty and 'messy thinking' is a valid and natural part of working mathematically.

I'M AMAZED BY...

The vastness of the world. There is so much to learn, to absorb, and to experience. One lifetime does not seem nearly enough.

TEACHERS ARE ...

Seriously impressive! I am in awe of the number of decisions a teacher makes every day and the range of expertise needed to be an effective teacher. Mathematicians and maths educators need to find more ways to learn from and with each other, across all year levels. I have gained so much from interacting with teachers at conferences and on Twitter. (I'd love to chat with you at @nomad_penguin.)

INSIDE OR OUTSIDE?

Inside. With a good book and a drink – either while curled up on the couch or in a deep bubble bath!

A SUPPORTIVE LEARNING ENVIRONMENT IS...

One where students feel safe to express themselves, and where their contributions are valued. I think this can look very different depending on the individual classroom, but is ultimately underpinned by a respect for students as individuals, as learners, and as mathematical thinkers.

MY FAVOURITE PODCAST IS...

Difficult to pin down – there are so many good ones! *Wilosophy* with comedian and television host Wil Anderson consistently provides nuanced, intimate and thought provoking conversations. He often interviews comedians and other creative types, and the parallels between the creative industries and mathematics are illuminating. *Conversations* with Richard Fidler and Sarah Kanowski is also consistently great.

Right now, I am racing my way through *Ms Represented* in which Annabel Crabb and Steph Tisdell provide a six-episode bonus to the TV doco about women in the Australian Parliament. It's so good while also being utterly enraging!

I'M INTRIGUED BY...

My students' mathematical ideas and explanations. When I listen carefully to student thinking, I always gain new insight. It might add another dimension to a concept I thought I understood or provide a clue as to what a particular student needs next to help them learn.

THE MATHEMATICS COMMUNITY IS ...

Slowly recognising that it has historically excluded many groups of people from full participation in mathematics – sometimes deliberately and sometimes unintentionally – and that the field of mathematics is itself poorer as a result. We need to interrogate what mathematics, behaviours and attributes we value, and potentially rethink the learning and research environments that we create.

STUDENTS LEARN BEST WHEN...

They are given repeated opportunities to articulate and justify their mathematical thinking, and to listen to and make sense of other's ideas. For me, a good classroom is a noisy classroom!

MY NEXT HOLIDAY....

Will (hopefully!) be in October to Hobart for the arrival of Australia's new Antarctic icebreaker, Nuyina. We have a fondness for stories of polar exploration and followed the journeys of the previous ship, the Aurora Australis, with great interest. (I highly recommend Sarah Laverick's 'biography' *Through Ice & Fire*.) I am looking forward to this new chapter in Australia's Antarctic mission.

Who would you like to see profiled in *Common Denominator*? Email suggestions to office@mav.vic.edu.au.

STIMULATING THINKING

Education consultants, Mathematical Association of Victoria

A picture sparks 1000 maths concepts! Use this picture as a prompt to stimulate thinking. If you have other ideas for investigations or lessons that could stem from the ideas here, add them to the conversation on our social channels. You can find us on Facebook, @mathematicalassociationofvictoria and on Twitter, @mav_info.

EARLY YEARS - YEAR 2

- Compare the sizes of the animals pictured in the map. Which are heavier, lighter, bigger, smaller?
- Where do you think the most people live on this map? Why?
- Cut out each State and Territory. Look at the shapes of each State – identify the lines that are straight and the lines that are not. Estimate, then measure how quickly you can put the pieces back together again. What will you use to measure this? Repeat this activity. Was your estimate closer to the actual time? Why?
- Before you put these pieces back together again, order the States and Territories from largest to smallest.
- Using positional language, describe the position of objects in relation to the kangaroo (near, under, next to, between).
- There are lots of different animals on this map. How many legs are there altogether? Can you use tally marks to record your counting.
- Sort the animals according to where they live - land or ocean. Create a graph to represent this data.

MAV education consultants can come to you to create a professional learning plan to build the capacity of teachers at your school.

YEARS 3 AND 4

- The Sydney Opera House is not in its correct location! Can you identify where on the map it should be? Are there any other iconic landmarks in the wrong location?
- Estimate how large the State of Victoria is compared to the rest of the country.
- Where am I? When I look 10 degrees North East I see a dingo. Now write 3 of your own 'Where am I?' instructions for a peer to work out.
- Could you throw the boomerang in a circular shape so that it captures 6 images?
- Find out how long it takes to fly and to drive to each capital city from Canberra. How could you display this information?
- You can see Uluru in this picture facing straight on. What would it look like from a bird's eye view? Visualise it and then draw it.
- Estimate how high Uluru is in metres, and how far around it is in metres.
- Estimate how long you think it would take you to walk around Uluru.
- Identify any images on the map that have a line of symmetry. Use a ruler to then draw the line of symmetry.
- Using a ruler, create a grid map as an overlay for this current map. Ensure it has accurate measurements and coordinates (A, B, C... 1, 2, 3).

YEARS 5 AND BEYOND

- Make a scale drawing (enlargement) of this map and measure how far it is from one landmark to the next. Give your directions for a peer to follow. Did you find these instructions easy to follow? Why/Why not?
- Create a cartesian coordinate system to locate some of the icons on the map.
- Plan a trip from Melbourne to Adelaide. How many kilometres is it? How long do you think it would take?
- Estimate how long Uluru would be if this map was the size of Australia.
- Estimate and then find out how many Victoria's would fit into the other States and Territories. Using this knowledge, estimate and then find out how many Tasmania's would fit into the other states. Were your estimates more accurate this time? Why?
- Locate the islands of Australia around the mainland and Tasmania. Which State or Territory has less area than the total area of these islands? How do you know?
- What time is it in Perth when it is midday in Melbourne, in January? Use analogue and digital clocks to illustrate your answer in 12-hour and 24-hour time. Write three other questions like this.
- Work out the land area of each State and order these from smallest to largest.
- Research the population of each State and Territory, and then order these from smallest to largest.
- Does the State or Territory with the largest area have the largest population? What do you notice?

NEW!

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YEARS 7–10

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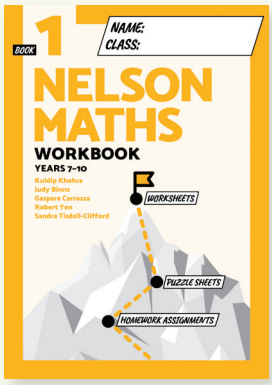

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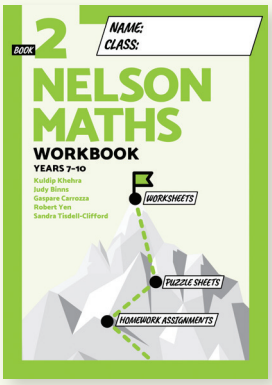

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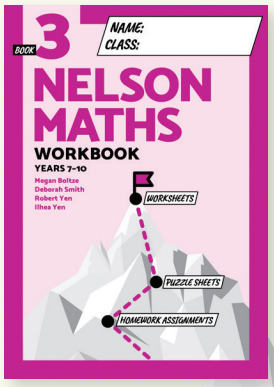

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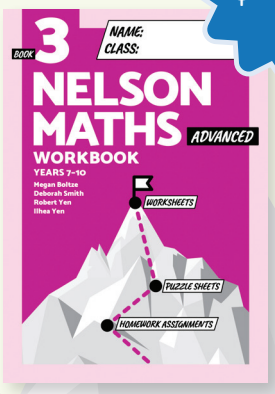

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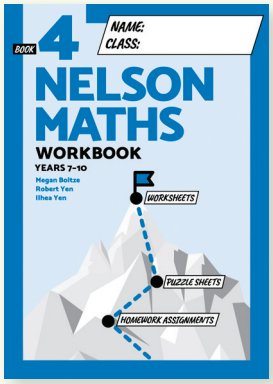

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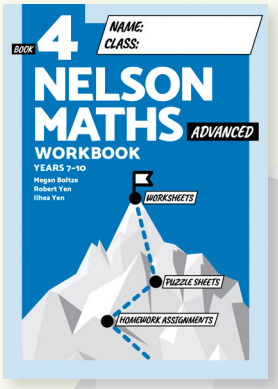

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VCE SACS: THINKING QUESTIONS

Andrew Stewart

'The Application task is a guided investigation of a given data set with several variables. The task has three components of increasing complexity...' (VCAA, 2021)

To me, increased complexity involves a problem requiring careful thought and planning and more than just a few minutes of working out. The best questions are those which are not straight-forward applications of a rule, but require finding the value of a term inside a key equation, or completing a particular analysis process in a different way. The following examples are developed from a past MAV Trial Exam paper, and a spreadsheet is a vital tool in the development, solution or extension of these questions.

FROM MAV TRIAL EXAM 2 2014 DATA ANALYSIS QUESTION 1

Figure 1 dot plot displays the goals scored against the Senior B netball team in every one of their 22 Home and Away games last season.

Write an appropriate calculation to explain why the goals against score of 63 is an outlier for this group of scores.

Although this kind of question is asked frequently in exams, students fail to provide necessary and sufficient working. A follow-up activity could state that a number of scores were incorrectly recorded. Given the values that have to be changed, how does this affect the dot plot, box plot or a set of summary statistics? Will the score of 63 still be an outlier?

FROM MAV TRIAL EXAM 2 2014 DATA ANALYSIS QUESTION 2

During the season, the Senior B netball team lost ten games. When their coach analysed the losing margins (the number of goals that the team lost by) in those ten games, she obtained the five-number summary given below and the boxplot as shown in the next column.

Measure	Value
Minimum	1
Q1	3
Median	4.5
Q3	8
Maximum	10

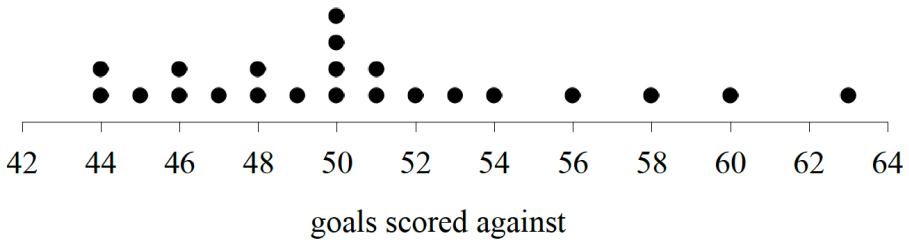
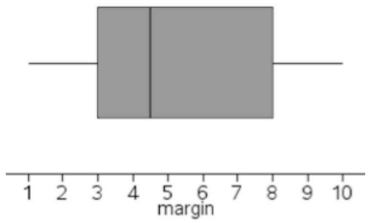


Figure 1.

No.	1	2	3	4	5	6	7	8	9	10
Value	1	2							9	10

Figure 2.



Given that all margins were integer (whole number) values, copy and complete the table in Figure 2 (above) to give all possible sets of losing margin values that would give the boxplot shown in the left column.

The original question (which asked for just one set of values) was inspired by Question 3 in the 2012 VCAA Exam 2 (Data) which required one set of eight values to construct a given box plot. In this question, there are eight solution sets (which could be hinted in the question if required). A spreadsheet displaying the boxplot of the data set was critical in the question design, as it enabled all alternatives to be quickly and carefully examined. If you want a smaller number of possible solutions, then a smaller range of data values may be necessary.

FROM MAV TRIAL EXAM 2 2014 DATA ANALYSIS QUESTION 3

A scatterplot of goals scored in each game by the Senior B Netball team is shown in Figure 3 (on page 16), with the values for the fourth and eighth weeks missing.

The least squares regression equation for this data, correct to two significant figures is *Goals scored* = 55 − 0.48 x *week number*

(a) In which week does this regression equation predict that 49 goals will be scored?

(b)(i) What was the actual number of goals scored in the fourth week, if the residual value, correct to the nearest integer, is + 7?

(b)(ii) What was the actual number of goals scored in the eighth week, if the residual value, correct to the nearest integer, is − 7?

Predictions involving regression lines usually involve substituting the explanatory variable value to calculate the response variable. (a) requires that the response variable be used to determine the explanatory variable by rearranging the regression equation. (b) requires thought and planning to use the regression equation to predict the response variable value for the particular week, before using the residual rule to find the actual value. This type of graph would be effective for these types of questions as the data spread does not make it easy to determine where the regression line lies. With a little preparation, a number of variations could be prepared giving each student their own set of questions to complete.

FROM MAV TRIAL EXAM 2 2014 DATA ANALYSIS QUESTION 4

The senior netball coach ran a fitness clinic, in which players undertook a series of activities. From their efforts a 'fitness score' was derived, being a number between 0 (very unfit) and 100.0 (super fit). The fitness score and age of sixteen players are given in the table Figure 4 (on page 16). A scatterplot showing *fitness score* versus *age* of these results is also shown in Figure 4.

VCE SACS: THINKING QUESTIONS (CONT.)

The relationship between *fitness score* and *age* shown is non-linear.

A transformation can be applied to one of the variables *(fitness score or age)* to linearise the data in the scatterplot.

(a) Use the 'circle of transformation' to determine the most suitable transformations. Apply each of these transformations to the appropriate variable and determine the least squares regression equations.

Write down all the regression equations, with coefficients correct to three significant figures.

(b) Which transformation predicts a fitness score of 68.3 (correct to one decimal place) for a netballer who is 26 years old?

Many activities or exam questions tell the student which transformation to use. In this case, only two transformations are suggested by the 'circle of transformation' (x^2 and y^2). The trap with these particular transformations is that students may forget to square or take a square root as required to correctly complete the calculations. Rather than determine which transformation gives the best linearity, I am challenging students to correctly use the transformed equations in a calculation. With other shapes on the 'circle of transformation', there can be up to four suggested transformations, and a greater challenge to correctly complete calculations and hence determine which prediction is being used.

MODIFIED FROM MAV TRIAL EXAM 1 2014 DATA ANALYSIS QUESTIONS 10, 11

The table in Figure 5 shows the number of goals scored by Jenny (the Senior B netball goal attack player) in each game for the first twelve games of the season. The values for games three to seven have been omitted.

For games three to seven, the 5-mean moving average is 13, and the 5-median moving average is 12. The number of goals scored in games three and five are identical.

The number of goals scored in games four and seven are identical **and** greater than in game three (or five). The number of goals scored in game six is greater than or equal to the number of goals scored in game two

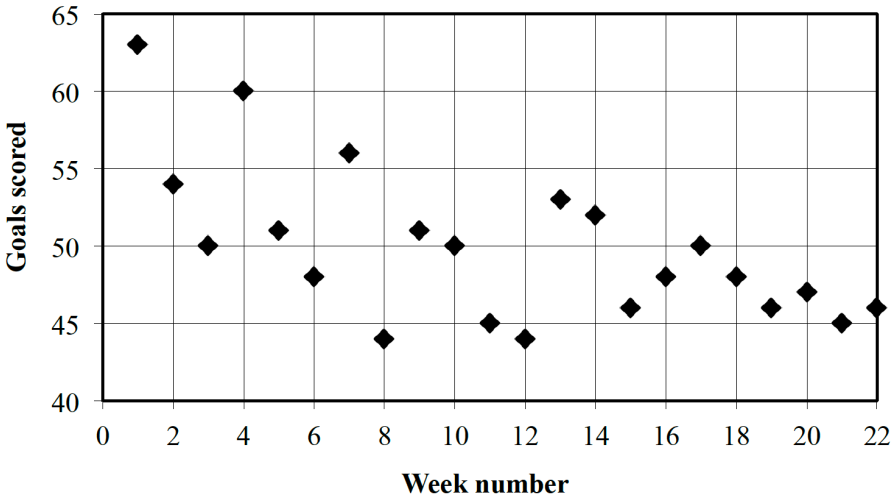
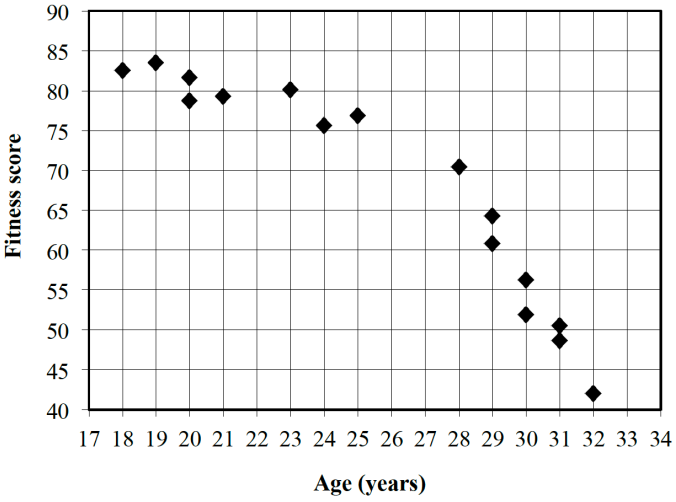


Figure 3.

Fitness score	Age
82.5	18
83.5	19
78.7	20
81.6	20
79.3	21
80.1	23
75.6	24
76.8	25
70.4	28
60.8	29
64.3	29
56.2	30
51.9	30
50.5	31
48.6	31
42.0	32

Figure 4.



Game	1	2	3	4	5	6	7	8	9	10	11	12
Goals	10	7						20	16	14	21	24

Figure 5.

and less than the number of goals scored in game three (or five). Write down possible sets of goals scored for games three to seven.

To make it more challenging, also omit the values for games eight and nine. For games three to nine, the 7-mean moving average is 14, and the 7-median moving average is 15. The number of goals scored in games three and five are identical. The number of goals scored in games four, seven and nine are identical **and** greater than in games three (or five). The number of goals scored in game six is greater than the number of goals scored in game two and less than the number of goals scored in games three (or five). Game eight is alone with the largest number of goals scored, which is less than 21. Write down possible sets of values for games three to nine.

There are several ways in which the solution sets can be found - including drawing a graph and manipulating values, or using trial and error arithmetically or in a spreadsheet.

The solution process requires a good understanding of how each smoothing measure is calculated, and where particular values sit in a ranked solution set. The first problem has three solution sets while the second problem has nine solution sets.

SUMMARY

These problems are more challenging in that they require time for thinking and planning for successful completion. Whilst you may not use these examples exactly, I hope that they inspire you to develop challenging problems of your own.

REFERENCES

VCAA (2021) Study Design Mathematics 2016 – 2022

www.vcaa.vic.edu.au/curriculum/vce/vce-study-designs/furthermathematics/Pages/Index.aspx

MAV produces VCE Trial Exams which you can find online at: www.mav.vic.edu.au/mav-shop

MONSTER MATHS

Gabrielle Cameron-Crisp – Prep and Year 1 teacher, Eagle Point Primary School

'Guess what?', I say to my Prep/Year 1 class, quietly hooking them in.

'What?' they whisper back.

'We have some new class pets.'

A Year 1 girl turns to the new student next to her and nods knowingly, 'We had fish, but Miss Gabi took them to her parents' house for a holiday.'

I try not to make eye contact with my aide, knowing very well that the fish are not on holiday at my parents' house. I have never been very good at looking after fish.

'We have something better than pet fish,' I announce, 'We have pet monsters!'

The children giggle and shriek excitedly, 'Pet *monsters*?'

I turn and pull out a little blue monster from behind my whiteboard.

'This is Fred,' I say carefully. 'Fred is my pet monster. Each of you will get your own pet monster, which you can name as you wish.'

The kids immediately start chattering about monster names.

'I'm going to name mine Princess Sparkles.'

'Well, I'm going to name mine Megatron.'

My aide looks at me and raises an eyebrow. 'Aren't we meant to be teaching them about Australian coins?'

I quickly pull them back on track.

'Does anyone know how we might look after our pet monsters?'

'You need to feed them every day,' says Sam, a Year 1 boy, seriously. 'Otherwise they die!'

'Don't forget water!' pipes up Harry.

'Very good,' I nod encouragingly, 'anything else?'

'Where do they sleep?' asks Lilly, my youngest student, shyly.

'Well,' I say, as I pull out a big list of items, 'Each day you will need to buy food and water for your pet monsters. They also need somewhere to sleep, like a house, which also costs money. You will each get a little wallet of paper coins, which you can use to buy these things.'

'Wait,' says Sam, excitedly. 'The list says we can buy hats for our monsters. And pet dogs!'

'And moustaches!' says another.

The children gather around and look at the list, pointing to the various items that they want to buy for their pet monsters. I think I might have to print out some more guitars. They seem very popular!

After each child selects a pet monster, I hand them out a little zip lock bag wallet full of paper coins. 'We are learning about Australian coins,' I say. 'And I hope this activity will teach you what Australian coins look like and what they are worth.'

The children rush back to their tables and pour out the coins.

'I wonder which coin is worth the most and which one is worth the least?'

'I think the 50 cents is worth the most because it is the biggest' says one student.

'My mum told me that two 50 cent pieces make a dollar, so it can't be worth the most.'

I smile, and begin to lay out the various items for sale. I pull out the little wooden cash register, which I have filled with left over paper coins. I model being a shop keeper for a few minutes, before the children take over.

'You have to buy food, water and a house first,' says one boy to another. 'You can buy a guitar for your monster after that.'

The children choose their items and glue them on to a piece of paper next to their monster. Thomas has already bought 7 hats. 'One for every day of the week,' he says proudly.

At the end of the lesson they pin their wallets next to their monsters for safekeeping, already talking about what they are going to buy for their monsters the following day.

Our school is lucky to receive an abundance of fresh fruit and vegetables for children in the classroom. The next day, I decide to create a classroom shop. The shop is set up at the back of the classroom on a table.

As soon as the children enter the classroom in the morning, they bustle over to greet their pet monsters.

'Miss Gabi, can I have a piece of fruit?' Poppy asks.

'Of course,' I say. 'You can buy anything from the fruit shop with your wallets. You can also buy things for your pet monsters here.'

I have stuck pictures of the coins and their value next to each fruit and vegetable item and ordered them from least amount to most. The fruit cups are very popular, and I limit them to one purchase a day. 'They are the most expensive,' points out Sam to his Prep buddy, 'They are $2 each.'

'Which one is $2?' she asks.

Sam picks out a $2 coin from his wallet.

'This one. See, it has a 2 on it. And it's gold. The gold ones are the best ones to have.'

'Ooh!' she says excitedly, 'I have four of those! I could buy four fruit cups!' She dashes off to the fruit stall with glee, forgetting the one fruit cup per day rule.

The children continue to guide the lesson as they see fit. They are learning from one another, questioning and teaching. I am merely there as a facilitator; I listen in, and only step in when necessary.

'Miss Gabi, what if we run out of money?' Lilly asks, worriedly.

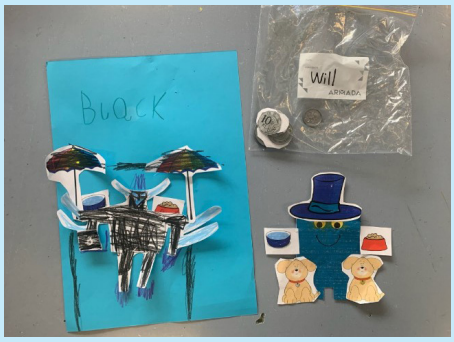
'How do you get money?' asks Poppy.

'Well,' I say carefully. 'This is my job, to be your teacher. I get paid to teach you.'

The children's eyes widen, as if they have just become privy to a very special secret.

'What if... what if maybe when we do our classroom jobs you could pay us?' pipes up Harry.

This is turning out better than I expected. Teaching using real life examples? Tick!



The Victorian Curriculum states that children in Prep, are to 'role play money situations' in order to become familiar with Australian coins and their value. The classroom shop works as a learning space where they can talk to each other and listen and learn from one another. They dictate when they feed their monsters or buy fruit from the classroom shop. I only step in occasionally, such as when they need support calculating change or when one little boy robs the other children of their money 'Miss Gabi, Max has stolen all the money from our wallets. Also, we need more carrots.'

Maths needs to be fun, engaging and related to real life. The authenticity of the classroom shop and pet monsters worked to achieve these things. Now, time to organise my unit on volume and capacity!

The Monster Maths activity was inspired by a TeachersPayTeachers resource titled 'Australian Money Pack: Foundation and Year 1!' by Little Aussie Learners.

Gabrielle is a maths leader at Eagle Point Primary School. They have been working with MAV and a network of local schools to collaborate and build leadership and teacher capacity.
To learn more contact Jen Bowden, jbowden@mav.vic.edu.au

Which engaging activities have created a buzz in your classroom? Share your ideas in a future edition of *Common Denominator*.

Submitting articles is easy, just email office@mav.vic.edu.au or refer to www.mav.vic.edu.au/Services-and-News/Common-Denominator-Magazine to read the submission guidelines.

365 PENGUINS: ART AND MATHS

Kate Smith – Education Assistant, Windsor Primary School and Jennifer Bowden – Mathematics education consultant, MAV

Picture story books are a fabulous and fun way to engage children in mathematics. Mathematical engagement is much more than appearing 'busy' and on task. In their book *Engaging with Maths Through Picture Books* (2017) Muir et al. describe engagement as:

- Operative
- Cognitive
- Affective.

In this article we will investigate the book *365 Penguins* by Jean-Luc Fromental and explore how it can be effectively utilised in a classroom context to engage children in all three aspects of engagement mentioned above.

OPERATIVE ENGAGEMENT

There are so many mathematical concepts that can be discovered through the books. To be effectively engaged, it is important that students are able to explore these concepts through communicating and collaborating with their peers. This art task is a fantastic cross-curricular opportunity that allows students to further explore the book and 3D shapes, specifically cylinders. In this task students can work together to create their own penguin that could be used to further explore the mathematical concepts in the book.

Materials

- Coloured paper
- Scissors
- Black paint
- Newspaper
- Glue
- Cardboard tubes
- Googly eyes

Instructions

1. Cut a piece of black cardboard to fit around the cardboard tube.
2. Cut a piece of newspaper to fit the front of the penguin.
3. Cut your shapes out, arm, nose and feet.
4. Stick all the body parts on.
5. Stick the googly eyes on.

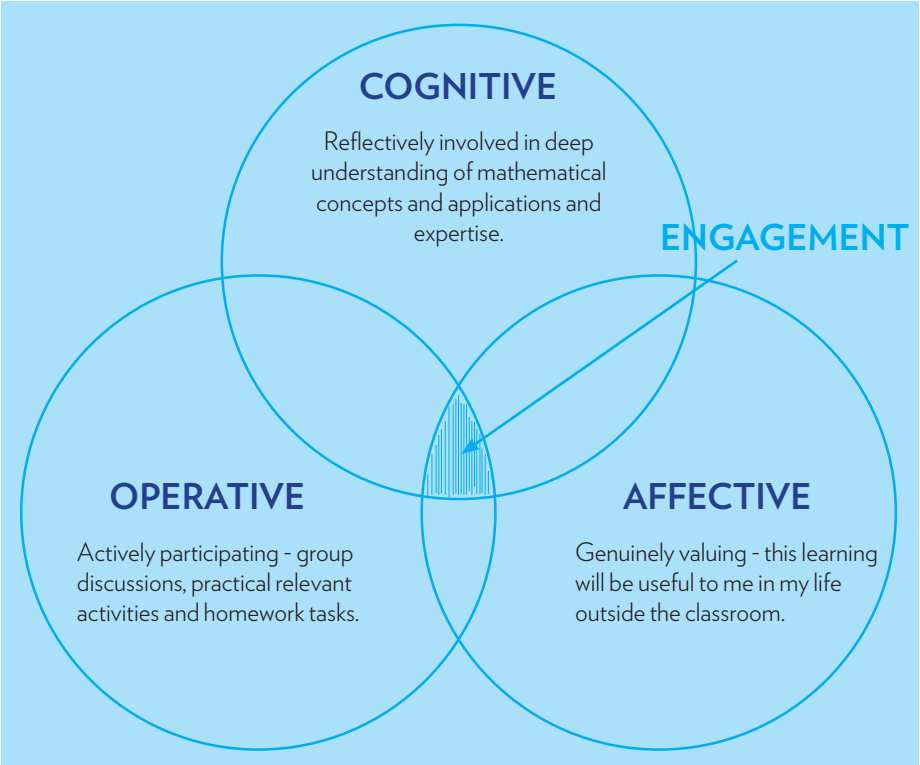


Figure 1. The coming together of affective cognitive and operative engagement results in true engagement with mathematics. (Engaging With Mathematics Through Picture Books (2017))

Dip the penguins' feet into black paint and print the feet onto the white paper to explore doubles and skip counting by two! The penguin will be a beautiful reminder of the books and mathematical tasks they completed with their peers.

COGNITIVE ENGAGEMENT

Students need to be challenged cognitively to be engaged! The book has a huge depth of relevant mathematical concepts that goes much further than the obvious cardinal number and ordinal counting and making connections with 365 days of the year. The book can be used to explore a wide range of concepts using questions to get students to think more deeply about mathematical concepts. The following concepts aimed at F – 2 (and beyond) were taken from the first half of the book. As the book progresses the concepts to be investigated in depth become more complex and challenging.

Measurement and Geometry

- The first penguin arrived on New Years' Day. What are some other special days we celebrate?
- The first penguin arrived at 9 o'clock in the morning, draw a clock to show 9 o'clock. What type of things do you normally do at 9 o'clock? Is there another way you can say or represent 9 o'clock?
- There are 7 days in a week and 365 days in a year. The days in a month is not as regular. Explain how many days there are normally in a month and how you decided on that number.
- The penguins arrive in a box. Design a box that would fit a penguin. Describe its features.
- On the 10th of April there are 100 penguins! How did they fit in a house? Describe and draw some spaces in your home or school that would fit 100 penguins.

Number

- The penguins have two feet. How many footprints would there be if one penguin walked across your classroom? What if it was day 10 and there were 10 penguins?
- At the end of February there were 31 + 28 penguins. How can you solve this addition problem? Show more than one way to solve it and compare your working out with a friend.

- When there are 60 penguins, they were able to fit in four identical stacks with a row of 4, then 3, then 2, then 1 on top. How else could you organise 60 penguins in groups. Why is there a problem organising the penguins in groups when one more arrives making 61 penguins? What is special about the number 61?

AFFECTIVE ENGAGEMENT

To be truly engaged, it is important to students that they can find genuine value for learning that they will be able to use in real life context. Whilst it's highly impractical and unlikely for 365 penguins to be delivered to your home, these books bring many links between mathematical concepts to real life situations, giving students opportunity to develop mathematical concepts and skills they can use in practical situations. Through the book students can make connections with the real world through exploring;

- Measuring quantities of food, the cost of feeding and housing penguins and how this relates to the economics of their personal lives.
- Climate change, weather and the needs of different animals across the world and it's relationship to seasonal changes within the student's life.
- Organisation of numbers and strategies to complete complex equations that can be generalised into many different mathematical and real-life contexts.

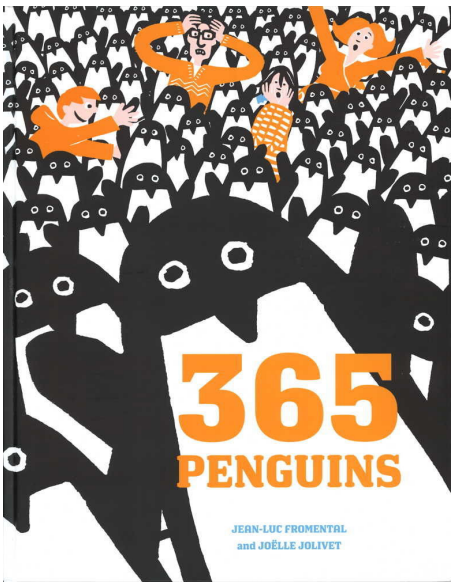
A picture book can be read many times, the art is in using it to create a engaging and purposefully activities that challenge students cognitively, operationally and allow them to see the value of their learning outside their life in the classroom. There are so many amazing picture books with rich literature, the craft is being able to select the right book to engage students in authentic classroom tasks.

REFERENCES

Muir, T, Livy, Sharyn, Bragg, Leicha, Clarke, J, Wells, J and Attard, C., 2017, *Engaging With Mathematics Through Picture Books*, Teaching Solutions, Melbourne.

Fromental, J, Jolivet, J., 2006, *365 Penguins*, Abrams Books for Young Readers, USA

Art task completed by Kate Smith, Education Assistant at Windsor Primary School. To see more of her artwork and connections with picture books visit Instagram @capturedartdesign



365 Penguins (and many more engaging picture story books) is available from the MAVshop, www.mav.vic.edu.au/mav-shop.

If you have used picture story books as stimulus for an engaging mathematics exploration, please share your story with the MAV member community. Email office@mav.vic.edu.au.

A LOT MORE THAN A LITTLE BOOK

Deb Irving – Maths consultant reviewing Mathology Little Books, a standalone component of Mathology K-2, Pearson Australia

One of the first things you notice about the new Pearson Mathology Little Books K-2 is that they are clearly 'maths first' literature, while still being highly engaging and relatable. There is no need for heavy thinking to determine how the story might work within your maths program or reading between the lines to figure what key numeracy concepts might be contained within. All 54 titles currently available link to a Big Maths Idea (from Pearson's researched based learning progression) with a clearly stated focus and work brilliantly for the teacher who loves to integrate literacy and numeracy learning.

A Class Full of Projects is one of my favourites, especially for a level 1/2 classroom; its key math focus is on comparing, ordering, adding and subtracting numbers to 100 (including some lovely conversations about place value), and the storyline is centred on groups of students conducting their own investigations about the number 100. The story is introduced through celebrating the first 100 days of the school year, often a favourite milestone.

The teacher's guide that accompanies the 6 copies of the Little Book is invaluable, stating the numeracy focus with tips on what to watch for, connections that the teacher might make to other learning areas and ideas for 6 differentiated follow up lessons and 5 independent learning activities. The QR code on the back cover directly links to a digital copy of the story with read along audio and a related interactive activity. A digital portal gives access to support materials, an assessment checklist and ways to connect the learning to home.

WATCH FOR...

- Does the child know that 10 more than 90 is 100? Explore if children can count by 10s to 100.

Composing 100

- The chart says "The 100 things must be easy to count." How would you arrange 100 things to make them easy to count? *(answers will vary and can be supported through quick sketches of groupings)*
- Will we get the same amount if we count by 10s (5s, 2s, 25s) as we do when counting by 1s?

Adding and subtracting

- How many more days are there until day 100? *(10)* How did you find out? *(accept any answer the child can justify)* Who used another way to find how many more days?
- Suppose it was day (75). How many more days would there be until day 100? *(25)* How did you decide? Who used another way?

I would suggest using an initial read aloud of the story to engage the students in the topic, then revisit parts of the story and choose appropriate question prompts, provided in the teacher's guide, to encourage a number chat through 'turn and talk' or 'think, pair, share'. Prompts such as 'Suppose it was day 75, how many more days would there be until day 100? How did you decide? Who used another way?' really get the students talking and sharing their thinking.

After reading, have the students represent the story with the Math Mat activity found inside the back cover. In *A Class Full of Projects* students use The Math Mat and base 10 materials to model different numbers and anecdotes from the story in a variety of ways, then use the materials to solve problems initiated by the story.

Make a Number

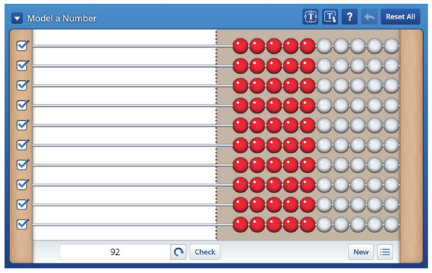
Move beads to the left side of the workspace to make the number at the bottom of the workspace.

Click **Check** to see whether the numbers match.

How many 10s are in the number? How many 1s?

How many more beads would you need to make 100?

Go to the next page.



In the following days, select from a variety of whole class, small group and independent learning activities provided in the teacher's guide, or be creative and use the story as a springboard for your own follow up lessons. Revisit the story with an enabling group, with each child having their own copy of the Little Book (rated at reading level I).

Again, choose appropriate prompts to promote further thinking and exploration of the concept, scaffolding the learning and following up by engaging the group with the digital interactive activity (6. Interactive activity accessed through the QR code on the back cover, where students model numbers using their understanding of place value. Engage an extension group in the game *Adding to Make 100*, where they will use dice prepared with the numbers 5, 10, 15, 20, 25 and 30; rolling the dice, adding the numbers and recording the results in equations and on a hundred chart. Use the provided Watch Fors and Probes to gauge student understanding and help them explain their thinking.

Have the whole class engage in the activity *This is 100* modelling and recording ways of grouping items to count collections of 100, similar to the way the students in the story did. While students are working, use the suggested Watch Fors to evaluate understanding and record student progress on the provided assessment checklist

Engage parents and follow up with learning activities at home by choose the game *Race to 100* from the suggested Home Connection Options, where students and their parents use selected playing cards and a hundred chart to add numbers to an ever-increasing running total - racing to be the first to the 'finish line' of 100.

As with all Mathology Little Books, *A Class Full of Projects* builds the confidence of teachers to deliver effective, hands on teaching and learning targeted to student needs through an engaging, accessible story and differentiated learning activities.

Little Books are available as individual titles, with each set containing 6 Little Books, a Teacher's Guide including follow up lessons and digital access to the story with read along audio, a related interactive activity and portal access to downloadable support materials. Little Books can be used independently or as part of Mathology K-2, a newly released Pearson Australia primary maths resource.

A selection of titles is available from the MAV shop www.mav.vic.edu.au/mav-shop.

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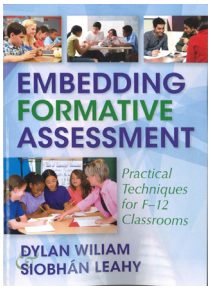


EMBEDING FORMATIVE ASSESSMENT

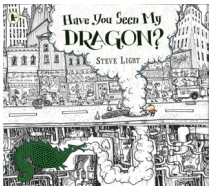
F-VCE

Effective classroom formative assessment helps educators make minute-by-minute, day-by-day instructional decisions, but putting it into practice requires both a robust collection of techniques and an understanding of how to use them. This book is a clear, practical guide for teachers, centred on five key strategies for improving teacher practice and student achievement:

- Clarifying, sharing and understanding learning intentions and success criteria
- Engineering productive discussion and activities that elicit evidence of learning
- Providing feedback that moves learners forward
- Activating students as learning resources for each other
- Activating students as owners of their own learning.

An overview of each strategy is provided and a number of very practical formative assessment techniques for implementing it in F–12 classrooms. Along with guidance on when and how to use the specific techniques, they provide tips, cautions and enhancements to sustain formative assessment. A student reflection form, peer observation form and self-reflection checklist accompany each strategy.

$35 (MEMBER)
$42 (NON MEMBER)

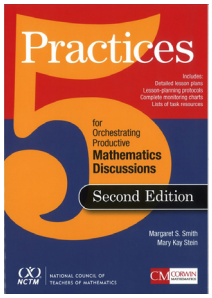


HAVE YOU SEEN MY DRAGON?

1–2

A search-and-find number book! Enter an ornately drawn cityscape and help a little boy find his dragon while counting objects from hot dogs to traffic lights. As the boy travels all over town searching for his dragon friend, can you spot the glorious beast, as well as an array of big-city landmarks and icons. Is the dragon taking the bus, or breathing his fiery breath below a busy street? Maybe he took a taxi to the zoo or is playing with the dogs in the park.

$14.50 (MEMBER)
$18 (NON MEMBER)



FIVE PRACTICES FOR ORCHESTRATING PRODUCTIVE MATHEMATICAL DISCUSSION

F-VCE

The five practices teachers know and love for planning and managing powerful conversations in mathematics classrooms, updated with current research and new insights on anticipating, lesson planning, and lessons learned from teachers and school leaders. This framework for orchestrating mathematically productive discussions is rooted in student thinking to launch meaningful discussions in which important mathematical ideas are brought to the surface, contradictions are exposed, and understandings are developed or consolidated.

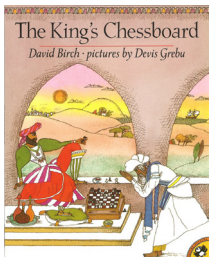
$45.50 (MEMBER)
$54.60 (NON MEMBER)

NUMEROUS CONNEXIONS

F–6

Features 630 laminated cards and three copies of the Teacher Resource book, specifically designed to build number sense and place-value understanding. The resource includes lesson ideas for investigations, number talks, games and assessment tasks to help students think flexibly about numbers and see numbers as quantities, not just digits. It includes suggestions for differentiation, encouraging collaboration and activating the four proficiencies in your classroom.

$650 (MEMBER)
$780 (NON MEMBER)



THE KING'S CHESSBOARD

2-VCE

A great story for children learning mathematical concepts, it tells the story of a wise man who refuses the king's reward for completing a favor. When the king insists the man accept a reward, the man proposes a deal: He will take a payment of rice equal to each square on the king's chessboard - doubling the amount he receives with each day. This quickly empties out the royal coffers!

$14 (MEMBER)
$17.50 (NON MEMBER)

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