THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 2/20

INVESTIGATING EPIDEMICS

INSIDE

James Mott - Suzanne Cory High School and Stephen Crouch - Frankston High School

Many of us will be tired of hearing about COVID-19, it's taken over our lives in ways we could not have imagined. Trying to look on the bright side, the pandemic gives mathematics educators a very rich real-world link to several relevant mathematics topics.

Any illness, whether it be the common cold or a global pandemic, is always a serious matter for individuals, family, friends and the community. The health of the community is determined by the health of the individuals that it constitutes. Whilst a significant event that is not to be taken lightly, the COVID-19 global pandemic is a real-world context in which students can investigate and learn about mathematical modelling as well as an introduction to the mathematics behind population modelling and the spread of disease.

Continued on page 4

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

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FROM THE PRESIDENT

Michael O'Connor

I want to begin by saying that I hope you are all safe and well.

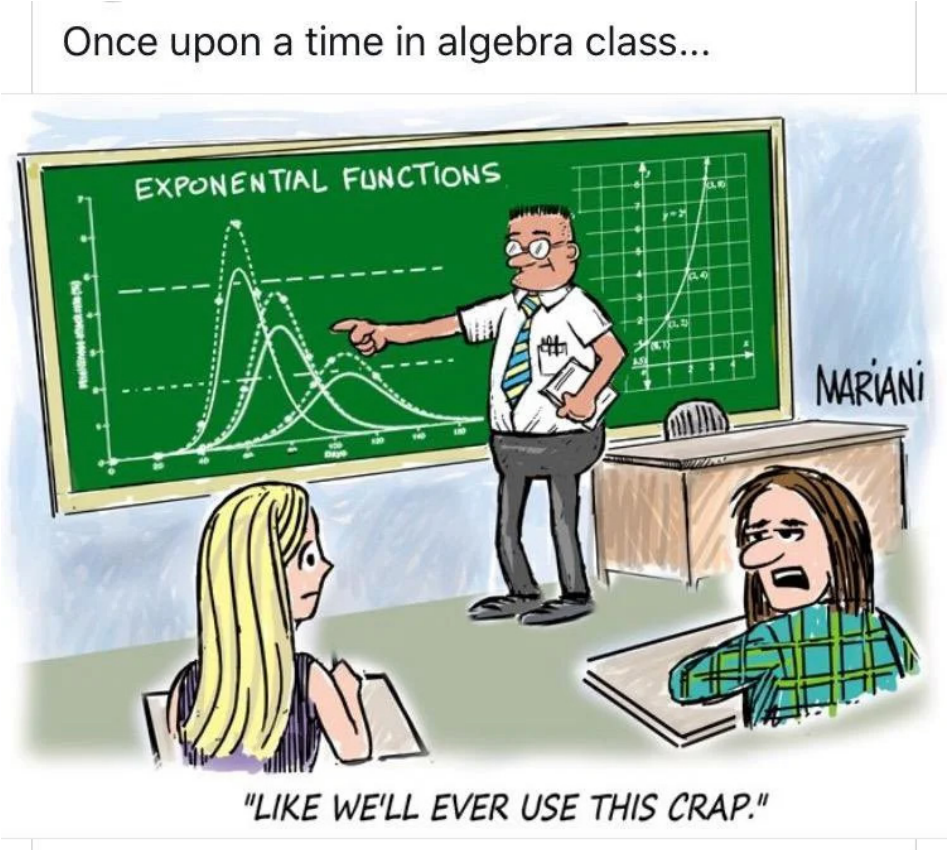
The last few weeks have been harrowing and the future is still uncertain. As teachers we are entrusted with not just the education of the next generation but also its protection and welfare. I do not think this has been more difficult at any time in living memory.

The means by which we must now continue to provide an education for our students has changed dramatically. There has been a proliferation of sites offering advice and materials for learning from home. As we know, there is so much more to learning than just resources. At its heart, teaching is about relationships and human interaction. Perhaps what students and parents need most at this time is the reassurance that some areas of life still have a routine and a predictability. Providing connection points through learning is one way of achieving this.

As we all struggle to work out how to teach remotely and get the technology to work without access to our IT gurus, please remember that it is the people we work with, our colleagues and students, who matter most.

The MAV staff and Board are continuing to work, providing you with resources, advice and professional learning as we have always done. While our face-to-face events are not viable for the next few months, we will be transferring as much as possible online (see note from CEO Peter Saffin on page 3). The MAVshop is also still in operation.

Looking to later in the year, I am sure that many of the VCE teachers among you will be wondering what the current crisis will meant for your students studying Units 3 and 4. I know that it is on the minds of our students, my son being one of them. While it is still too early for discussions about this, let alone decisions to be made, know the MAV will represent the best interests of the students and their teachers when such discussions do take place.



MAV PROFESSIONAL DEVELOPMENT

During Term 2 2020, a variety of presenters and MAV's own mathematics educational consultants will present online workshops focusing on innovative teaching practice.
Make sure you reserve a place by booking early, www.mav.vic.edu.au/pd.

TOPIC	DATE	YEARS	PRESENTER
Maths Talent Quest: How do we run MTQ in 2020?	16/4/20	F - 12	Jen Bowden
School and home - Engaging maths games to develop fluency	21/4/20	3 - 6	Jen Bowden and Ellen Corovic
School and home - Engaging maths games to develop fluency	27/4/20	F - 2	Jen Bowden and Ellen Corovic
Using picture books to inspire and develop mathematics	7/5/20	F - 4	Jen Bowden and Ellen Corovic
The problem with numbers	12/5/20	F - 6	Nathalie Parry
Developing numeracy in the real world – ideas for task using real world situations and environments.	19/5/20	3 - 6	Jen Bowden and Ellen Corovic

COVID-19

Peter Saffin - CEO, Mathematical Association of Victoria

Dear Maths Educators,

MAV, like many organisations, is being impacted by the COVID-19 pandemic. Business as usual isn't an option, but the good news is that we are working to find innovative ways to support you over the coming months.

Look out for these exciting opportunities for students:

- Maths Talent Quest (MTQ) will run, although there will be changes to judging and entry submission. You can do the MTQ as a remote learning activity or at school. We are planning to run a great state awards program. It's unlikely that there will be an awards ceremony but the MAV team will suggest other ways for students to celebrate their achievements.
- 2020 VCE revisions lectures will be available online.

SUPPORT FOR TEACHERS REMAINS OUR TOP PRIORITY

- Online professional learning sessions will be available. Sessions will have a focus on providing activities to support students, regardless of location.
- Learning at home resources are being developed which will be useful for all maths educators. MAV supports the sharing of engaging ideas and useful resources – supporting maths educators is vitally important.
- We hope our much loved annual conference will run in December. It may not be possible to run face-to-face, but our intention is to deliver the conference in one format or another.

Keep an eye on our Matrix newsletter for more information.

Lastly, MAV needs your support to get through this challenging time. Please ensure your membership is up to date. If you are unsure about your membership status, drop an email to mgreen@mav.vic.edu.au.

Another way you can help is to enrol in our digital events so that we can continue to provide services to all maths educators during this challenging time.

The effects of COVID19 on schools continues to unfold, if there is a way MAV can help and support you and your school, please get in touch: psaffin@mav.vic.edu.au.

Stay safe, we are thinking of you!

INVESTIGATING EPIDEMICS

James Mott - Suzanne Cory High School and Stephen Crouch - Frankston High School

CONT. FROM PAGE 1.

This article shares activities that could be used to engage students (in a range of year levels) in the learning of mathematics by using the context of COVID-19, and more broadly the spread of any infectious disease.

YEAR 5 – YEAR 9

Standing disease (NRICH, 2020) is a highly visual class activity where students can act out a simple model of spreading a virus. To play, first begin with all students sitting down. It could be better if the students were sitting in a circle or around the perimeter of the classroom so that everyone can see each other. On day 1, the first person to be infected (sick) with the 'standing disease' stands up. They then choose two people to infect, and then they stand up. On day 2, each of the newly infected people then chooses two more people who are still sitting. The activity continues until everyone is infected and standing. On the board, or on a computer, keep a record of how many days pass and how many people are infected/stand each day.

After everyone has been infected the following questions can be posed for a rich class discussion:

- How many days did it take to infect everyone in the room?
- What would happen if three people were infected each day rather than two? Get the students to make some conjectures and then pay the game again to see the outcome. Record the number of days and the number of infected/standing at each stage beside the first game to compare results

To extend students you could ask the following questions. Encourage students to collaborate and try different ways to attempt the problems (e.g. numerical, tabular, graphical, trial-and-error, symbolic).

- Can you observe a pattern? Can you plot the results on a Cartesian plane? What does the graph look like? Could you suggest a rule?
- What would happen if the class were bigger? How many days would it take to infect the whole school?
- If the Year 7s (or which ever year level you might teach) were to stay at home to avoid getting sick, how many days would it take to infect everyone else at school?
- What would happen if one person was infected on day 1, then on day 2 that infected person infected two people, then on the third day the two sick people infected three people, then on day 4 the three infected people infected four people? How many days would it take to infect the whole class? The whole year level? The whole school?
- What are some things we could do to reduce the number of people getting sick in total, or the number of people getting sick each day?

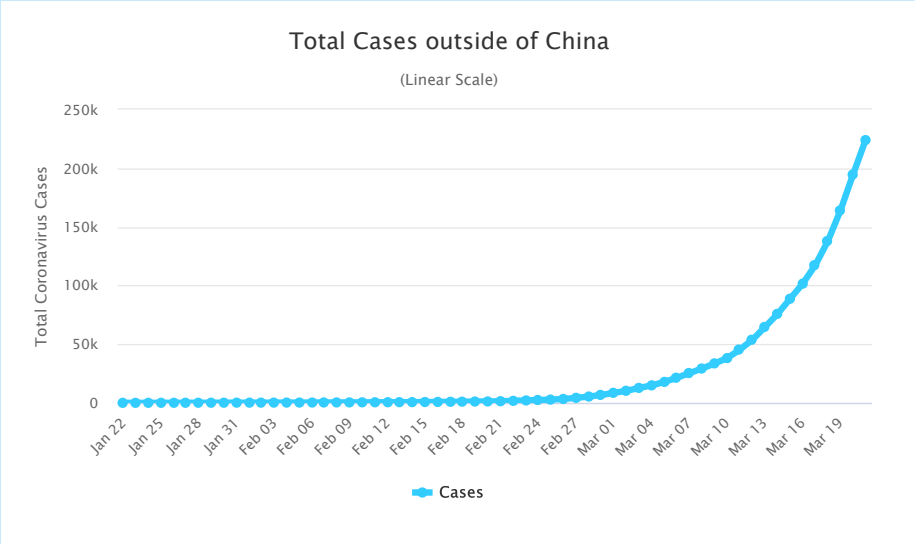


Figure 1. The total cases outside of China (linear scale).

The *Standing disease* activity is just one of several activities on the Nrich website (NRICH, 2020) which can help teachers engage their student in simple mathematical modelling of an important and real-life context such as the spread of infections. Additional resources, games and class discussion questions are available on Nrich. The *Vaccination game* could be used in the subsequent class to explore how the role of a vaccine can reduce the spread of infectious disease, along with exploring the concept of herd immunity. Lesson objectives, instructions, and class questions are all included.

The *Corona Simulator* news article (Stevens, 2020) offers several virtual simulations that, when combined with a physical simulation in class, further give students insight into how quickly disease spreads. In addition in simplified models, the aforementioned blog post also contain simulations that involve quarantining, social distancing, and recovery. Rich qualitative discussions can stem from comparing these simulations, which has the opportunity to drive investigative mathematics in a collaborative environment.

VCE MATHS

Each VCE Mathematics subjects lends a unique perspective to analysing data, functions and graphs related to the spread of disease. Given the rapidly changing situation that changes on a daily basis, all data mentioned henceforth is current as of 22 March 2020.

Further Mathematics

The Worldometers website (Dadax, 2020) provides interactive charts that give context for the utility of logarithmic scales and transforming data so as to observe and predict trends, and consequently interpolate and extrapolate from the data. See Figures 1 and 2.

The Nrich *Disease dynamics* module (NRICH, 2020) offers two teaching activities *Epidemics on Networks* and *Analysing Networks* which provides students a opportunity to act as an epidemiologist. By using networks, students are able to track how an infection spreads in a community, investigate how the location of the source of the infection determines the growth of

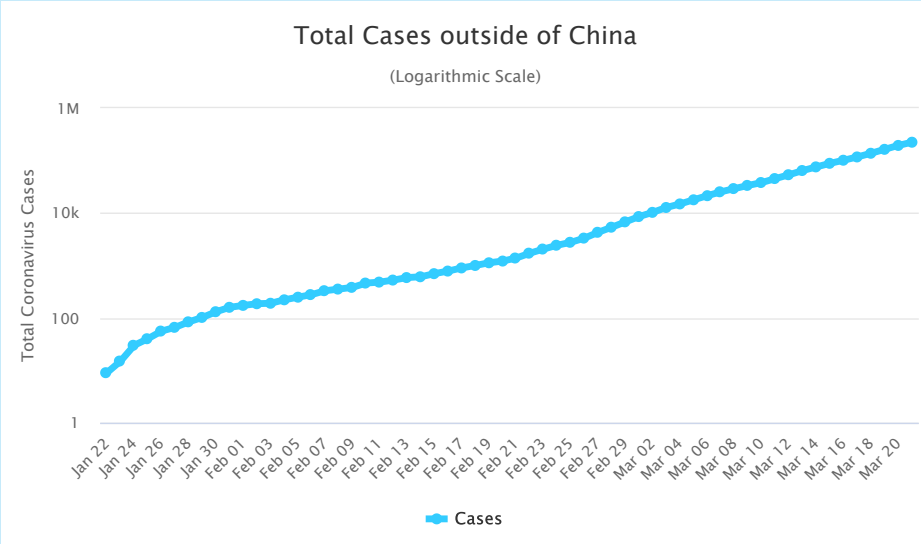


Figure 2. The total cases outside of China (logarithmic scale).

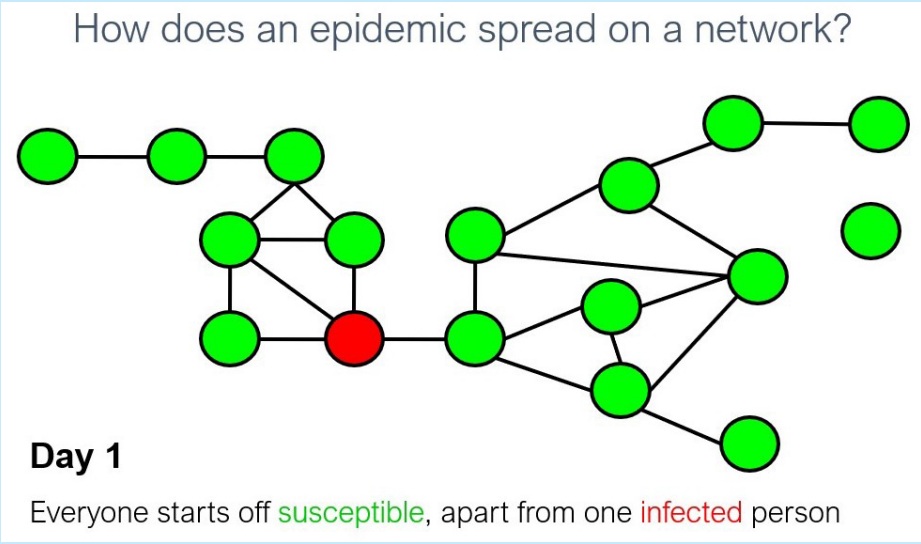


Figure 3.

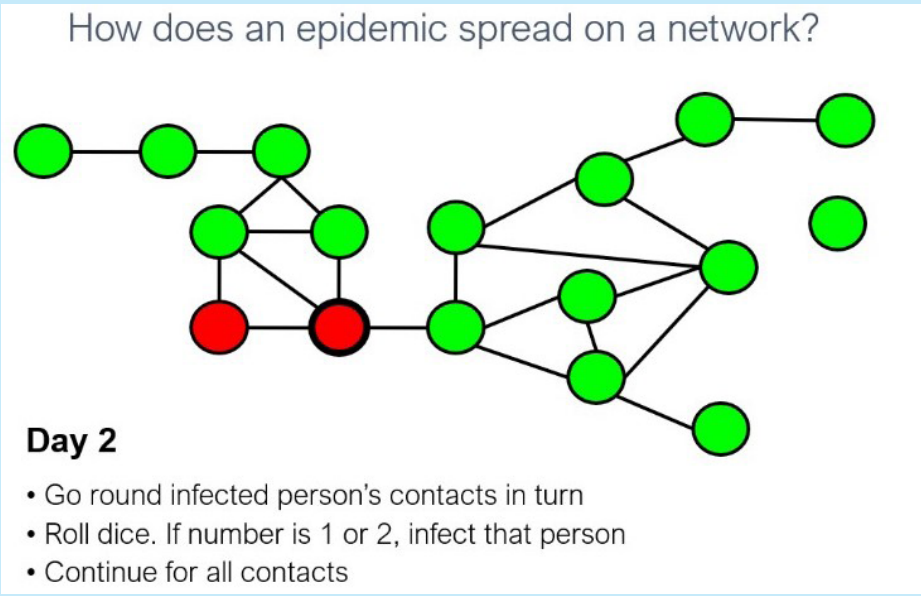


Figure 4.

the number of infected, and explore how targeted vaccines can be used to help mitigate and reduce infection.

Further class activities and questions are included. These models can be extended further by considering quarantining and social distancing. See Figures 3 and 4.

Mathematical Methods

Exponential change (both exponential growth and exponential decay) is prominent in the Mathematical Methods course, throughout Units 1-4. Most students are exposed to the concept of exponential change from the viewpoint of population growth, such as bacteria, animals and humans, and often in other situations such as the continuous folding of paper (only 42 folds required to reach the moon, assuming a piece of paper can be folded that many times).

Exponential growth is also prevalent in the study of infectious diseases. As a simple example, if one person has an infectious disease, and then infects three further people the next day, whom in turn infect three more people the following day, the number of people infected follows an exponential relationship $N = 3^t$ where there are N new infections on day t. When explaining this to students, care must be taken to mention that a continuous function is being used to model a discrete scenario, and therefore only positive integer values of t are being used. To further amplify the meaning of this exponential growth, a CAS calculator or other graphing software can be used to visualise this relationship – indeed, by the end of one week the number of cases is predicted to be 2187, and by the end of the second week, a staggering ~4.78 million.

Given the existence of the current global pandemic of COVID-19, this presents a useful case study for exploring exponential growth – in particular the concepts of rate of change (differentiation), logarithms and graphical analysis. Take Figure 1, a quick glance at this shows clear exponential growth. This data can be used to create a scatterplot on CAS, and hence exponential regression can be performed. See Figure 5 on page 6.

INVESTIGATING EPIDEMICS (CONT.)

COVID-19 provides a rich real-world application of many mathematics topics.

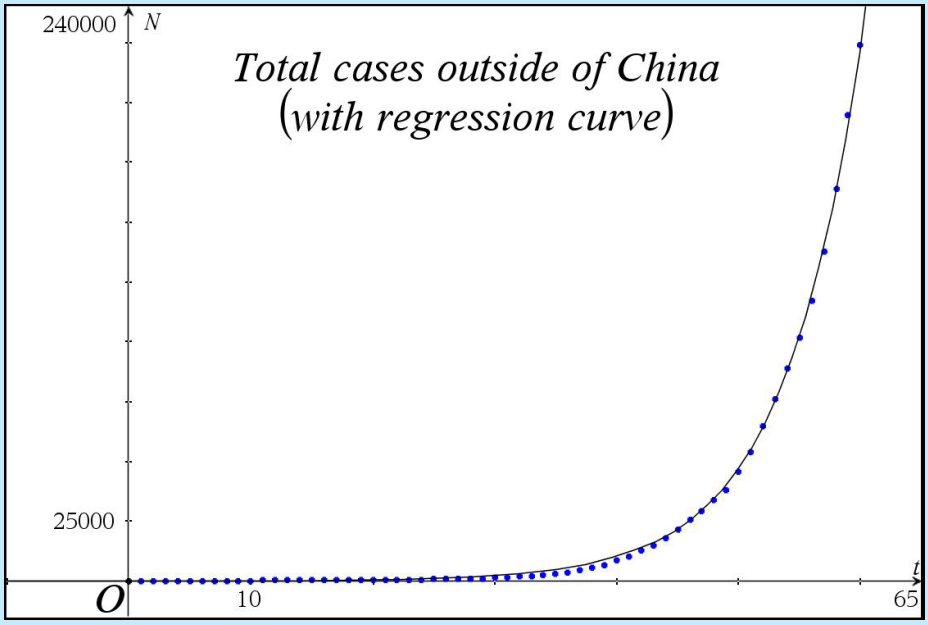


Figure 5.

The equation of the regression curve is $N = 19.89 \times (1.168)^t$ where t represents the number of days after 21 January 2020. The regression curve, using 4 significant figures, closely matches the actual data.

As a Maths Methods activity, students may discuss the meaning (and effect) of the numbers 19.89 and 1.168, including using a CAS or other software to vary these numbers by various amounts to model different scenarios. Furthermore, logarithms are able to be discussed too, either as a way of 'linearising' the graph, or in order to predict the day that the number of cases reaches a particular value.

Closer to home, similar data is also available for Australia (Dadax, 2020), where the regression curve is $N = 1.446 \times (1.199^t$, for t days after 14 February 2020, see Figure 6 on page 7.

Specialist Mathematics

The concept of differential equations, introduced in Specialist Mathematics, is a very powerful tool in modelling and analysing the spread of infectious diseases such as COVID-19. Students and teachers may also have heard the terms 'flattening the curve' being mentioned, and one way of visualising this is via a special curve called a logistic curve, which exhibits exponential growth in the early stages, reaches its maximum growth rate at its inflection point, following which the growth rate slows down and then 'flattens'. Note that the logistic curve models the cumulative cases over time, as opposed to the number of new cases each day.

The differential equation for logistic growth typically takes on the form

$$\frac{dC}{dt} = rC\left(1 - \frac{C}{K}\right)$$

(Batista, 2020), where C is the cumulative

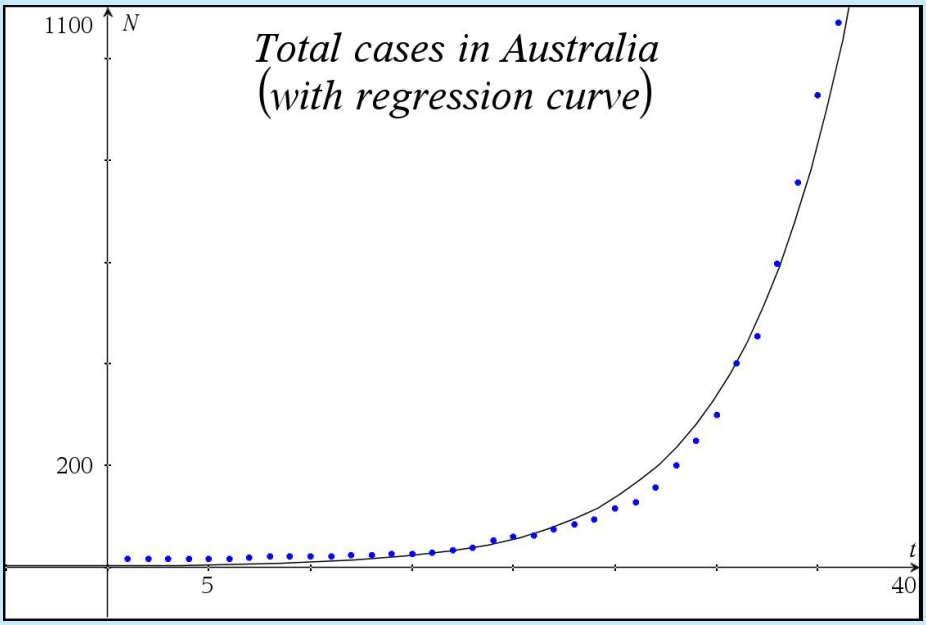


Figure 6.

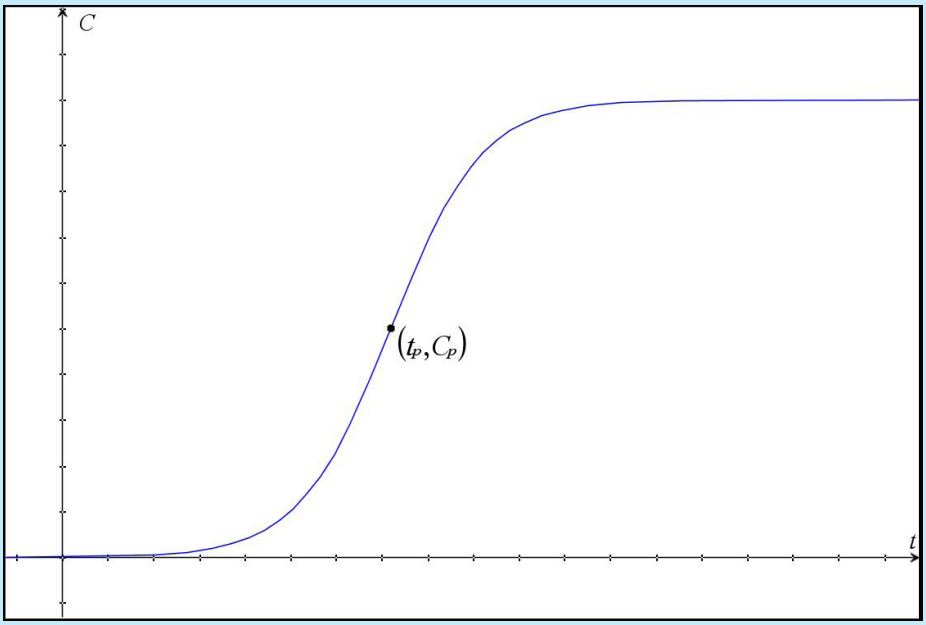


Figure 7.

number of cases after t days, r is the infection rate and K is the maximum number of cases (which can be calculated via other means – such as a certain percentage of the total population).

The solution of this logistic model is

$$C(t) = \frac{K}{1 + Ae^{-rt}},$$

where $A = \frac{K - C(0)}{C(0)}$ and $C(0)$ is the initial number of cases.

Graphing a typical logistic curve results in Figure 7.

(t_P, C_P) is the inflection point. A Specialist Mathematics student can use implicit differentiation on the logistic growth differential equation to find the second derivative and hence the coordinates of (t_P, C_P), or can simply differentiate the solution twice.

Discussion then can revolve around the size of C at the inflection point, as well as the growth rate at that time.

As an extension, current data from Worldometers can be used to fit a logistic curve, and hence predict what the maximum number of total cases could reach – either in Australia or across the world.

CONCLUSION

Investigating how diseases spread in a community can provide a rich environment to conduct mathematical modelling, and engage students in their learning through a real-life context. By exposing students to these discussions and flavour of mathematics, hopefully we can inspire a greater number of students to go on to study mathematics and epidemiology, and potentially save more lives in the future.

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A GAME OF CHANCE

Cath Epstein - MAV curriculum consultant and numeracy leader St Peter's East Bentleigh and St Paul's Bentleigh

'Probability assigns a number from 0-1 to an event. The more likely an event is to occur, the larger the number assigned to it, and so the probability is 1 when something is certain to happen.'

A couple of years ago a Level 3 team asked me to work with them to unpack chance in relation to their historical inquiry topic, *People Past and Present*.

I thought this was such a rich and interesting way to investigate probability and a simple request has led to a collation of a range of rich and varied cultural games that lend themselves to unpacking chance. Here are four of my favourite games which can all be easily differentiated according to the level you are working with and the key ideas you wish to explore. Lets begin at home with a game I often investigate around Anzac Day.

COME IN SPINNER (AUSTRALIA)

'Sample space is the fundamental concept that needs to be understood before they probability of specific event scan be determined. The sample space for a probability problem represents all possible outcomes.'

This game is a child-friendly variation of Two-Up. You can find Returned Service men and women still playing Two-Up on ANZAC Day, to commemorate the simple game that Australian diggers played during times of war. Evidently the convicts had a liking for this game and it was also a favourite on the goldfields. Traditionally, Two-Up was a gambling game (made legal only on Anzac Day)

Resources: Two identical coins, large icy pole sticks or a kip to toss the coins. (Originally pennies were tossed with a kip as it was very clear to see which way they landed). Kips can often sometimes be bought from a game or dollar shop.

How to play: Choose a spinner who will toss the coins in the air. The class calls out 'Come in spinner'.

Place the coins on the kip to show how they landed. The children choose how they think it will land by placing hands on:

- Heads
- Tails
- One head, one tail

Figure 1. The winner is the person who can complete a lap of the 40 stones.

Children are eliminated as each game progresses until there is one winner. Be sure to keep a tally of results.

Analyse:

- Talk about the probability of toss outcomes or sample space (heads 25%, tails 25%, odds 50%)
- Use words to describe the probability of each outcome (likely, unlikely, probably, possibly etc.)
- Use fractions/percentages to describe the probability of outcomes (e.g 25% or 1/4)
- Test the probability. Keep a tally of each coin toss and record the results using fractions.

Extension what is the sample space if we tossed 3 coins?

The following American Indian game unpacks this scenario through a different game.

THE NAVAJO STICK GAME

This game was initially introduced to me by Matt Sexton from Australian Catholic University who later told me he had sourced the activity from illuminations.nctm.org.

The Indian Stick game is played with 40 stones or counters that are placed in a large circle and three sticks with one side decorated (icy pole sticks). The idea is to throw the three sticks in the air and move around the stones according to how the sticks land.

Moves	
3 patterned sides facing up	10 stones
3 blank sides facing up	5 stones
2 patterned, 1 blank facing up	3 stones
2 blank, 1 patterned facing up	1 stone

The winner of the game is the first person to complete a lap of the 40 stones. See Figure 1.

The game was traditionally played by the Navajo women before sunset where it was stopped at night time; a principle designed to teach moderation. The circle represents the Navajo homeland of trees, rivers and rocks and the play around the stones

symbolising the movement of life. Playing the game encourages socialisation and friendship.

Analyse:

How many possibilities do we have for the sticks to land? Is the scoring system fair?

Most children think there are only four possibilities of how the sticks could land:

- 3 patterned sides up (PPP)
- 3 blank sides up (BBB)
- 2 patterned sides and one blank (PPB)
- 2 blank and 1 patterned (BBP)

Which would suggest the four outcomes have an even chance of being thrown!?

However, if you ask children to collate their data during a game and compare the results they will observe that the three sticks land either two blank or two patterned sides up more often than three blank or three pattern. Why is it so?

We need to consider how the sticks land in relation to each other and the best way to represent or unpack this sample space is through a tree diagram. (See Figure 2).

Thus, we can see that there are in fact eight possible ways the sticks can land

Of these there is only one way 1/8 or 12.5% chance of it landing three blank sides up or three patterned sides up while there are 3/8 or 37.5% chance of it landing two blank or two decorated sides up. Hence the results we experienced before. So the next question we ponder ... is the scoring system fair?

Hopefully now they can consider that the scoring system should be equal for throwing three decorated or three blank and less but equal for scoring two of the three decorated or blank as there is a greater chance of this happening. One group suggest nine moves for throwing three blank or decorated and three moves for throwing two of one and one of another as it is 3x as hard to throw three. Do you agree with this?

Illuminations suggest you can take it further by either moving on to playing or testing the game with a fairer scoring system you agree to or investigating outcomes if you say play the game with four sticks?

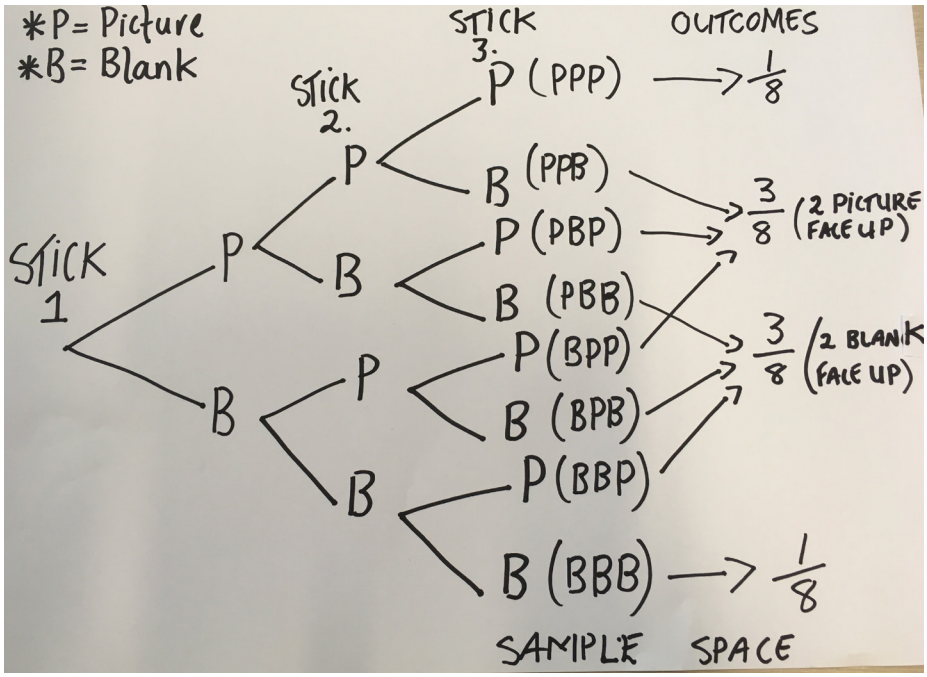


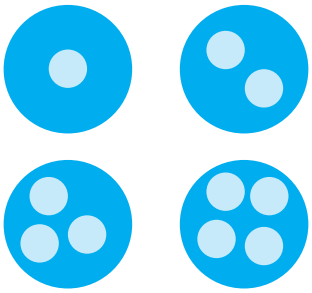
Figure 2. Probabilities of the Navajo Stick Game.

Either way the stick game is a fun way to unpack theoretical chance by conducting and comparing a large range of experimental data and exploring the probability of outcomes through an interesting diagram or data chart they may not have explored before.

LU - LU (HAWAIIAN)

This game was played by early Hawaiians with discs of volcanic stone about 2.5cm in diameter. These were called lu lu meaning 'to shake'.

Resources: The game is played in pairs using four counters with dots drawn on one side. This image is an example of possible dots that can be drawn on one side.



How to play: Children shake the four counters and throw them on the ground or on a plate and add the total of the dots that turn up. Taking turns, the first to 50 wins. (you may need a 100 chart or number line for some children to help with adding and keeping track of their total)

Analyse:

- What are all the possible outcomes in one toss?
- Is it similar or different to the Navajo Stick game and can we use a tree diagram to investigate? (Yes, we can use a tree diagram with one more stone to consider, so there are now 16 outcomes).
- Is there another way of representing the sample space?
- Can all the numbers 0 - 10 be scored? (Unpack with the tree diagram).
- How many different ways can each score be obtained? Why?
- What is the probability of each score?

Variation: In the challenge version, a turn consists of two tosses. On the first toss, if all four stones fall face-up, the player scores 10, then tosses all dice again. If all four do not fall face-up on the first toss, the dots of those face-up are scored and only the face-down pieces are tossed a second time. The dots showing on the second toss are added to those from the first toss. The winner is the player who first reaches a score of 100.

- What are all the possible outcomes in two tosses? Consider the retossed dice. Order does not count.

A GAME OF CHANCE (CONT.)

Cath Epstein - MAV curriculum consultant and numeracy leader St Peter's East Bentleigh and St Paul's Bentleigh

- What scores are possible for a turn?
- How many different ways can each score be obtained?
- What is the probability of each score?

There are many ways you can moderate this game to extend your thinking or change the possible outcomes or maybe even change the area of mathematical investigation depending on the key ideas you wish to explore. For example, it can be differentiated to explore a range of mental computation strategies.

PAPER, SCISSORS, ROCK (LIZARD,SPOCK?)

I noticed my children, Neive (9) and Amelie (6), playing Paper, Scissors, Rock to decide who got the last cup cake and my curiosity was aroused. I hadn't taught them this game but they were expertly playing best of three to decide who got the cake.

Paper, Scissors, Rock originated in China around the time of Christ and in the 1700's made its way over to Japan where it was played for many years.

Why do we play Paper, Scissors, Rock? 'It's a fair way to decide!' Neive exclaimed.

So... why is it fair? To investigate, I found an excellent lesson investigation at www.resolve.edu.au.

To begin our investigation, I discussed the notion of fairness with the class and most agreed that you had an equal chance of winning. In actual fact if you unpack it with the two way table that ReSolve suggested you can see that you have...

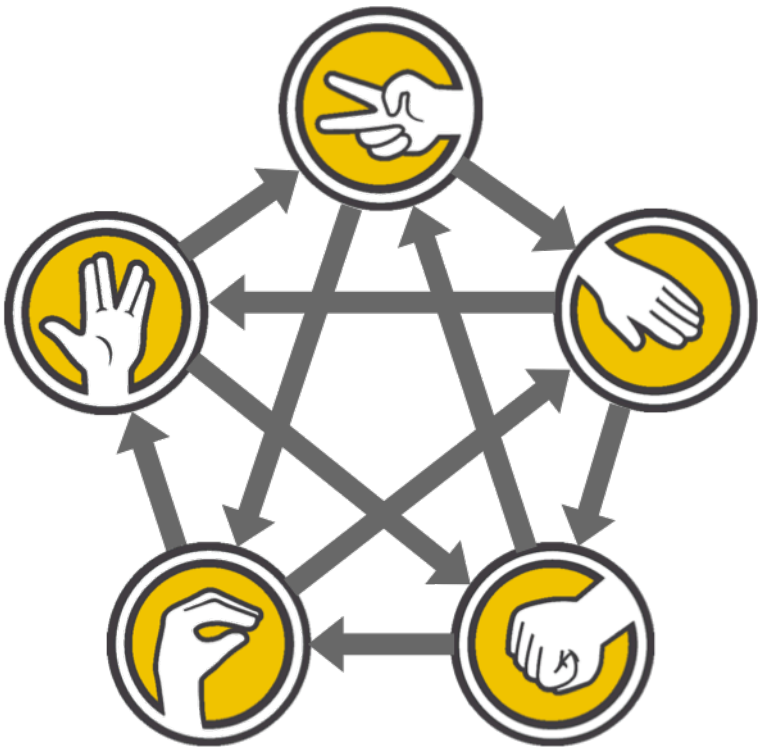
- A 3/9 or 33% chance of drawing,
- A 3/9 or 1/3 chance of person 1 winning and
- A 3/9 or 1/3 chance of person 2 winning

I wanted to test the theoretical probability and predicted that with five groups playing 20 games, data should show around 33 draws, person 1 winning 33 times and person 2 winning 33% of the time. (ReSolve provides a data chart to collate data for 20 games).

As predicted, results were similiar but there seemed to be slightly more draws. Why?

P2 \ P1	ROCK	PAPER	SCISSORS
ROCK	DRAW	WIN P1	WIN P2
PAPER	WIN P2	DRAW	WIN P1
SCISSORS	WIN P1	WIN P2	DRAW

Figure 3. Paper, Scissors, Rock outcomes. Image sourced from www.resolve.edu.au.



Scissors cuts Paper
Paper covers Rock
Rock crushes Lizard
Lizard poisons Spock
Spock smashes Scissors
Scissors decapitates Lizard
Lizard eats Paper
Paper disproves Spock
Spock vaporises Rock
Rock crushes Scissors

Figure 4. Paper, Scissors, Rock , Lizard, Spock outcomes. Image sourced from www.resolve.edu.au.

To take it a little step further, I gathered those who lost more than they won and shared a little secret to winning. (This secret can be found on the ReSolve site) and we then played the game 20 more times. Results showed those who lost the first time winning a little more on the whole but not significantly. Why? Well, the tip worked initially but then quite often the opposition clicked on to what was going on and changed their tactics.

However, consider this... when you play Paper Scissors, Rock you usually play best of three or five and in these circumstances knowing the trick just might be the key to winning. Is this fair?

To extend a little further we then looked at a clip from *The Big Bang Theory* (www.youtube.com/watch?v=iSHPVCBsnLw) where Sheldon claims that when people know each other well, 75% of the time you end up having a draw. He then goes on to outline his extended version, Paper, Scissors, Rock, Lizard, Spock which might be best explained by Figure 4.

The kids loved this and we went on to analyse why Sheldon added another two options rather than one and looked at a two way table to analyse the sample space. We discovered that in this version there was a 5/25 or 20% chance of a draw and 10/25 or 40% chance of either person winning.

We played 100 games between us predicting the theoretical probability that a draw would result around 20 times.

Experimental data did not match exactly but we discussed factors that may impact on the choices we made such as whether you could actually make the spock signal in a hurry. It was a rich discussion!

I have explored this lesson sequence with Levels 4, 5 and 6, who have enjoyed it immensely. They were all able to identify sample space and likelihoods using a range of language and numerical explanations and analysed data according to the levels of understanding through robust discussion.

These are just some of the games we have explored to unpack the key ideas in chance, it's been a fun and thought provoking investigation. I have referenced a range of other games that you may wish to explore further.

So..... let the games begin!!!

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FUTURE MATHEMATICS PLANNING

Belinda Cheong – Learning and Teaching Leader, Sacred Heart Primary School, Preston

As a small school based in the northern suburbs, teachers and leaders shared an eagerness to reignite a passion for mathematics and rethink how we best teach mathematics for our students today. But how do you begin such a task? How do you possibly create a spark in your teachers and have those volunteer to change or adapt their current practices?

Our school had a PLAN (Purpose, Logistics, Assessment and Nurture). Mathematics facilitated planning was our priority and this journey, commencing in 2016, continues to show a growing success in academic achievement and teacher confidence. Let's dig further through the model, unpacking key elements to the success of facilitated planning...

PURPOSE

Building a vision was essential because as Sinek (2009) explains, you need to begin with the 'why' to know 'how' and 'what' you need to do to achieve your goal. Post school review, where the analysis of data showed inconsistencies in teachers' confidence and capacity in teaching and assessing mathematics, leadership recognised it was time for significant and timely action.

Leadership engaged with other schools through networking and school observations and sought answers for...

- How were teachers engaged in mathematics planning?
- What evidence was being collected?
- How were teachers using evidence?
- How were teachers targeting student needs?
- How flexible were teachers in responding to those needs?

It was through these questions that we recognised the importance of the *Teacher Inquiry and Knowledge Building Cycle* (Timperley, 2008, pp. 26-27). Through this cycle, leaders and teachers are recognised as learners, continuously building their knowledge and skills to impact student understanding.

LOGISTICS

Planning was important for all at the school. School closures helped unpack the Timperley model inquiry cycle and guest speakers helped contextualise it in various learning situations. Leadership spent time exploring options and creating a facilitated planning model that best suited our school which involved an agenda, staff protocols and step sheet guide. As Kotter (2012) claims, there needs to be a balance between leading educational change and the management that foresees the processes and resources that will drive it.

A restructure in timetabling meant teams met fortnightly with the principal, learning and teaching leader, and mathematics leader to analyse data, discuss professional readings and plan learning sessions together. Our learning and teaching leader and mathematics leader reviewed individual planners to support the development of one consistent planner across Prep to Year 6 that encompassed a topic planner with key ideas, vocabulary and notes from professional readings discussed each fortnight.

ASSESSMENT

Evidence was needed to build an understanding of what our students know and how to help set their next targets. We reviewed P-6 online assessment tools and discussed ways both summative and formative assessment inform our teaching when triangulated. We found success in using Essential Assessment (2019) to identify student understandings and misconceptions, as well as utilising resources to help inform our teaching.

Staff also looked at rich assessment tasks, open-ended questioning and spent time sharing the type of data and how we collect it to plan future sessions. We explored tools such as rubrics, checklists, video samples and anecdotal records. We reviewed how we set learning intentions and success criteria (Hattie, 2015) to better help students understand what they are learning and how to achieve targets. We also created a show and tell time in our planning to have teachers share tools or lesson ideas for units currently being taught which was both successful in boosting confidence and collegial efficacy.

In 2019, we trialled using data walls to visually represent how students are progressing through various mathematical content, helping to recognise students' gains throughout the year in several mathematical domains. This has come through the unpacking of Sharrat's (2019) work with clarity and how we focus on the use of data to inform instruction.

NURTURE

Leaders believed in the capability of every staff member. Teachers were positive agents of change: critiquing and evaluating how they were teaching and how they could be more effective. We supported them on their journey through building a professional learning community where each individual brought a different opinion, question or idea to the table. We encouraged teachers to see facilitated planning as a form of valuable self-driven professional learning as, often, there was a misconception that the only 'real' professional learning involved outside expertise, with the expert as the holder of knowledge.

An important part of nurturing learning is the relationships we build with our children. We celebrate our data from students and parents about the positive connections and sense of belonging students feel at our school. Therefore, each child was reminded every day they were mathematicians, that mistakes were accepted and learnt from and assessment was an opportunity for goal-setting.

It has been an exciting and fulfilling journey and our results show so far that the process has improved individual student growth, engagement levels and collective efficacy. Such a model has been so successful that we have adapted it to our literacy planning in both reading and writing. It is not to say that this model is perfect and it has certainly had some pitfalls. But essentially, the positive change generated was from increased inclusivity, trust and self-awareness which led to positive engagement and an improvement in our mathematics teaching.

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MARVELLOUS MATHS DAY

Monique Iluk and Kayne Johnson - Mernda Primary School

Mernda Primary School's *Marvellous Maths Day* at was held at the end 2019. All teachers planned for exciting maths lessons to be conducted during the day with a focus on problem solving, collaborative activities and ways to celebrate maths. Students wore dress-ups related to maths, some also participated in a parade within their year levels to show off their creative attire. There were outstanding efforts with the costumes and clearly the outfits demonstrated the effort that parents and families had contributed.

Students in each year level participated in maths challenges and activities. It was amazing to see how the staff and students had approached this in their classrooms. The day was much bigger than we had anticipated, as everyone was on board and shared our excitement in maths.

Our staff team were fully on board with the Marvellous Maths Day and their dress-ups were quite impressive!

WHAT DID WE DO?

Prep

Prep celebrated with a cohort parade and practiced counting activities in their classrooms.

Year 1

Our Year 1's held a parade in the morning where parents were invited to be part of the celebration with the students. They then completed activities in the classroom including a fraction-o-sauraus.

Year 2

The Year 2 students created and decorated a kite demonstrating number facts and completed problem solving activities including tasks like 'How many legs?'

Year 3

Year 3 students completed rotations for the morning sessions including craft activities to show symmetry and patterns with tessellations, physical activity outside which was timed, tallied and then graphed such as 'how many star jumps in 30 seconds', and finally card/dice games and brain teasers to challenge students as they worked with others to find the answers.

Year 4

Year 4 completed an amazing race around the school where multiple choice maths problems were set up by the teachers and once they found the correct answer they would collect a letter that would help them crack the code after completing all of the activities.

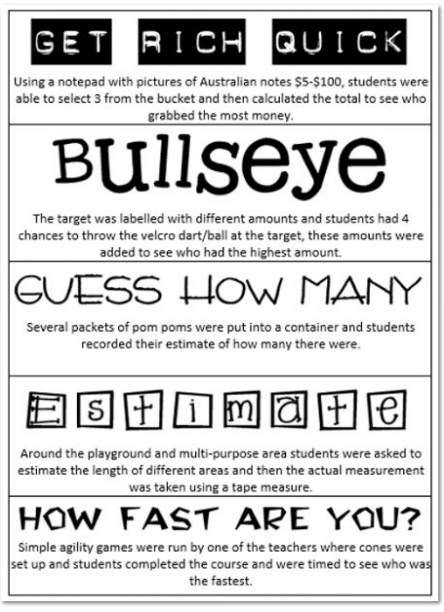
Year 5

Year 5 completed problem solving tasks in the classroom and created tessellation activities where they used their knowledge of scale, patterns and angles.

Year 6

Year 6 students rotated and completed maths games including card games, teamwork with a combination of maths skills and topics. In the classroom's teachers coordinated games such as bulls eye, chance with cards and also some worded problems.

At recess the members of the Maths AIP team ran activities for students as a competition. Some of the activities are listed on the right. Winners of the competitions received maths picture books, cards or foam dice as an award.



HISTORY OF MATHEMATICS

Terence Mills and Aimé Sacrez

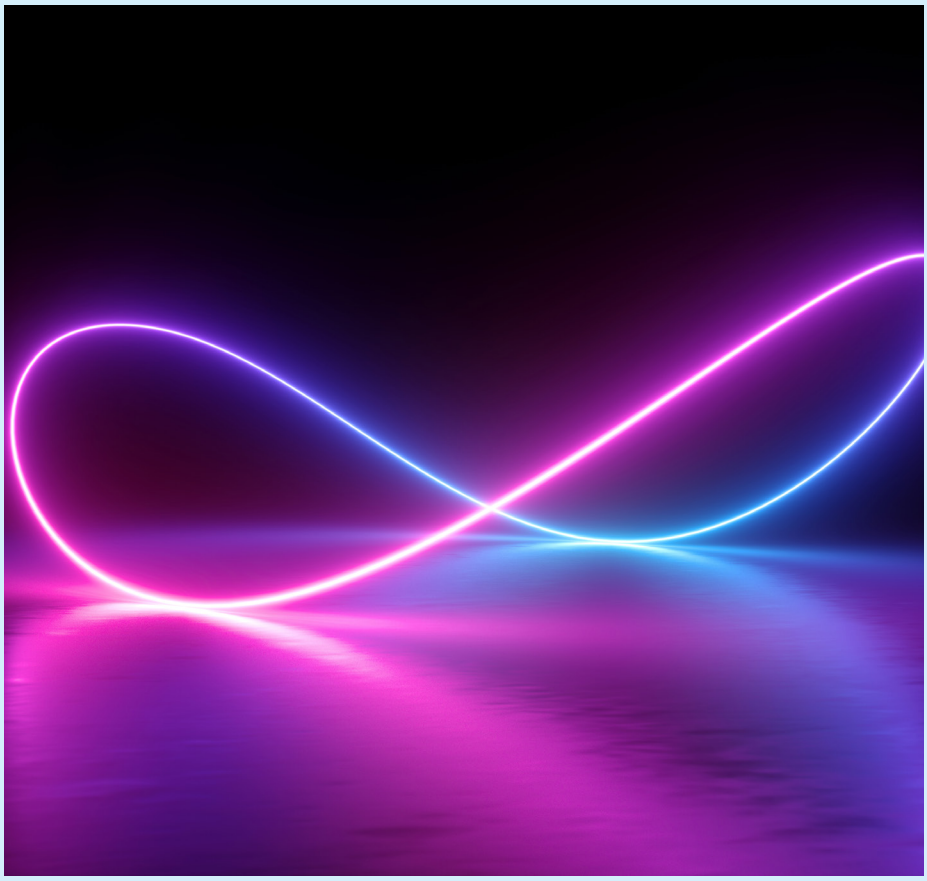
Infinity is a mysterious subject. It has been considered by scholars over the ages from many disciplines: philosophy, art, theology, science, and mathematics.

Galileo (1564–1642) noticed something curious. He observed that there seem to be as many perfect squares as there are positive integers. The first perfect square is 1, the second one is 4, the third one is 9, the fourth one is 16, and so on. Thus, we can identify 1 with 1, 2 with 4, 3 with 9, 4 with 16, and so it continues. However, each perfect square is in fact a positive integer!

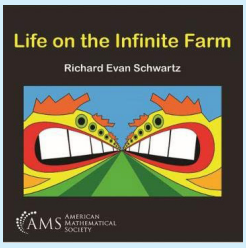
The smaller set of perfect squares seems to be the same size as the larger set of positive integers.

How can the smaller set be the same size as the larger set? Curious indeed - and tantalising.

Here we describe two very different books on infinity.



LIFE ON THE INFINITE FARM

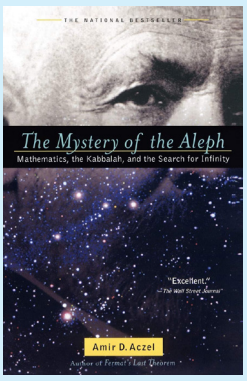


Richard Schwartz (2018) explores a number of mathematical concepts and conundrums related to infinity in his illustrated book, *Life on the Infinite Farm*. From Gracie, a cow with an infinite number of shoes for her infinite number of feet but wanting to wear new pairs of shoes, to Hammerwood, a crocodile with an infinite number of teeth needing replacements for his lost teeth, this book brings an abstract concept to life through humour and imagination. These are two qualities which are lacking in many mathematics school lessons.

Rather than attempting to simplify the complexity of infinity, Schwartz revels in artistically visualising and communicating the paradoxical situations his characters find themselves in. This book is sure to spark the curiosity of the young and the young at heart. It serves as a perfect platform for diving deeply into mathematics.

It also promotes the exploration of infinity from philosophical, theological, scientific and artistic perspectives which is well suited to the current STE(A)M focus in education. *Life on the Infinite Farm* does not provide textbook answers, rather it generates questions from the curious, which like the number of shoes on Gracie, are infinite in number.

THE MYSTERY OF THE ALEPH: MATHEMATICS, THE KABBALAH, AND THE SEARCH FOR INFINITY



It was the German mathematician Georg Cantor (1845-1918) who eventually brought some remarkable clarity to the subject of infinity. Cantor's work changed mathematics forever. The story of Cantor and his work is wonderfully described in Aczel (2000). Azcel gives us a reasonably non-technical outline of Cantor's highly technical work. Cantor's life was peppered with disappointments. Aczel reminds us that mathematics is created by human beings whose lives may not be all plain sailing, no matter how brilliant they are.

Both books would be excellent additions to a school library.

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MATHEMATICAL MASTERCHEF

Maria Harkins - Year 6 teacher, St Paul's Anglican Grammar School

Some years ago I was fortunate enough to work with Ian Whitehead as a maths specialist at St Paul's Anglican Grammar School. He presented a series of tasks to the students relating to gathering data. As a result of the data gathering, we decided to create a Masterchef task just as a wrap up to the activities.

BLIND TASTE TEST: PEACHES

The students were given several different plates of canned peaches. They needed to taste these without knowing which brands they were.

Students gathered data on agreed topics such as taste, colour, texture, smell, and overall appeal.

They then were required to rank the peaches in order from the most expensive to the least. The students were given the names of the brands and they needed to decide which was which.

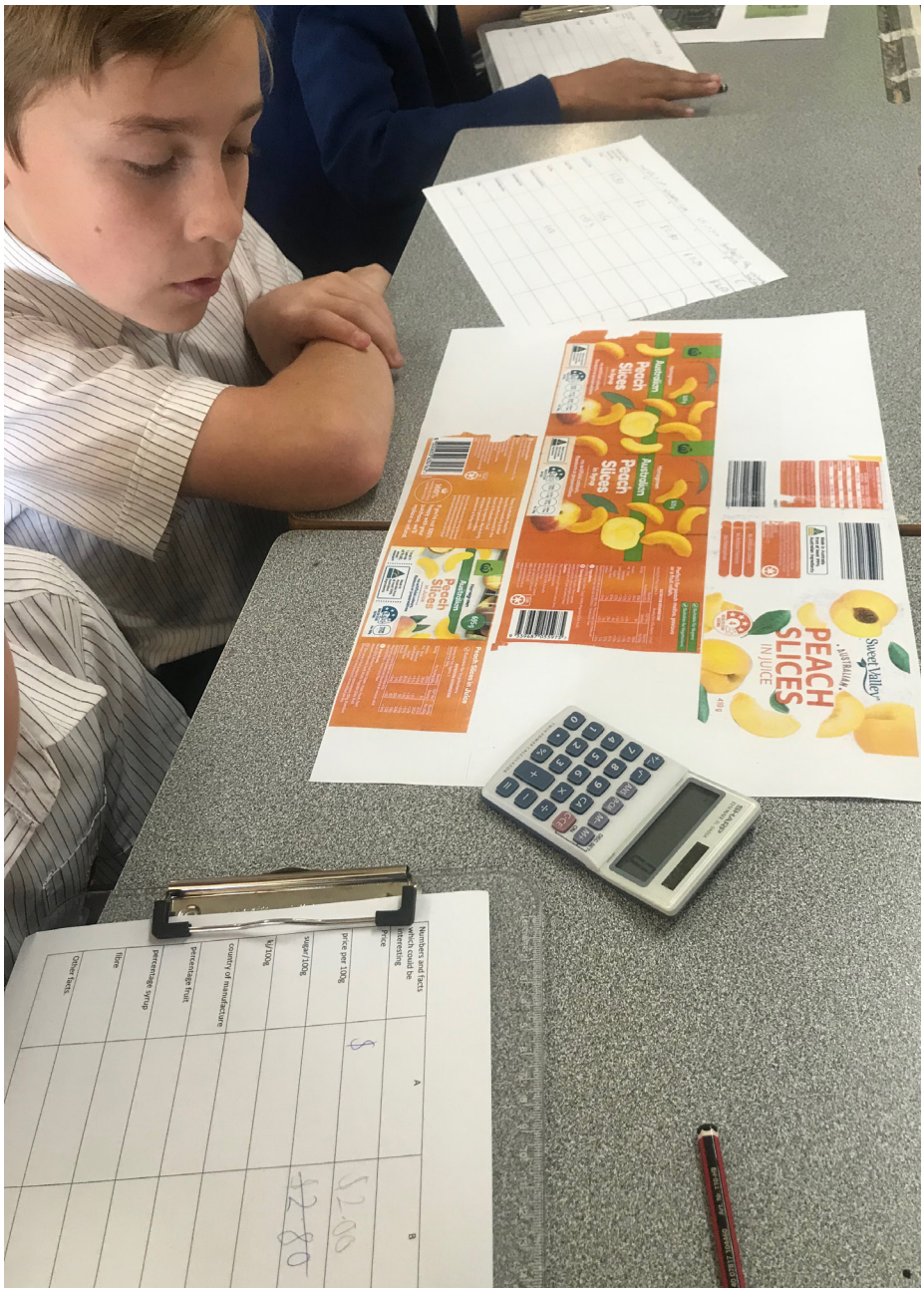
Students were given the labels from the different brands and were challenged with seeking details from the label. Where had the fruit come from? Where had the juice come from? How much sugar was in the mix? Were there any preservatives, was it packaged in Australia? A variety of discussions were had regarding proportion of peaches to juice – was the weight in the can predominantly juice or peaches?

A few lessons later, the cans were used as a prop for learning about circumference, understanding Pi and just for interest.

JELLY

Our next step was to do the same type of process with jelly. The format was the same and the students tasted a variety of jelly considering similar questions on stability, colour, texture, flavour, visual appeal and so on.

The students were given the jelly boxes and research began into the ingredients. Discovering that jelly had gelatin in it (meaning non vegetarian) was a blow to many kids. Realising that some of the additives are not allowed in some countries resulted in much discussion and some further investigations.



Peach reseach was rich with mathematical investigations.

The students were stunned to realise that a sea mould could be the colouring for a green jelly. Much data was collected, much awareness was taken away, and many students were even more interested in reading the labels of their foods.

CHOCOLATE

The final step in the research phase was possibly the most exciting – blind tasting of chocolate. There were a variety to select from including white, milk, dark, very dark. The task was to evaluate the taste, texture, appearance and so on.

Students had discussions regarding the labels and the details about percentage of fat and cocoa. The discovery that some chocolate was more confection than chocolate was quite alarming to some, and the realisation that white chocolate probably isn't chocolate at all, was really interesting.

As a follow on from this data collecting, we were able to discuss Fair Trade and the impact on less fortunate communities and the way the cocoa industry functions.

Each one of these sessions took about 1 – 1.5 hours for a rich discussion around the

maths. The other discussions then occurred in humanities or science as a follow up.

THE CHALLENGE

Children were given the option creating a dessert made from the three ingredients. They were able to work in pairs or groups but the creation had to be predominantly just three ingredients. Students did trial runs in their homes, at school they had to organise their ingredients, manage their time and resources to serve their creation to the judges.

Amazing is the only word I can use to describe the desserts. The variety of creations that come to the tasting table was incredible. I know that you are probably thinking that their parents had a hand in making them – think again, this was all done by our students. Given an open ended challenge, children will create far more than you would have expected. When we restrict them, they must work to a lower standard to just fit within the box.

The prizes were very modest, the winners received a wooden cooking spoon and a spray painted paper plate. I found a silver tray at the op-shop and we engraved the names of the winners on the tray. All of this was a little bit of silliness, but the kids absolutely loved it. Every year, the students in the Year 5 group come to watch the judging process and are inspired to begin thinking about what they could potentially do when it's their turn to participate.

When the word maths is mentioned, some students roll their eyes - but never during mathematical Masterchef!

Jelly data collecting and taste testing (above). The dessert masterpieces (below).

PLANNING A STEM WEEK

Cathy Devlyn - Fintona Girls' School

Fintona Girls' School sucessfully conducted its third biannual STEM week extravaganza and it is time to reflect and evaluate the purpose and outcome of investing in such activities.

Scheduling a STEM week gives the opportunity for teachers to share their love of mathematics and science and to delve into areas of the subjects that capture interest and inspire. Education in STEM is also the key to broadening and deepening the community's grasp of the complex challenges facing society. For schools, along with content, we need curricula that encourage curiosity, reflection, critical thinking and develop scientific method. STEM is about promoting an awareness of science and maths related careers and career opportunities and ensuring the development of relevant skills necessary to participate in STEM careers of the future.

Running a successful STEM week involves lots of behind the scenes planning but with a few key systems in place there can be great outcomes for students and teachers alike.

Here is a five step framework to assist in setting up your own STEM week at school.

DECIDE ON A THEME

2019 marked the celebration of man walking on the moon so it was fitting to incorporate an acknowledgement of such a stellar occasion into STEM week. Having a theme helps give direction and purpose and, with an internationally relevant topic of the lunar landing anniversary, it was great to have an astrophysicist come and talk about space, the universe and the importance of mathematics in his world. The students were enchanted and expressed determination to continue with higher-level mathematics in the hope of one day working on a NASA mission.

Our new STEM building is under construction and sees fractals emerging from the surface of the façade. Continuing with this notion of fractals and recursive patterns, we treated our Year 7's to some sessions enjoying the ancient art of Kirigami. This was an inexpensive exercise requiring only some skilled teachers, precise cutting and plenty of paper.

Sustainability and environment conservation are issues that evoke passion in our young generation. So often we absorb ourselves in the big issues relating to the environment, however it is our smaller creatures that are in dire need of our attention and an awareness of the vital role they play in the future of our planet is crucial. The wider Fintona community learnt about the importance of preserving a healthy habitat for bees. We enlisted a local apiarist to run a session highlighting the struggle bees are facing and what we can do to ensure their continued survival. As part of the session the participants also made their own environmentally friendly wax paper cling-wrap substitutes.

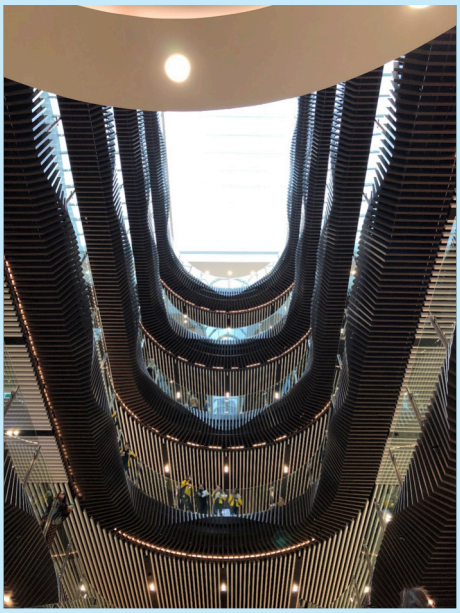
GLEAN IDEAS FROM EVERYWHERE

The internet is full of inspiring people doing inspiring things and many ideas can be readily adapted for the classroom. We used a YouTube clip by the Mathologer (Burkhard Polster) and turned it into a maths craft exercise where our students stitched the times table. The patterns that emerged kept them intrigued and wanting to complete more. Can you see the cardioid and nephtoid? (see www.youtube.com/watch?v=qhbuKbxJsk8 for inspiration).

Data visualisation puts a fresh slant on statistics and we took inspiration from a TED talk by Jer Thorpe (www.ted.com/talks/jer_thorp_make_data_more_human/discussion) to complete a class activity on homework habits (looking at work/life balance) and holiday destinations. We collected data from the class on the time spent on different activities over a three day period. This data was then presented on painted chopsticks to form a piece of maths art. Circles were also produced to represent the relative times on the activities - it was concerning that there were some very large circles for passive activities!

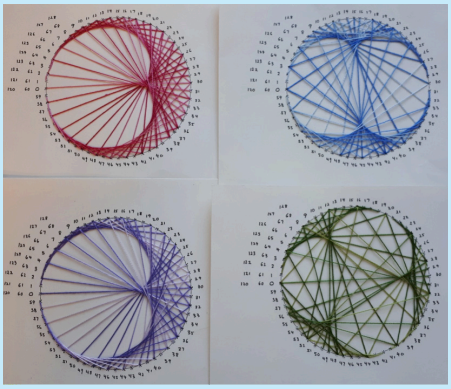
SOURCE INSPIRING GUEST SPEAKERS

The generosity of others is admirable and we are always thrilled when academics and other experts are willing to give their time and share their knowledge. Researchers and those working in STEM related industries are great presenters for assemblies and



Fintona students explored the mathematical wonders of Myer Emporium.

This Year 7 student is proud of her kirigami fractal.



Stitching the times table uncovered some hidden patterns.

assist in setting a focus for the week; utilising alumni and the parent community also provides for ongoing relationships.

Fintona has hosted leading Australian scientists and mathematicians at our school assemblies during STEM week over the past few years, including presentations from Drs Andy Casey, Graham Mitchell and Roslyn Hickson together with Associate Professor James McCaw. Their presentations have stimulated interest and enthusiasm in their varied and unique fields.

Dr Graham Mitchell, a veterinary science graduate and gold medallist from the University of Sydney, spoke of the importance of science in an ever changing world. His discoveries, while at The Walter and Eliza Hall Institute, were fundamental in the global development of tools to control parasitic diseases. As well as holding many varied roles including Director of the Royal Melbourne Zoological gardens, he is an advisor to the government on innovation and technology.

The ability to interpret and analyse large sets of data and model and predict future trends in such areas as the spread of disease is a rapidly expanding field of science, known as bioinformatics. Our senior students were stirred by the presentation given by Dr Roslyn Hickson where she presented a summary of her work in modelling the spread of malaria and how it serves to inform government policy and drive medical research.

Associate Professor James McCaw uses mathematics and science to build models that simulate the transmission of diseases such as influenza. His work through the Department of Mathematics and Statistics and the Centre for Epidemiology and Biostatistics at the University of Melbourne enables the development of new strategies for controlling the spread of transmissible diseases. James' work on the mathematical modelling of infectious diseases is of great importance to many other public health practitioners.

At Fintona, we challenge our students push the boundaries beyond the classroom and to look skyward. Dr Andy Casey, an astrophysicist, spoke at assembly about his mathematical journey so far.

He gave insight into his research, which looks at what the chemical abundances of stars can tell us about the development and evolution of galaxies. His message was to be open to learning new things and most importantly, be comfortable with making mistakes, as it is from making mistakes that great learning follows.

The presentations serve to break down many of the stereotypes of what scientists and mathematicians do. The speakers focussed on actual examples, exposing what working in fields of the science and maths mean and how they are relevant to society.

TAKE STUDENTS OUT OF THEIR USUAL COMFORT ZONE AND USE IT AS A CHANCE TO LINK CURRICULUM WITH THE OUTSIDE WORLD

Teamwork, collaboration and communication are competencies that sit alongside the skills of mathematics and science as essential attributes for future STEM thinkers. Our Year 5 and 6's , assisted by Year 9 students, were challenged by a school based mathematics trail. The trail designed, by the Year 9 students, saw the junior girls racing around the campus uncovering mathematical puzzles using iPad QR technology. It was wonderful to see students sharing ideas and solution processes, and hearing of the great mathematical discoveries that were unveiled.

Our Year 8 students, with their mathematical eyes wide open, ventured into Melbourne CBD to examine the geometry of the architecture along Swanston St and surrounds. With a mini lesson at each site on the historical and mathematical significance of the buildings, the girls developed a new appreciation for the shape and form of the facades. This activity laid a solid platform for the mathematics curriculum work on geometry and tessellations.

BE PREPARED TO GET YOUR HANDS DIRTY

Setting up a STEM week is also about setting up open communication. Plan early, share ideas with your colleagues, work alongside as a team and do not be afraid to question and challenge each other.

Rich professional dialogue is fostered and passions are ignited when ideas are presented, dissected and refined; hidden talents are also uncovered. I was unaware I was so skilled with the glue gun until I was faced with the task of assembling of a 3D tetrahedron sierpinski triangle!

The message from our STEM weeks is clear: a broad, comprehensive education in mathematics, science and technology is key to being future-ready. Teaching maths and science is much more than the cramming in a busy curriculum, worrying about NAPLAN and VCE results and debating the tensions between skills-driven courses versus open-ended investigative learning.

It's about ensuring we fuel and promote the right passion in our teachers; that our teachers are knowledgeable and energised to educate and invigorate the STEM learners of tomorrow.

HEADSTART FOR VCAL

Jason Austin - Headstart learning leader, Brimbank Melton cluster

As a teacher who has worked in the VET/VCAL space for the last 15 years, I have witnessed many changes and developments. From a VCAL Certificate perspective, I have had an eye on the VCAL Numeracy Intermediate Level Unit 2 initiative for quite some time. Having an industry focus is very valuable to a student who has chosen a VET subject and is looking at moving into this area as a career. So it makes great sense to enable students to develop relevant numeracy skills in an industry-based project.

The state wide Headstart program is a pathway option for students who want to start their apprenticeship part-time while completing their senior certificate at school. This is a win for families who would like their child to complete a Year 12 VCAL or VCE Certificate and also move into full-time employment after school has finished. This program requires flexibility from both employers and schools to negotiate a timetable that benefits both parties. To further assist students in post-school pathways, I have consulted with stakeholders and discovered that schools need of support with this new unit, the support assists students who are in and out of school more than your everyday student.

INTERMEDIATE UNIT 2

Upon my first read through the project template, I mapped out a generic curriculum that incorporated the requirements of the unit. My focus was on giving students an introduction to the unit's content - not by giving them the choice via the grid initially, but by giving them a framework developed from the grid to show them the skills required to complete an industry-based project.

The initial concept was developed around making a pizza. Every student has eaten a pizza, some may have made them, but I was looking for common ground to introduce the numerical concepts. With the opportunity to make a pizza or combine pizza making on a larger scale it could be incorporated into a personal development project.

Inputs, processes and outputs when it comes to numeracy is a foreign concept for some students, so I needed to layout the curriculum to break this down with a familiar item such as a pizza. Throughout the trial of the project, students developed the skills to identify the parts of a pizza, estimating amounts and costings, the costs of ingredients from various suppliers then working with scales, ratios, tables and conversions that you would use in the hospitality industry.

Students were encouraged to visit a local business with a planned question sheet to gather the required data for making a pizza. Together with this collected data, students researched industry statistics to find trends in the pizza business, such as the most popular pizzas, the most popular pizza companies and where people purchase their pizzas.

Students then made pizzas at school. In one trial school students linked into their local community garden. Together with the members they made, cooked and ate from the outdoor pizza oven. All evidence was collated and the data presented using their choice of software and through class discussion. The students in the trial also completed a self and peer evaluation using graphic organisers.

After completing the pizza project, students are equipped with the basic skills to move into their industry specific numeracy project.

Following the same thread as the pizza activity we can now investigate, through the VCAL Learning Outcomes, how this may be applied to a hands-on training task that could be carried out by a VET Building and Construction student.

LEARNING OUTCOME 1: DESIGN A NUMERACY-BASED PROJECT PLAN IN A FAMILIAR INDUSTRY AREA

Students investigated how to cost out a lap and cap fence for an average suburban block.

Inputs for this project include:

- **Number:** identifying the exact amounts of raw materials to complete the fence.
- **Measurement:** perimeter of block, linear meter quantities, post quantities and size.

Making pizza at school.

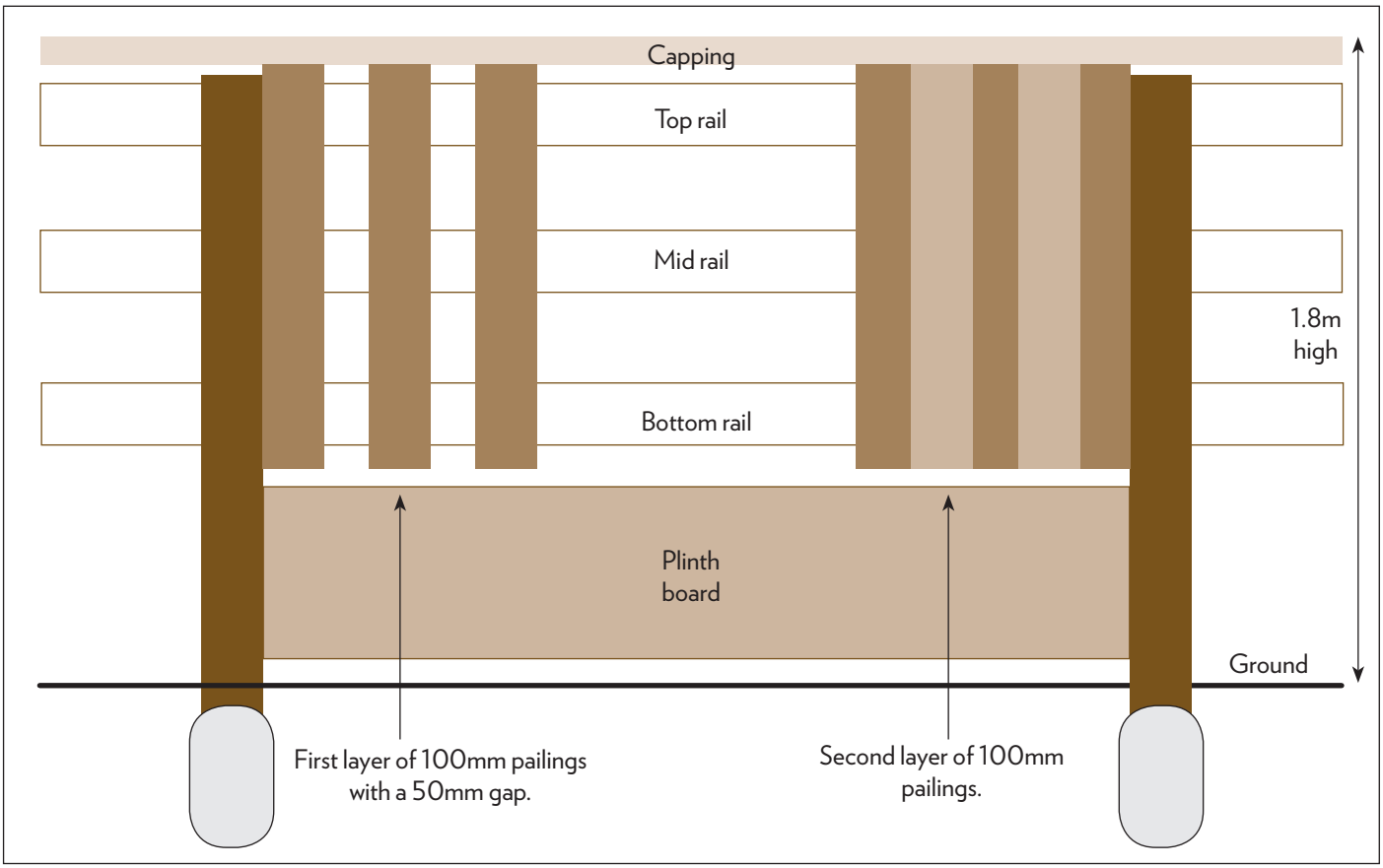
- **Financial:** estimating and costing of all materials, labour and hire.
- **Probability and statistics:** comparing trends in input costs and material supply. For example: timber availability, sustainable practices and species growth rates and farming.

Processes for this project include:

- **Number:** set out onsite, labour, comparing estimations with quotes.
- **Measurement:** calculating perimeter, linear meters, mm, calculate cubic meters.
- **Financial:** phone three fencing contractors and find out cost per hour or cost per linear metre.
- **Probability:** Costs of old fence removal, review of cost per linear metre over the past three years, cost increase of raw materials.

Outputs for this project include:

- **Number:** compare your quote to a local fencing contractor, calculate and find out supplier costs from more than one supplier.
- **Measurement:** calculate total quantities of materials for your job, total linear metre of quoted job.
- **Financial:** calculate all final costs to confirm that the job was profitable, rates of hire, labour and profit margins.
- **Probability:** go to job outlook and identify and compare key stats relating to fencers.



This diagram of a lap and capped timber fence shows the first layer on the left and then the lapped palings in place on the right.

- Wages, employment trends, average age, main industries, education level.

LEARNING OUTCOME 2: APPLY NUMERICAL SKILLS IN AN INDUSTRY CONTEXT

For this learning outcome, students carry out their project collecting relevant data related to the fencing project. Along the way students record any deviations from the original plan. For example, in regard to problem-solving strategies, variations in soil type may require deeper foundations and so cement costings will be increased as a result.

Once the data has been collected for the six selected tasks, students are required to analyse them using one or two methodologies. For example, one could tabulate and graph the data relating to the exploration of lineal meters of fencing costs offered by a number of fencing companies. In this regard, students could look at the spread of the data and calculate average costs. Students could then compare their costings and comment upon factors such as labor costs and overhead expenses affecting fencing companies.

LEARNING OUTCOME 3: USE APPROPRIATE SOFTWARE TOOLS AND DEVICES TO REPRESENT DATA

Students are encouraged to use software programs that they are comfortable with. The elements for this outcome explore why students have selected out particular software and ask them to justify their choices. For example, students could use Excel because they can tabulate their data and then manipulate it to produce a graph that they feel best represents their findings.

LEARNING OUTCOME 4: COMMUNICATE THE RESULTS OF THE PROJECT

One of the most difficult tasks required of students is to present to an audience. An audience may simply be the teacher if this helps reduce the anxiety around talking infront of a large amount of people.

Feedback to the student can take many forms, including a self, peer or teacher evaluation.

I hope I have given you some ideas for presenting the VCAL Numeracy Intermediate Unit 2 and encouraged you to offer the unit, if you aren't already.

Remember that Unit 2 is meant to build upon concepts delivered by Unit 1. In this way, Unit 2 is not a compulsory unit for students and offers a general VCAL credit.

Still, VCAL Numeracy Intermediate Unit 1 remains the unit to be presented at VCAL Quality Assurance and offers a credit at the intermediate award level. As well, once students have achieved competency for VCAL Numeracy Intermediate Unit 1 they can use it to fulfil their numeracy components for all three VCAL Certificates.

PUZZLES

Michael Nelson - Learning specialist, Drysdale Primary School

LOWER PRIMARY

A sphere has three, a circle has two and a point has zero. What is it?

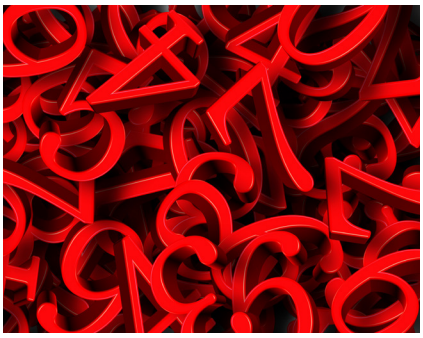
Describe and draw two-dimensional shapes, with and without digital technologies (VCMMG120)
Describe the features of three-dimensional objects (VCMMG121)

MIDDLE PRIMARY

Find four of the same coin that when you halve them they equal 100.

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

UPPER PRIMARY



I add five to nine, and get two.
The answer is correct, but how?

Measure, calculate and compare elapsed time (VCMMG227)

A new school has 100 rooms.
The principal has to put the numbers on each of the rooms. How many times will the principal write the number 9?

Describe patterns with numbers and identify missing elements (VCMNA112)

To stop postal letters, Steve Smith is going to place four different house numbers: 27, 42, 91 and 83 – on the front fence. One number is correct. The others are out by 49, 15 and 41.
What is Steve's house number?

Apply place value to partition, rearrange and regroup numbers to at least 10 000 to assist calculations and solve problems (VCMNA131))

On a small island, half of ten is six. If this same proportion holds true, then what is one sixth of 30 on this island?

Find a simple fraction of a quantity where the result is a whole number, with and without digital technologies (VCMNA213)

Images from Pixabay, (left to right): _Alicja_, Tony_Media, TheDigitalArtist, Shannon Anderson, Karen Arnold, EliasSch

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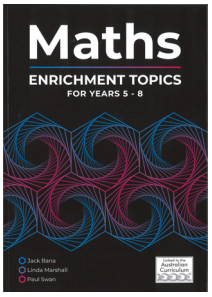
ALL STUDIES	$127.50 (MEMBER) $159.50 (NON-MEMBER)



MATHS ENRICHMENT TOPICS FOR YEARS 5-8

5–8

Suitable for both teachers and parents, the content of this book is linked to the Australian Curriculum in Mathematics, and designed for students to pursue very interesting maths topics that are often missed in standard classroom lessons. There are 17 topics with worksheets, the topics span a wide range of interests and difficulty levels. The topics are ideal for extension work and motivation.

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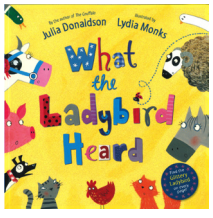

WHAT THE LADYBIRD HEARD

F–6

'Oink!' said the cats ...With all the mooing and hissing and baaaing and clucking, the farmyard is full of noise. But when Hefty Hugh and Lanky Len hatch a plot to steal the fine prize cow, it's the quietest animal of all who saves the day! Spot the glittery ladybird on every page of this wonderful rhyming tale.

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PLEASE NOTE: this resource is only available to current practising Victorian secondary teachers. The product is for school use only. It is not to be used by private tutoring services.

INDIVIDUAL STUDY	$54.50 (MEMBER) $68.10 (NON MEMBER)
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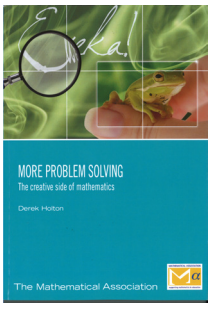

MORE PROBLEM SOLVING: THE CREATIVE SIDE OF MATHEMATICS

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 and 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.

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