THE MATHEMATICAL ASSOCIATION OF VICTORIA

THE COMMON DENOMINATOR 2/15

AN AMAZING RACE

Students are totally absorbed in Lumen Christi's mathematics challenge: The Amazing Race.

INSIDE

As children darted from stage to stage eagerly chatting about strategies, encouraging and praising each other's mathematical efforts it was clear that this of all school days was one that would be remembered. A day from which we could establish interest and engagement, a day from which we could raise both the profile of mathematics in our school community and in the minds of the students that we teach. What had started as an ambition to host a competition had quickly permeated through the school and taken on a life of its own. Indeed, from little ideas big things grow or in this case from MAV Games Days whole school engagement grows.

In early September 2014, our school, Lumen Christi Catholic Primary School, was fortunate enough to host a Year 6 MAV Games Day. The day was a great success and really helped students apply their knowledge of mathematics in a supportive team environment, where the focus was less about getting the 'right' answer but more about enjoying everything that maths has to offer.

Continued on page 4

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

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The Mathematical Association of Victoria, 61 Blyth Street
Brunswick VIC 3056

ABN: 34 004 892 755
Tel: 03 9380 2399
Fax: 03 9389 0399

office@mav.vic.edu.au
www.mav.vic.edu.au

Office hours:
8.30am – 5pm
Monday to Friday

President: Marj Horne
CEO: Simon Pryor FSAE FAIM

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FROM THE PRESIDENT

Associate Professor Marj Horne - Faculty of Education,
Australian Catholic University

SOAK UP MATHS DURING THE SUMMER

Applications for the 2016 National Mathematics Summer School are now open.

Being awarded a place at this summer school gives students who love mathematics an opportunity to have fun together as they discuss and explore mathematics from some very different perspectives. Give your students who love mathematics a chance to apply. There is generally a limit of two applicants from each school selected, this gives more chance for a variety of schools to be involved. Students from all over Australia who are in Year 11 in 2015 apply. It is a two-week program held at the Australian National University in Canberra from 3-16 January 2016. Many enduring friendships are made on this very special summer school, now in its 48th year, and each year a few past students return to help run the program.

There is a strong emphasis on solving problems and many students often find themselves working on problems well into the night (because they want to)! There is also a strong emphasis on recreation, exploration and fun and many activities, tours and talks are organised. During afternoon recreation, students are free to socialise and explore Canberra (popular activities include ice skating, ten pin bowling, tandem bike riding around the lake). There is an entertaining dinner and concert on the last night.

Selection is based on the strength of a student's written application, a teacher reference, and the creativity and perseverance you show on a problem solving test. The NMSS contribution is $1200 and an additional travel surcharge (amount to be advised) applies if students/parents want NMSS to organise return travel from Melbourne airport. The closing date for applications is 24 July, 2015 and the 90-minute selection MAV Test for NMSS will be held on 7 August, 2015 at the applicant's school.

Application form can be downloaded at www.mav.vic.edu.au/activities/student-activities/national-mathematics-summer-school.html.

REVISED VCE MATHEMATICS STUDY IMPLEMENTATION SUPPORT WORKSHOPS

The revised VCE Mathematics study design is now available for implementation from 2016 and can be downloaded from www.vcaa.vic.edu.au/ Pages/vce/studies/futuresd.aspx.

The Victorian Curriculum and Assessment Authority (VCAA) in conjunction with the Mathematical Association of Victoria (MAV) have organised a series of Professional Learning workshops during May and June 2015 to support teachers in preparation for implementation of the revised VCE Mathematics study design 2016 – 2018. Participants are encouraged to take the revised mathematics study design and any draft course plans to the workshops. Workshops will be provided for each of the following studies:

Mathematical Methods: Units 1 - 4

Specialist Mathematics: Units 1 - 4

Further Mathematics: Units 3 & 4
General Mathematics: Units 1 & 2
Foundation Mathematics: Units 1 & 2

Participants can attend one or more of these workshops as applicable.

WORKSHOP DATES AND VENUES

The majority of venues have Polycom access, hence allowing participants to attend at a live venue or participate via video conferencing. A main school will host the presenter and other schools can video conference via Polycom into the main school feed.

ALL SESSIONS ARE FREE

To find dates and venues refer to the flyer inserted in this edition of *Common Denominator*. To register, visit http://registration.mav.vic.edu.au/reg/. For more information contact Helen Haralambous, 9380 2399 or email hharalambous@mav.vic.edu.au

MATHEMATICALLY ACTIVE

Is your school doing amazing things in the area of mathematics education? Applications are now open for MAV's Mathematics Active Schools program.

Visit www.mav.vic.edu.au/maths-active-school-accreditation.html to get more information about the program and details on how to apply.

MATHEMATICS ACTIVE SCHOOLS

- Baden Powell College
- Killara Primary School
- Penleigh and Essendon Grammar School (Primary)
- Richmond West Primary School
- Sunshine College
- John Monash Science School
- Milgate Primary School
- Mount View Primary School
- Sacre Coeur
- Serpell Primary School
- Stonnington Primary School
- St Thomas Moore Primary School

MAV Councillor, Max Stephens presents Serpell Primary School with their Mathematics Active Schools Accreditation.

MATHS ON ABC SPLASH

MAV has produced several units for maths on ABC Splash. Check them out.

EXPONENTIAL GROWTH

Exponential growth and doubling time utilises video and spreadsheets for background and investigations to help student understand this difficult but important function.

http://splash.abc.net.au/media/-/m/1150634/exponential-growth-and-doubling-time

THE STORY OF MATHS (EXCERPTS)

http://splash.abc.net.au/search?keyword=keyword:Marcus%20du%20Sautoy

FASCINATING PRIME NUMBERS

http://splash.abc.net.au/res/teacher_res/25-Fascinating-prime-numbers.html

CHOOSE YOUR OWN STATISTIC

http://splash.abc.net.au/media/-/m/1520313/statistics-game

SLOT CAR CHALLENGE

Slot car challenge provides an onscreen slot car game with several types of cars (varying power and mass) and several tracks (varying levels of difficulty). Students improve performance by interpreting graphs of velocity against distance or time.

The effect of added mass or power on the ability to round a corner is studied to (almost) simulate real driving.

AN AMAZING RACE

Cassandra Lowry and Marguerite McGrath - Lumen Christi Catholic Primary School

Students absorbed in a puzzle activity.

Preparations for this day had seen the school host an 'in house' Year 5 Maths Games day earlier in the year. Following a similar format to the MAV Games Day, where teams of four students participate in a series of challenges, this event had the added incentive of involving three adult teams (two teacher and one parent team). The additional challenge of facing the adults not only helped to ensure the success of the day, but really created a buzz around mathematics in the school community.

Even after the buzz of the day had subsided, the teachers in other year levels were still talking about hosting their own special maths day. It was seen as a valuable exercise, one that would raise the profile of mathematics among the students and a way of making mathematics more accessible to parents. However, while other levels wanted to 'have a go' the challenge was evident, in what format could we achieve maximum mathematical engagement as well as strong parental involvement and make use of the whole school? The answer came not from a lofty tomb about mathematics education but rather from the hit TV show *The Amazing Race*. Could we host a Maths Amazing Race? A race in which teams worked together to solve a series of challenges? The answer came loud and clear 'of course we can!'.

The Amazing Race was an easy sell but coordinators were conscious of building towards the MAV Games Day too and so both were adapted for the special maths day. Mixed ability teams of four were established and the day divided into three rounds. The teams were chosen by teachers to ensure that teams were as fair as possible and had a range of mathematical abilities. Maths buddies were already established in the classrooms and discussions were had as to how teams could work together to achieve success.

Round one was similar to the MAV day and involved teams of students working together to solve a series of multiple choice questions (adapted from the format used in NAPLAN tests). Round two was the Amazing Race and round three was the final team challenge. (See page 6 for more detail).

While the format of rounds one and three were familiar and relatively easy to set up, the middle round the Amazing Race took a little more planning.

The fifteen mathematics stations were set up across the school. Each of these stations required students to complete a task from a different area of mathematics. Stations included measuring distance, comparing capacity, matching facts, following directions, ordering numbers, creating shapes and continuing patterns. Like the show, each station involved a choice of two similar challenges. For example at the comparing capacity station (set in the school sand pit) students had the option of finding and ordering the capacity of five different containers or calculating the number of cups a much larger container would hold. After choosing and completing one of the tasks, students were rewarded with a yellow letter that would include a clue to the location of the team's next challenge.

Parent helpers, student leaders and a few teachers helped to supervise each of the 15 stations. Clear instructions and solutions were provided at each station, which allowed station supervisors to encourage, rather than needing to constantly check the accuracy of student responses. The emphasis was on trying to problem solve as team rather than being right or wrong.

To assist students to complete each challenge efficiently the option of using a clue card was incorporated into the Amazing Race. These blue clue cards (adapted from the television series, *Blue's Clues*) could be used by teams at each station in order to provide them with either additional information or equipment to help them complete their chosen challenge. For example, at a station which required students to order the mass of five unlabelled tins, the clue card gave students the option of using a measuring balance.

Teams began the race at different stations and teams were given an hour to make their way through as many stations as possible in order to accumulate points for their team. Staff members walked the course taking photos and giving out extra clue cards to any teams who were demonstrating effective teamwork, following school rules or were simply in need of some assistance.

AN AMAZING RACE

All our stations!

With the stations in place, parent and student helpers organised and a bucket full of enthusiasm the day began.

Round one, which was held in classrooms, began in earnest with teams working through the questions carefully and enthusiastically. It was a sight to behold as the more capable students read questions aloud and the other students, many of whom find mathematics challenging, answered and discussed options, justifying their thinking to each other along the way. This method of working was not instructed to them. The children established this routine themselves and it was with an enormous sense of pride that the classroom teachers looked on. Following the scoring, all students were praised and encouraged for team work and given quick positive feedback about being 'Good Mathematicians'.

The excitement was palpable as the students gathered in the shared learning space for round two. Armed with a yellow piece of paper for all, the coordinating teacher handed out the first clue to each group.

Clutching their clue, a map and brimming with excitement the students took off to various points in the school to begin their activities. Roving around it was evident that the students were enjoying the tasks. Automatically they were applying past knowledge to new situations, making connections and working interdependently. There were very few occasions in which children had to be reorientated to a task and in fact there was a general reluctance to ask for a clue card or help. They were, in short, determined to succeed.

From station to station the students discussed what mathematics they had used or how they would have done something differently. The parent helpers were impressed and found themselves learning quite a bit. One parent remarked that if she had learned mathematics in that way during school herself that she may have been more confident today - a resounding parent endorsement if ever there was one! As the announcement was made to return to the shared area after the hour there were shouts of joy at completing the challenges and groans of disappointment that it was over.

After lunch the children assembled again for round three. This was adapted for each year level. The Year 3's looked at establishing a series of numbers in a set while the Year 2's built a boat to specific dimensions that could hold weight. The final hour of any day can be a challenge but engagement remained high and the children persisted well through the tasks. A brain break and run allowed for the helpers to finalise the scores and the prizes given out.

There were prizes for the team that had achieved the highest overall score, the team that worked most effectively together, the best mathematician and the most supportive team member. However, all teams were praised and encouraged for their efforts.

Speaking with students afterwards many commented on how much fun the day was but an equal number said that maths was now one of their favourite subjects and that they had learned so much. Most of the students went home and told their parents and the photos were shared through the class blogs and newsletter.

AN AMAZING RACE

It was wonderful to see team work amongst the students.

This sparked more interest among parents and soon class teachers and co-ordinators were being approached to explain more. The mathematics buzz that had been so evident after the MAV Games Day had returned once more.

Of course lessons were learned throughout the day not only by the students participating but also by the teachers and co-ordinators. Some tasks will need to be revised for complexity or simplicity and of course a new cohort of students brings with it different challenges. However, the framework is there and the goal of raising the profile of mathematics among parents and students was definitely achieved. This is particularly evident since we have returned to school this year, with teachers on yard duty being approached with questions like 'When is the Amazing Race on?', 'Can I be a leader that helps out?' and comments like 'I loved that maths day last year, it was one of my favourite days'.

In all ways I think we can conclude that this maths race was indeed amazing.

THE BREAKDOWN OF ROUNDS

Round 1 Question time	Round 2 The amazing race	Round 3 The final team challenge
Similar to the MAV day, teams of students worked together to solve a series of multiple choice questions (adapted from the format used in NAPLAN tests). After completing each page of questions (3 questions per page; 10 pages in total) one student from the team would take their solutions to the judging table. The judge would mark the given solutions and if any errors were made return the page to the student so their team could have a second chance. Points were awarded to each team, with additional points given if the team was able to select the correct answer on their first attempt. Clue cards were given to each team depending on the number of points scored.	Each team started at a different station. Our school had 28 teams so two teams started at the majority of stations. Teams were encouraged to use their clue cards if they ever ran into difficulty and additional clue cards were provided to teams (by supervisors who demonstrated supportive teamwork.)	Modified to best suit the particular year level, this challenge involved teams of students working together to complete a specific challenge. The Year 2 final challenge involved students constructing a boat which not only met the given dimensions, but was also able to hold weight. Students were able to use their remaining clue cards to trade for additional items to better support their boat design, such as corks and small plastic containers.

PATTERN AND STRUCTURE

Pattern and Structure Assessment (PASA)

An assessment program for early mathematics (F–2)

Australian Council *for* Educational Research

Patterns and their structures underpin all mathematical ideas. A pattern is some regularity observed in a mathematical context and the description of this regularity is its structure.

Pattern and Structure Assessment (PASA) is an innovative way of investigating young children's understanding of mathematics. A new assessment tool from the Australian Council for Educational Research, PASA seeks to find out how children think about mathematical ideas underlying tasks; a revolutionary approach that assesses fundamental aspects of mathematical understanding, not specific skills. By knowing how children approach tasks, teachers can plan and scaffold individual learning experiences.

As an interview-based individual assessment, PASA can provide deeper insight into a child's mathematical understanding than a group test. It consists of three one-on-one assessments designed for children in the first three years of formal schooling (Foundation to Year 2). Each assessment consists of approximately 15 high-engagement, play-like child tasks; teachers use the guidelines in the assessment to evaluate and categorise children's responses to each task.

PASA results have been equated to the same scale as PAT Maths, ACER's popular mathematics assessment, allowing teachers to compare how young children are thinking mathematically with the skills they are developing. The scale also allows teachers to compare children's results regardless of year level and to track individual progress over time.

PASA was devised by Joanne Mulligan and Michael Mitchelmore, two mathematics and teaching experts at Macquarie University's School of Education, and further developed in collaboration with ACER Senior Research Fellow Andrew Stephanou. It was conceived and developed by Joanne and Michael over the course of a series of innovative research studies on early mathematical development spanning more than a decade. Andrew applied Rasch measurement principles to the PASA study and worked closely with the developers of the PASA instruments to interpret the results of the analysis.

The PASA series includes a teacher's guide, three response booklets (Foundation, Year 1 and Year 2), an assessment materials kit with reusable stimulus materials and a short guide for teachers wishing to use PASA with PAT Maths. Scores and reports can be generated by using an Excel spreadsheet or can be provided by ACER's Test Scoring and Analysis service.

For more information, and to view a video demonstration of the PASA assessment, visit: www.acer.edu.au/pasa.

AN INVITATION

Join the MAV and ACER to discuss great outcomes for students through effective assessment to guide teacher's planning and student learning opportunities.

This event will allow teachers to discuss the use of assessment tools such as the ACER Progressive Achievement Tests in Mathematics (PATMaths) (1-6) and the new Pattern and Structure Assessment (PASA) Maths (F-2) with colleagues and experienced maths education consultants.

You will be able to view samples of these products and discuss with consultants how we can assist with improving teaching and learning outcomes at your school.

We look forward to meeting you!

Date	Venue	
Thursday 23 April	Malvern Central Primary School	3.45pm registration 4pm - 5pm Refreshments provided.
Thursday 30 April	St Mary's Williamstown	
Thursday 7 May	ACER Camberwell	
Thursday 14 May	Balcombe Grammar Mt Martha	

REGISTER ONLINE AT
WWW.MAV.VIC.EDU.AU/PD OR CALL +61 3 9380 2399
THIS IS A FREE EVENT

Australian Council *for* Educational Research

THE MATHEMATICAL ASSOCIATION OF VICTORIA

PROBLEM SOLVING CHALLENGES HIGH ABILITY STUDENTS

Penny Willoughby

JOHN'S ACHIEVEMENT

I noticed John (Year 4) stealing glances at his neighbour's work and went over to quietly chat with him.

'How are you going, John?'

John was in a class with a group of high ability students, selected specifically for doing challenging maths problem solving with me.

'Okay,' he answered cautiously, but then admitted, 'It's really hard.'

'It can be a bit frustrating when you don't know how to tackle a problem, can't it?' I wanted to acknowledge how John was feeling. He's a clever kid but is used to working out maths questions quickly, without having to think much. This problem was challenging for John because he didn't immediately know what to do with it.

John nodded, and glanced again at his neighbour's notes.

'I know it's really tempting to find out how someone else is doing the problem, John ... but I wonder how you'd feel if you didn't get help from anywhere else? If you kept trying on your own? Do you think you'd feel pretty pleased with yourself if you managed to solve it without any help?'

'Yeah, that'd be great.'

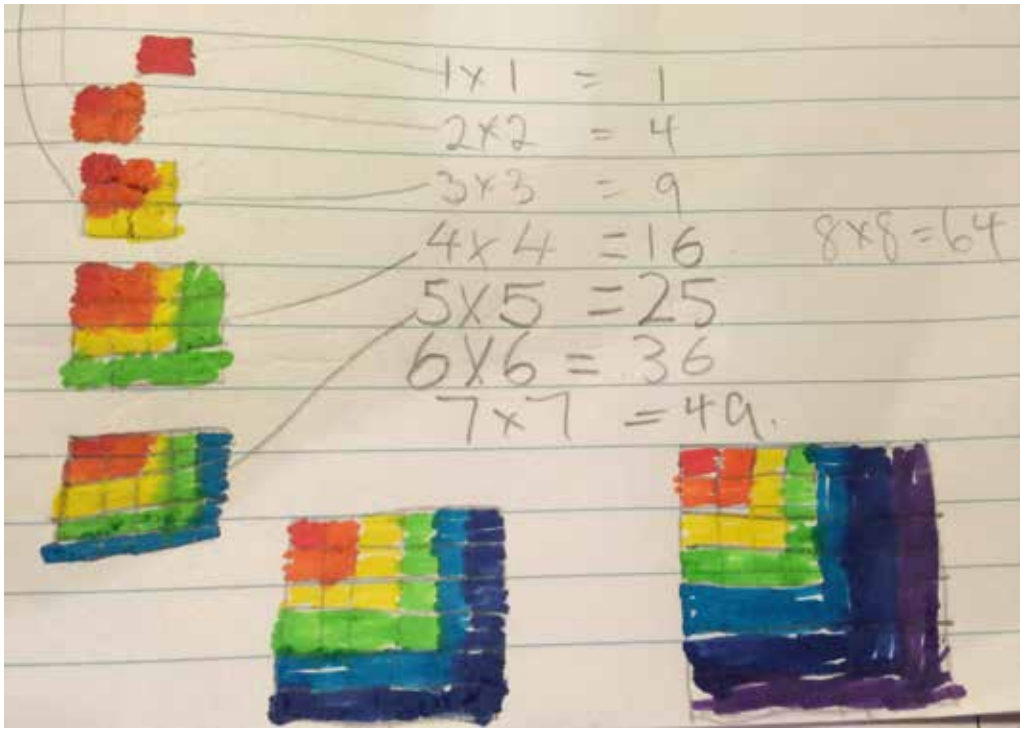
'How about you move to a different table so that you don't feel tempted to look at anyone else's workings out? See if you can challenge yourself to do it alone?'

'Nuh. I'll be okay here. I won't look.'

'Okay, John. It's your choice,' I said evenly - I really meant it and wanted him to know.

As I turned away to another student I noticed John lean over and look closely at the other child's writing. I wanted to stop him, but it was important to let him make his own learning decisions. After all, that's my teaching philosophy - to support students to become autonomous learners.

About a minute later, John got up and announced that he was going to sit by himself. I asked him if he'd like any help with the problem, but he said 'No,' and seemed determined to 'go it alone'.



Finding patterns.

I did touch base with John a couple of times on that problem to check he wasn't completely stuck or getting too frustrated. I made some small suggestions to prompt him in the right direction, but kept them light. It was really important that John knew he was doing it on his own.

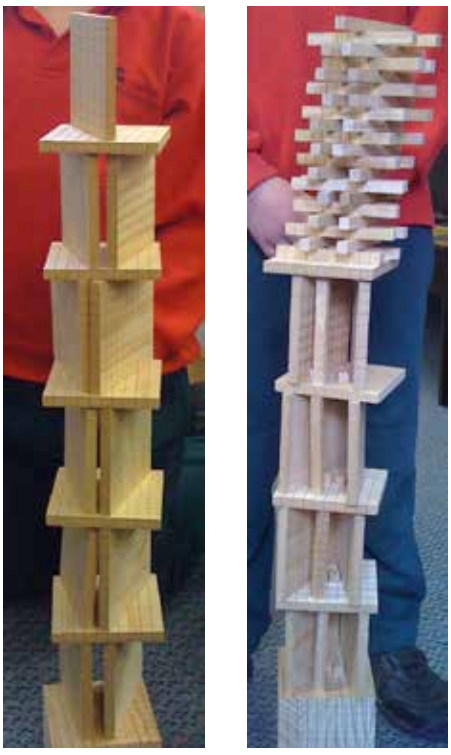
My reward came about ten minutes later, when John ran over to me calling across the room. 'I've got it! I've got it!' He was practically bursting.

When I checked, he was right – he had a logical solution to the problem.

'I did it all by myself!' John was grinning.

I was absolutely thrilled. 'Hey, how do you feel about not copying someone else's work and doing that by yourself? You must feel pretty satisfied with that?'

'Yeah! I did it all by myself! I can't believe it!'



Building patterns.

WHY IS PROBLEM SOLVING SO BENEFICIAL FOR HIGH ABILITY STUDENTS?

I am a firm believer that all children benefit from doing maths problem solving. However, my specialty is developing high ability (gifted*) students and helping them move towards achieving their potential. Here are some compelling reasons why problem solving is ideal for these clever minds:

- Children with high mathematical ability often coast their way through most of primary school and at least some of secondary school. Because they coast, they don't develop the persistence and self-confidence they need when they later face more complex, mathematical concepts. Setting problems at the right level (neither too easy nor too hard) for these students will stop them coasting and cause them to draw upon and stretch their abilities.
- When high ability learners coast, they can lose faith in themselves as learners; this is known as low self-efficacy. These students need regular opportunities to struggle, such as tackling challenging maths problems, in a supported environment, to build and maintain their self-efficacy. This enables them to become resolute and successful learners and grow towards their real potential.
- High ability students are equipped with brains that are capable of complex and creative thinking. Problem solving provides a real opportunity for them to exercise and strengthen these capabilities.
- When facilitated well, problem solving builds your relationship with the students. Trust develops and the students learn that you will not make it too easy or too hard, nor will your abandon them when they're struggling. They learn that you are working towards their proud moments of 'I did it by myself' rather than spoon-feeding them through their schooling. This is what they need from us.

EXAMPLE PROBLEMS

Here are some examples of problems I use with high ability students when I run incursions in schools:

Year 2 – Children meet Marty the Martian, explore unusual number patterns based on engaging stories and hands-on activities.

Year 3 – Pulsar Beam Confusion in which students rethink calculator numbers by focusing on their light bars.

Year 4 – Puzzle Me Please provides children with a range of secret number, alphabetic and other number puzzles.

Year 5 – Risky Remainders where students solve complex division puzzles with just a few clues about the remainders.

Year 6 – Secret Signs invites students to apply the BODMAS rules to solve mystery maths statements.

Year 7 – What's Your Base? Students use non-decimal number bases to solve problems.

PROBLEM SOLVING CHALLENGES HIGH ABILITY STUDENTS (CONT.)

Year 8 – In Prime Suspect Decomposition the students use prime decomposition to solve number problems.

TIPS FOR TEACHING PROBLEM SOLVING

Here are my top tips for effective teaching of maths problem solving:

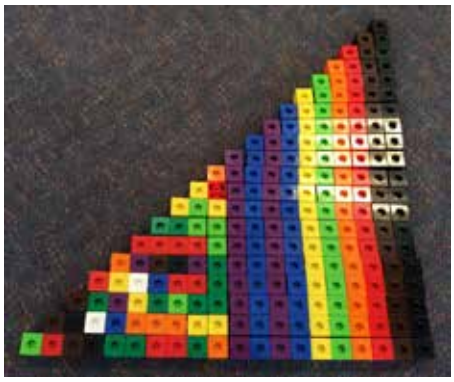
- **Pre-assess** - Start with a maths problem solving pre-test to assess students' levels of problem solving competence. This will assist you to pitch the right level of problem to each student.
- **Call-out the challenge** - Early on, explicitly discuss with the students that they may experience frustration, want to give up and that the goal is to develop persistence and derive satisfaction from solving something challenging. (I have a light 'Never-give-up' story that I start the discussion with.)
- **Establish a cone of silence** - Seek the students' agreement to keep their answers secret so that everyone gets a chance to do the thinking. (I sometimes give the students a scorecard to rate their independence and satisfaction in solving problems independently. More points when they don't ask for help and try several strategies or approaches, less when they work together or use hints.)
- **Teach steps and strategies** - Explicitly teach the steps and strategies for effective maths problem solving and ask students to plan how they will tackle each problem, then reflect on how they went.
- **Do it first** - Unless it's really easy for you, always do the problem yourself first to ensure you're fully prepared to troubleshoot the students' questions, sticking points and frustrations. I sometimes write notes about how I worked an especially tricky problem out, what order I did it in as well as the steps and strategies I used.
- **Resist giving too much away** – Avoid the temptation to give the answer, how to do something or hints that remove the students' need to think. Instead ask the students questions to direct them back to their plan of action, the effectiveness of their processes and choice of strategies. Have a range of levels, hints and support materials available to offer to students once you work out what level of support they need.
- **Focus on explanations and mathematical thinking** – Acknowledge correct workings out and answers but give more encouragement (or marks) for justifying an answer, explaining thinking, choosing strategies wisely and effectively following a logical process.
- **Don't panic** - Expect and accept the students' reactions and objections to problems that at first appear impossible. When a student resists your attempts to challenge them, remember that it may take time for them to learn to trust you and reach that feeling of immense satisfaction they will get when they independently solve their first difficult problem.

AUTHOR

Penny Willoughby is a teacher and professional learning facilitator who is passionate about gifted education, creativity, problem-solving and differentiation.

To visit Penny's website, a wonderful resource on gifted learners for teachers, go to www.thinkingoutsidethebox.com.au or email penny.willoughby@mac.com.

** In Victoria, the widely accepted definition of giftedness is adopted from Françoys Gagné's model (2004), where 'giftedness' is understood as outstanding potential. Around 10-15% of people may fall within the full range of gifted abilities. (Victorian Department of Education & Training, 2015, www.education.vic.gov.au/school/teachers/teachingresources/diversity/pages/gifted.aspx, Victoria, Australia.)*



Using patterns to calculate.

Penny does contract work with the MAV and is available to conduct professional development sessions to teachers.

To book professional development email Jennifer Bowden, jbowden@mav.vic.edu.au or telephone 9380 2399.

GAMES: JUST TRIVIAL PURSUITS?
PAUL SWAN PD SESSIONS

Games are often used in mathematics to develop fluency. In these sessions Dr Paul Swan will share some games that he has created and show how to gain the most from playing a game. Links will be made to the four proficiency strands from the Australian Curriculum while playing the games. Suggestions will be made for catering for a wide range of abilities while playing games.

COME ALONG – IF YOU ARE GAME!

DETAILS
Monday 18 May, 4pm – 5pm
Stonnington Primary School

Tuesday 19 May, 4pm – 5pm
Cliveden, MAV, Brunswick

COST
$40 each session. You will receive a game of your choice to take back to school.

Stonnington Primary School was lucky enough to receive various mathematics board games for our Year 1/2 students to use.
As the students were learning about place value, these resources aided them to learn more about place value in a fun and challenging way.

These games allowed for differentiation in learning styles and learning abilities it was also easily accessible and could be utilised within our mathematics curriculum, as students only needed a board game and counters.

This meant that students could readily pick up the games and play in small, unaided groups. The students really enjoyed playing the games. We asked a few students what they thought of the resources and here is what they had to say:

Book online to avoid missing out!
www.mav.vic.edu.au/pd.

They were really fun because we got to learn how to play new games about place value.

- Year 1 student

I loved using the place value board games because they were fun games to play. It was really easy because all we needed was the board game and nothing else. I also really liked how there were questions on the board games that we needed to answer. That made it fun.

- Year 2 student

Jade Lipson
Classroom Teacher, Stonnington Primary School

May 17-23 is Education Week and this years theme is *Mathematics: Crack the code with maths*. Visit www.education.vic.gov.au/about/events/Pages/edweek.aspx.

GAMES DAYS

In September 2014, Malvern Central School, Ripponlea, Stonnington Primary School, South Yarra Primary School, St Kilda Primary School and Armadale Primary School attended The Stonnington Maths Games Day, organised by the MAV and hosted at Stonnington Primary School.

Some of the things that we did during this very fun and exciting day were Geoshape challenges, such as making 3D shapes out of them and trying to construct 2D letters using the shapes. We also did a pair-challenge where we got into pairs and played games against other pairs from different schools. Some other activities involved problem solving and team maths relays.

I would like to thank Clem Newton-Brown, the former State member of Prahran, for coming to present medals to the teams who came in 1st, 2nd and 3rd place and Jennifer Bowden from MAV for hosting this wonderful and exciting day.

My favourite activity was the Pair Challenge because I really enjoyed meeting other people and getting to know them as well as playing against them. Another one of my favourite activities was the Geoshape challenges because I felt that it was really fun to create shapes out of Geoshapes - but it also got a bit tricky!

Malvern Central School took out 1st and 2nd place with only 2 points between them. I was in the team that came second by 2 points but we missed out on 5 points because we forgot to put our name on our Geoshape Letters challenge which would've won us the competition.

All up this was an extremely fun and tiring day of non-stop maths fun! Well done to all of the competitors that competed in the day's events and congratulations to the medal winners.

- Ben Romeo
Year 6 Student, Malvern Central School

WHAT BETTER WAY TO ENHANCE YOUR STUDENTS' SKILLS WITH THE PROFICIENCY STRANDS THAN PARTICIPATING IN A MATHEMATICS GAMES DAY?

A Maths Games Day is an opportunity for students to develop their mathematical talents and thinking skills in a setting where maths is regarded as fun and worthwhile with like-minded students from a diverse range of schools.

It is an ideal way for students to participate in mathematical activities without the usual class room pressures and is a very effective vehicle for getting young people - particularly in the middle years of schooling - excited about maths.

Problem solving and mathematical games address the AusVELS proficiency strands.

Besides the Statewide Mathematics Games days, the MAV can coordinate and run a Maths Games Day to suit your school or a cluster of schools in your area, or we can assist you to run your own games days.

The MAV is particularly interested in hearing from regional school who may like to host a games day.

If you are interested in learning more about Games Days, contact Jennifer Bowden, jbowden@mav.vic.edu.au (primary) or Helen Haralambous, hharalambous@mav.vic.edu.au (secondary) or phone 9380 2399.

MATHS TALENT QUEST AND STATEWIDE GAMES DAY REGISTRATIONS ARE OPEN.

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MATHEMATICA AND THE AUSTRALIAN CURRICULUM

Carmen Popescu-Rose, Director, Mathematics for Excellence. www.wolfram.com/training/instructors/popescu-rose.html.

This article follows on from article in the Term 1 edition of *Common Denominator* where we focussed on Essential Mathematics and General Mathematics. This article looks at teaching and exploring mathematical concepts as outlined in the Australian Curriculum at Year 11 level for Mathematical Methods and Specialist Mathematics.

YEAR 11 – MATHEMATICAL METHODS – UNIT 1 – TOPIC1: FUNCTIONS AND GRAPHS

- **RECOGNISE FEATURES OF THE GRAPHS OF $X^2+Y^2=R^2$ AND $(X-A)^2+(Y-B)^2=R^2$, INCLUDING THEIR CIRCULAR SHAPES, THEIR CENTRES AND THEIR RADII (ACMMM020)**

This investigation requires the use of the function ContourPlot in order to plot the graph of a circle and explore the connections between *a*, *b* and *r* and the centre, the axes intercepts and the radius of the circle.

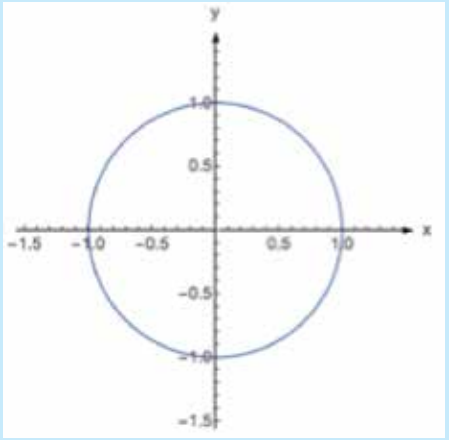


Figure 20. *Output displaying a circle of radius 1 with centre (0, 0).*

The command ContourPlot[*x*^2 + *y*^2 == 1, {*x*, -1.5, 1.5}, {*y*, -1.5, 1.5}, LabelStyle -> Directive[14, Thick], AxesLabel -> {'*x*', '*y*'}, AxesStyle -> Arrowheads[{0.03}], Frame -> False, Axes -> True] produces a circle of radius 1 and centre (0, 0).

The following command can be used to generate circles of various radii and centres. Students could observe the new positions and dimensions of the circles as they change the values of *a*, *b* and *r*.

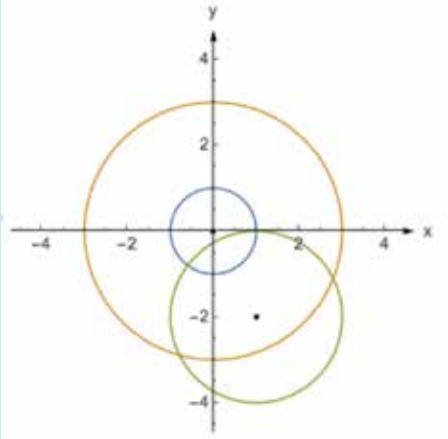


Figure 21. *Input and output for three different sets of values for a, b and r and the corresponding circles.*

The commands for plotting the centres of the circles, Point[{{1, -2}, {0, 0}}], can be used in order to emphasize the relationship between *a* and *b* and the coordinates of the circle.

TOPIC 3: INTRODUCTION TO DIFFERENTIAL CALCULUS

- **EXAMINE THE BEHAVIOUR OF THE DIFFERENCE QUOTIENT $\frac{f(x+h)-f(x)}{h}$ AS $h \to 0$ AS AN INFORMAL INTRODUCTION TO THE CONCEPT OF A LIMIT (ACMMM081)**

This behaviour can be easily examined using one or more of the demonstrations from the Wolfram Demonstrations Project. The snapshots shown in figure 22 (over page) provide some information regarding the features of this manipulation.

Students can easily interact with this interactivity by moving the points on the curve. The gradient of the line connecting the two points is automatically calculated and displayed so the students can observe what happens to the value of $\frac{f(x+h)-f(x)}{h}$ as $h \to 0$.

YEAR 11 – SPECIALIST MATHEMATICS – UNIT 1 – TOPIC 2: VECTORS IN THE PLANE

- **DEFINE AND USE THE MAGNITUDE AND DIRECTION OF A VECTOR (ACMSM011)**
- **REPRESENT A SCALAR MULTIPLE OF A VECTOR (ACMSM012)**
- **USE THE TRIANGLE RULE TO FIND THE SUM AND DIFFERENCE OF TWO VECTORS. (ACMSM013)**
- **USE ORDERED PAIR NOTATION AND COLUMN VECTOR NOTATION TO REPRESENT A VECTOR (ACMSM014)**
- **DEFINE AND USE UNIT VECTORS AND THE PERPENDICULAR UNIT VECTORS I AND J (ACMSM015)**

Students could be introduced to the notion of vector by first using the Mathematica Graphics functionality to construct arrows in the Cartesian plane between two given points. The command used to construct the vectors in figure 23 is Graphics[{Arrow[{{0, 0}, {1, 1}}], Arrow[{{-1, 0}, {-4, 1}}], Arrow[{{4, -3}, {1, -1}}], Arrow[{{-2, -1}, {-1, -3}}]}, Axes -> True, AxesLabel -> {*x*', '*y*'}, AxesStyle -> Arrowheads[{0.03}]].

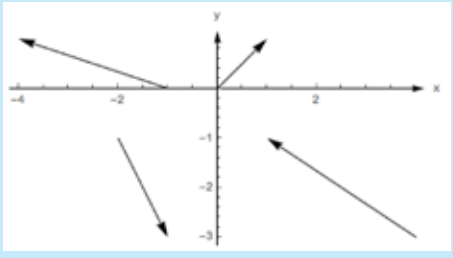


Figure 23. *Four vectors in the Cartesian plane.*

Depending on the purpose of the investigation, it can be further extended by instructing students to construct polygons using 3, 4, 5 or 6 vectors.

The next step in this investigation is calculating the magnitude and the direction of the vectors plotted in previous step. To calculate the angle between the vector in the first quadrant and the horizontal axes use VectorAngle[{1, 0}, {1, 1}].

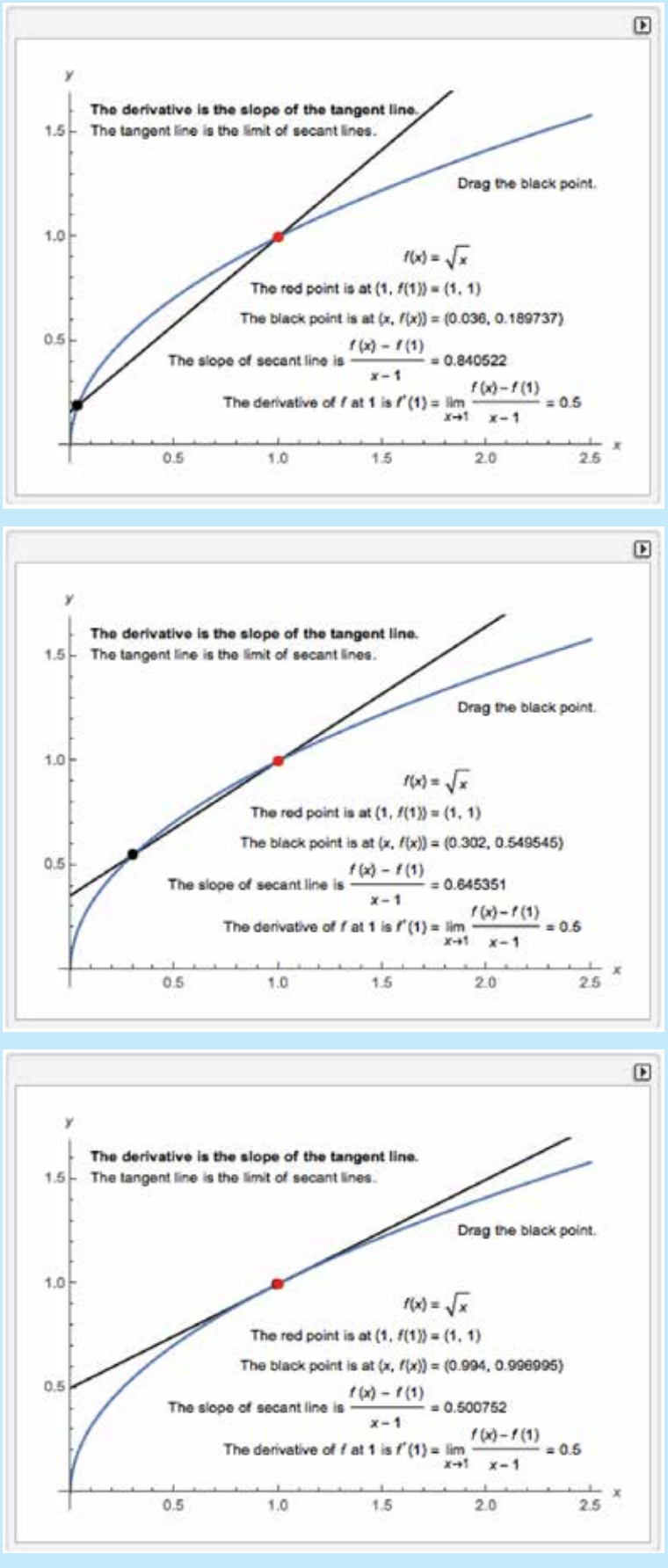


Figure 22. *Snapshots from the demonstration 'The Definition of the Derivative'.*

The first set of values, {1, 0} represents the unit vector in the *x*-axis and the second set of values represents the vector in the first quadrant.

```
In[21]:= VectorAngle[{2, 0}, {1, 1}]
Out[21]= π/4
```

Figure 24. *Input and output for the direction of the vector.*

The length of the vector is calculated using the command EuclideanDistance[{0, 1}, {1, 0}] where {0,1} is the horizontal vector component and {1,0} is the vertical vector component.

```
In[22]:= EuclideanDistance[{0, 1}, {1, 0}]
Out[22]= √2
```

Figure 25. *Input and output for calculating the magnitude of the given vector.*

The next step in this exploration is calculating and plotting a scalar multiple of a vector. For ease of calculations define the vector $v = \{1,1\}$ and then calculate $3v$ and $\frac{1}{2}v$ as shown in figure 26.

Next plot the three vectors on the same set of axes. Students could also be instructed to calculate the magnitudes of the two new vectors and check if the magnitudes are 3 times larger than the original vector and $\frac{1}{2}$ of the original vector respectively.

```
In[23]:= v = {1,
Out[23]= {1, 1}

In[24]:= 3 v
Out[24]= {3, 3}

In[25]:= 1 / 2 v
Out[25]= {1/2, 1/2}
```

Figure 26. *(from top to bottom) Defining vector v = {1,1}, Calculation for vector 3v, Calculation for vector v.*

MATHEMATICA AND THE AUSTRALIAN CURRICULUM (CONT)

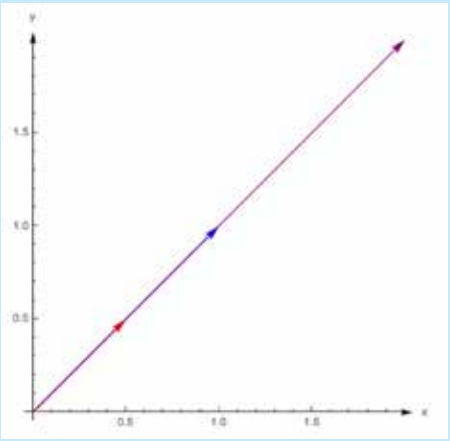


Figure 27. *Cartesian plane displaying vectors v = {1,1}, 3v and v.*

Adding and subtracting vectors in Mathematica is fairly easy to compute. First define the vectors as *a* = {2,2} and *b* = {2,-1}, and then simply perform *a* + *b* and *a* - *b*.

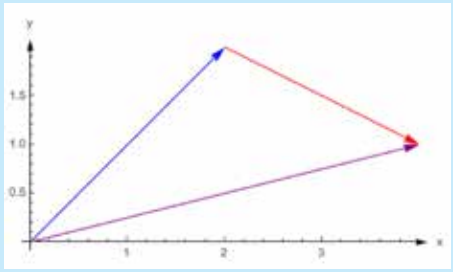
```
In[28]:= a = {2, 2}
Out[28]= {2, 2}

In[29]:= b = {2, -1}
Out[29]= {2, -1}
```

```
In[30]:= a + b
Out[30]= {4, 1}
```

```
In[31]:= a - b
Out[31]= {0, 3}
```

Figure 28. (top to bottom) Defining vectors a and b, a + b, a - b.

The geometrical representations of the vector addition *a* + *b* and the vector subtraction *a* - *b* is shown in figure 27.



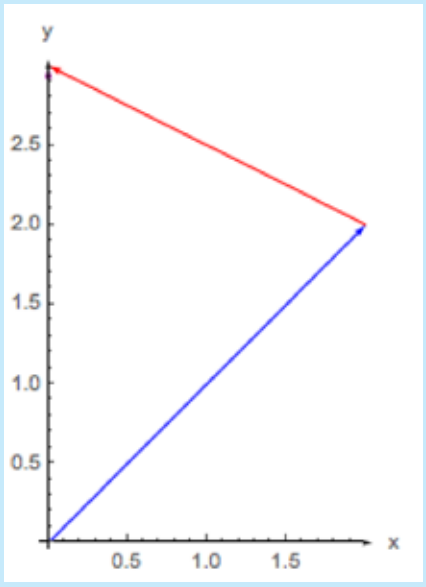


Figure 29. *Graphical representation of (top) Vector addition a + b, (bottom) Vector subtraction a - b.*

The command used to represent the addition vector is Graphics[{{Blue, Arrow[{{0, 0}, {2, 2}}]}, {Red, Arrow[{{2, 2}, {4, 1}}]}, { Purple, Arrow[{{0, 0}, {4, 1}}]}}, Axes -> True, AxesLabel -> {'*x*', '*y*'}, AxesStyle -> Arrowheads[{0.03}]].

The command used to represent the subtraction vector is Graphics[{{Blue, Arrow[{{0, 0}, {2, 2}}]}, {Red, Arrow[{{2, 2}, {0, 3}}]},{Purple, Arrow[{{0, 0}, {0, 3}}]}}, Axes -> True,AxesLabel -> {'*x*', '*y*'},AxesStyle ->Arrowheads[{0.03}]].

Mathematica functionality can also be used to determine the unit vector of a given vector by using the command Normalize [*x*,*y*]. In figure 28 the two components of the unit vector in the direction of vector {1,1} are given by using the command Normalize[{1,1}].

```
Normalize[{1, 1}]
```

$$\left\{\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right\}$$

Figure 30. *Input and output to determine the unit vector in the direction of vector {1,1}.*

CONCLUSION

Mathematical concepts can be taught in various ways and it comes down to the teacher's creativity and imagination to inspire their students in the learning of Mathematics. One might ask: 'Why use Mathematica to introduce this topic (or any other topic as a matter of fact)?'

The answer that comes to mind is 'Because the student can take home a notebook full of information, interactive activities, examples and solutions to questions, and hints. They can open it when completing homework or when studying for an assessment task and ... it's all there at their fingertips.'

REFERENCES

Australian CURRICULUM, Australian Curriculum, Assessment and Reporting Authority (ACARA), Senior Secondary, Mathematics, Essential Mathematics www.australiancurriculum.edu.au/SeniorSecondary/Overview

Mathematica (Version 9) [Computer software], Wolfram, www.wolfram.com/mathematica/

timeanddate.com, www.timeanddate.com/time/map/

The Definition of the Derivative from the Wolfram Demonstrations Project http://demonstrations.wolfram.com/TheDefinitionOfTheDerivative/ Contributed by: Jim Swift.

The MAV offer professional development advice and workshops on the use of Mathematica.
Contact Helen Haralambous, hharalambous@mav.vic.edu.au.

SURVEYING ANZAC TRADITIONS

Michelle Brooks - Surveying Taskforce

Students who excel at mathematics may be interested to consider a career in surveying, a career wherein maths is at the foundation of the day-to-day work of Surveyors. A career in surveying can lead to all kinds of exciting adventures and endeavours, and enables participants to help shape the face and future of the country. The surveying profession also helps safeguard some of our most esteemed Australian traditions, such as Remembrance Day.

The Shrine of Remembrance is heralded as Melbourne's most iconic landmark and one of Australia's largest war memorials. Many people know that the Shrine of Remembrance is central to ANZAC and Remembrance Day services and that it was specifically built to honour Australian men and women who served in the war. The Shrine of Remembrance, which houses the Stone of Remembrance, was built in such a way that at precisely 11am on the 11th November a band of light hits the Stone illuminating the word 'love', harking back to the time and date that the armistice ended the war.

What few people know is that the introduction of Daylight Saving in Victoria in 1971 meant that the Remembrance Day ceremony could not go ahead without some clever workarounds. Enter Frank Johnston, an RMIT surveying lecturer whose elegant solution would save the day - for many years to come.

His solution involved two mirrors, inclined at angles. At 11am on Remembrance Day morning, the sunlight hits an inclined mirror installed on the pole on the outer walkway.

That mirror reflects the sunlight up to a space in the roof of the building, where another mirror directs the sunlight through a space in the ceiling and down onto the granite Stone of Remembrance.

Each year the mirrors must be calibrated to ensure the sunlight hits the plaque at the correct time as the mirror in the outer walkway is mounted to pavers, which move slightly due to age. Further, only on Remembrance Day morning is the second mirror installed which requires precise calculation in order for them to align correctly.

There are only a small handful of people who share the knowledge of how to ensure the sunlight hits the stone at precisely the right time and place. Along with this knowledge, a theodolite, small stool and angular mirror aid the team in their mission. 'In 32 years...You feel as though you're in the tradition of the constructors of the pyramids and Stonehenge. You find that all of these have astronomical features of a similar nature similarity built into them,' says Frank.

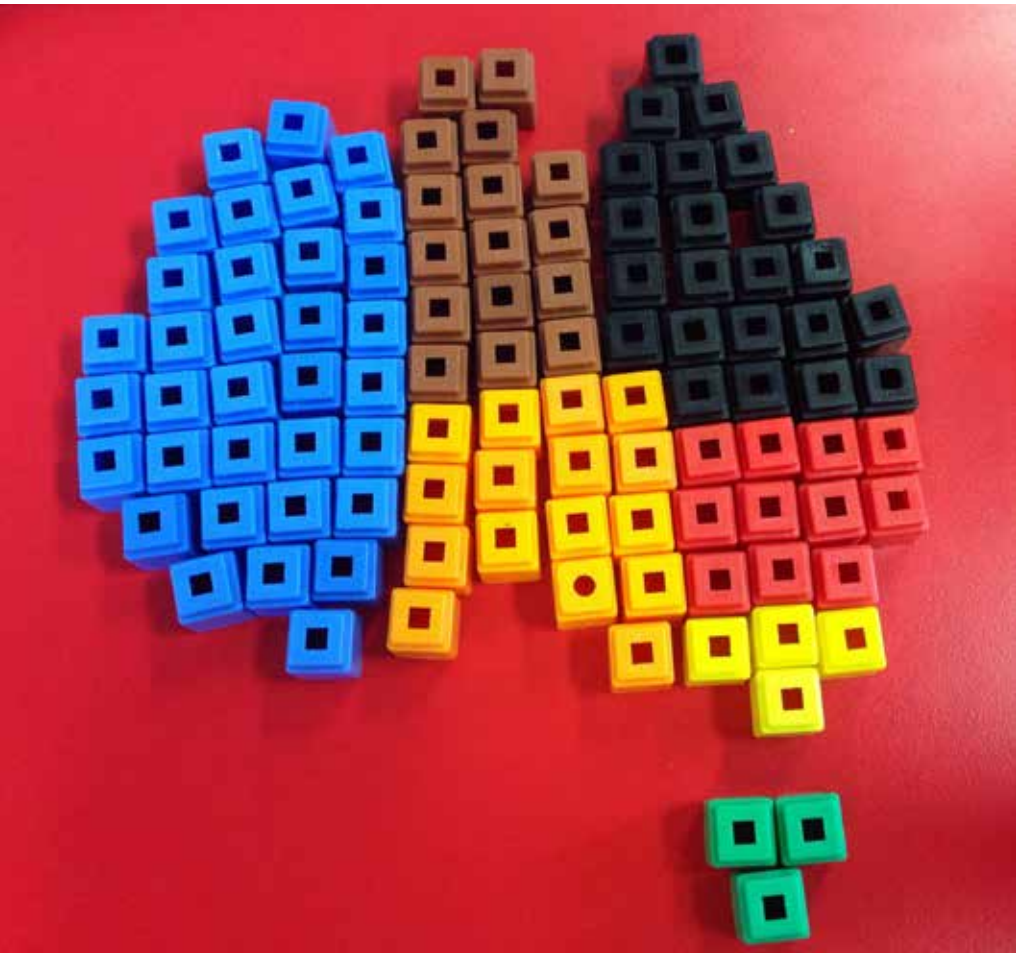
For further information on Frank and his colleagues' work, a video and article published in *The Age* can be found at www.theage.com.au/victoria/-11hbkt.html.

The mathematics employed for the calculation of the dip and strike of the inclined mirror, have been developed into an RMIT undergraduate student assignment and are freely available for school use.

Whilst fairly technical given they involve spherical trigonometry, teachers of upper level mathematics classes are invited to contact Rod Deakin at randm.deakin@gmail.com for a copy of the assignment and solutions.

Victorian school-leavers can embark upon a four year undergraduate degree with RMIT University in surveying, or study for five years with Melbourne University (a three year Bachelor of Environments followed by a two year Master of Engineering in Geomatics). Assistant Surveyors with a Certificate or Diploma in Surveying can also work at a technical level to collect, analyse data and develop plans for land surveyors, though with reduced capacities to analyse and apply data.

Surveying a is a great example of applying mathematics to real world situations. If you have students who are interested in finding out more about surveying as a career, direct them to www.alifewithoutlimits.com.au.



MAP OF AUSTRALIA

CLOSE YOUR EYES AND IMAGINE A MAP OF AUSTRALIA.

- If the state of Victoria is considered as having an area of one unit, what is your guess for the sizes of the other states?
- Which state is bigger?
- Which states are the same size?
- Is Tasmania the smallest?
- If Victoria equals five cubes what do the other states equal?
- Can you make a map using different materials to represent your answer?
- What is the area of Australia?
- What is the area of the different states?
- How might we estimate our answers?
- Is my map correct?
- How do we measure area on a map?
- What other questions might you ask?

Reference:
Lesson 50 Maths300 Country Maps

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MATHS HANDBOOK FOR TEACHERS AND PARENTS

3-9

This book includes an overview of the early childhood years, but covers the detailed content ranging from around mid Year 3 to Year 9 and beyond. The book covers all the content in the Australian Mathematics Curriculum. However, no matter what maths curriculum is followed in your school, the content of this book will still apply.

Each strand and topic is developed sequentially without reference to year levels, so it is merely a matter of locating the material appropriate for the particular stage of learning being considered.

$20.74 (MEMBER)
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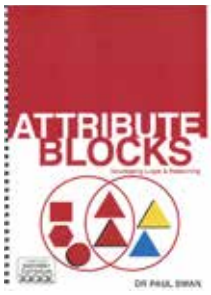

ATTRIBUTE BLOCKS: DEVELOPING LOGIC AND REASONING

F-6

The games and activities contained in this book are designed to focus on the problem solving and reasoning proficiency strands from the Australian Curriculum: Mathematics. In addition, the understanding of fundamental mathematical principles will be enhanced. This book includes a free Attribute Block Spinner.

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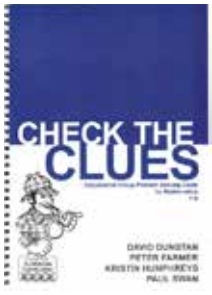


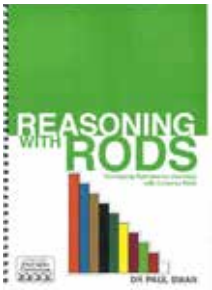
CHECK THE CLUES

F-3

This book targets the problem solving and reasoning proficiency strands of the Australian Curriculum and is written for young students. Children work co-operatively in groups to solve these problems, learning valuable mathematics content and language along the way.

The book is written by Dr Paul Swan, David Dunstan, Peter Farmer and Kristin Humphries.

$17.88 (MEMBER)
$22.34 (NON MEMBER)



REASONING WITH RODS: DEVELOPING MATHEMATICS CONCEPTS WITH COLORED RODS

1-6

Coloured rods or Cuisenaire rods are often under-utilised in schools. Because a lot of teachers don't really know how to use them to their full potential, the rods are left gathering dust in the cupboard.

This book will help teachers gain the most from this simple but effective resource. There are sections on early number as well as algebra, the development of fraction concepts and tasks that make you think or reason about mathematics.

Dr Paul Swan's aim is to share quality mathematics teaching ideas and resources with teachers, other educators and those interested in improving mathematics outcomes for students. His books are packed with easy to follow and understand activities and games.

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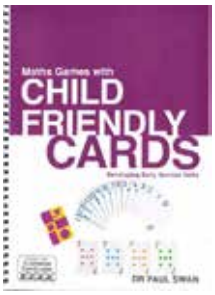

MATHS GAMES WITH CHILD FRIENDLY CARDS, DEVELOPING EARLY NUMBER SKILLS

F-3

This book will give you plenty of ideas to use child friendly playing cards for a wide range of mathematical activities. Playing cards are an extremely versatile resource to re-inform many key maths concepts and this book will help teachers to assist young children in learning these key early number concepts while playing simple card games.

The child friendly playing cards display numbers 0-13 instead of the Jack, Queen, King and Ace, and comes in four colours and shapes instead of the suits. This completely removes the gambling association that often comes with playing cards. The book comes with a free pack of child friendly playing cards.

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