SHORT CIRCUIT

Newsletter of the Canberra Mathematical Association INC

VOLUME 11 NUMBER 4 JULY 2020

NEWS AND COMMENT

The Covid disruption continues, but looking on the less dark side, we can marvel at the mathematical modelling on public display every day concerning the behaviour of the epidemic. Mathematics does appear to have its uses.

Now wash your hands.

No Conference 2020

On the darker side, the CMA council has made the decision to cancel the annual conference for this year. There are too many uncertainties and risks, making planning infeasible.

By way of compensation, *ceteris paribus*, there will be an even better conference in 2021, and Council is likely to set exceptionally attractive rates for 2020 CMA members wishing to attend.

National Mathematics Summer School

As announced in the last edition of Short Circuit, AAMT is going ahead with plans for the National Mathematics Summer School, 10 - 23 January, 2021 at ANU.

High achieving students going into year 12 can apply For information, go to the websites for AAMT and NMSS. There is a flyer on the CMA website.

Students from ACT schools are selected by a CMA subcommittee, and some financial assistance may be offered for attendees.

Short Circuits more often

Expect to receive more frequent editions of Short Circuit. It is hoped that this newsletter will now present more articles on classroom matters and about mathematics itself as well as the usual news and information items. The 'puzzles' section has already been expanded and will continue similarly. Submissions from readers are encouraged.

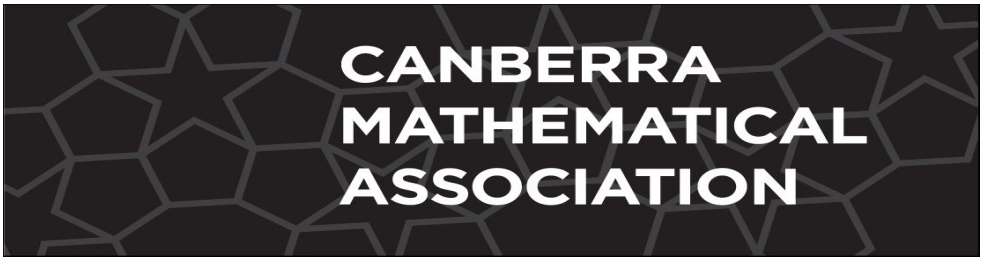
Online resources

Perhaps a little late now that schools are back to face-to-face mode, but on page 3 we have pointed to some resources that other AAMT affiliates have collected or devised during the remote learning experience.

There is benefit in looking at what other states are doing and at how they are responding to the current situation. However, it may emerge that not everyone is adhering to the same interpretation of the Australian Curriculum. *Caveat emptor*!

On language

Beginning in this issue, Heather Wardrop writes a series of articles on the roles and difficulties of language in mathematics as encountered by students. See page 6.



Inside:

Coming Events:

CMA conference: CANCELLED.

CMA AGM: 11 November, 2020.

Wednesday Workshop:

MEMBERSHIP

Memberships run from 1 Jan to 31 Dec. each year. Membership forms can be accessed from the CMA website: http://www.canberramaths.org.au

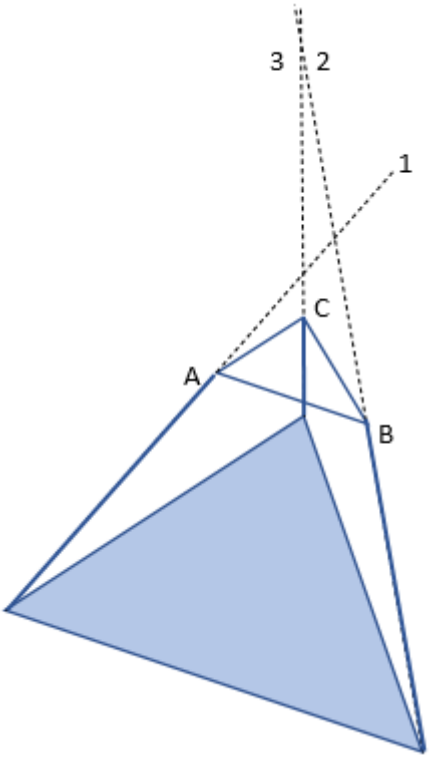
Membership of CMA includes affiliation with the Australian Association of Mathematics Teachers and a subscription to one of two AAMT journals.

As a member, you are entitled to attractive rates for the CMA annual conference and CMA professional development events.

CMA members may attend conferences of the AAMT affiliates in other states, MAV, MANSW, etc. at member rates.

PUZZLES

1 3-D Geometry



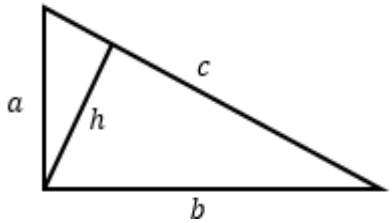
The diagram above seems to show a perfectly good truncated triangular pyramid, but can you explain why the figure is actually an impossible polyhedron? (We found this in an article from 1991 by Martin Gardner: Twisted Prismatic Rings.)

2 Pythagoras upended

Everyone knows that in a right angled triangle like the one below, the sum of the squares of sides *a* and *b* is the square of side *c*. It is less well-known that

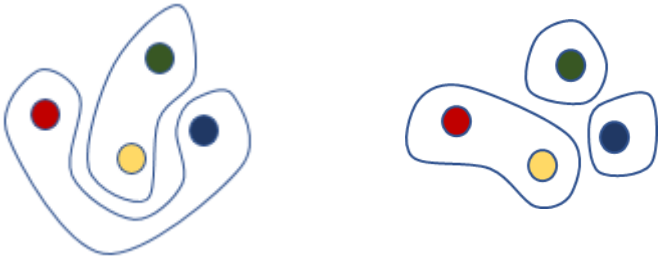
$$\frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{h^2}$$

where *h* is the altitude from side *c*. Can you prove it?



3 Counting

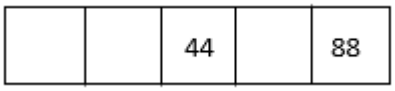
For reasons as yet unknown, a teacher wishes to allocate four animals: a goat, an alpaca, a sheep and a wombat to a number of enclosures, from one to four. The teacher wants to know in how many ways this can be done, but we might also wonder why the animals had to be all different and whether the problem would be harder or easier if there were four of just one kind.



Etc.

4 Addition

Suppose that you put numbers into the three empty boxes below, one number in each, so that the numbers in any three consecutive boxes add up to 200. (Note that two boxes already contain a number.) What number goes into the leftmost box?



AAMT

The professional associations of mathematics teachers in each Australian state and territory are affiliated with the Australian Association of Mathematics Teachers. Membership of AAMT is automatic on joining one of the local associations, such as CMA.

Download a catalogue of resources sold by AAMT from www.aamt.edu.au/Webshop/Catalogue. CMA members can order items from the AAMT catalogue at a discount.

IM²C GOES SHOPPING

One hundred and two teams battled the COVID-related shutdowns and disruptions towards the end of first term to complete and submit their entries to the 2020 International Mathematical Modeling Challenge (IM²C).

Coordinated in Australia by the Australian Council for Educational Research (ACER), the IM²C sees students use their research, mathematical and creative abilities to develop a mathematical model to address a real world problem.

At least one team from each of Australia's states and territories submitted an entry, including just from the ACT – down from previous years, but a substantial percent up from a feared zero base.

Two years on from the 2018 world-beating effort of a team from Radford College in Canberra, teams from Caulfield Grammar School in Victoria and North Sydney Boys High School in New South Wales will represent Australia in the international judging of this year's IM²C. The teams each received a 'meritorious achievement' award from the Australian judging panel and will progress to the international judging round for 2020. The international results will be announced in July.

The 2020 problem required students to determine how a 'bricks and mortar' store should arrange its goods during a flash sale to minimise the risk of damage.

Teams had to review data on goods to be offered during a sale, including the price and discount to be given, in order to identify which items would likely be most popular and the store layout factors that might affect damage risks. They had to develop and use a model that would predict damage to goods in order to recommend optimal product placement and department locations for the given store layout. Teams were also asked to create and evaluate a new and better floor plan for the flash sale scenario, and to write a one-page letter to the store manager presenting and supporting their findings.

Experiencing mathematics as a mental discipline, with its set of tools and techniques that can be used to explore something that may not be well defined, is novel for many students. They may start out thinking there must be a single correct answer but quickly realise that the real world is often much messier than that.

A total of 358 Australian students were in teams that submitted an entry to the competition this year. The successful teams and schools can be found at this link: https://www.immchallenge.org.au/results

Ross Turner

Principal Research Fellow, ACER

RESOURCES FROM A DISTANCE

Some of the larger AAMT affiliates have developed or collected online resources that can be accessed by teachers, students and parents.

From Victoria, explore https://www.mav.vic.edu.au/Resources/parents

There is also a potentially useful article, Investigating Epidemics, in the MAV magazine The Common Denominator.

From Western Australia, MAWA has free resources for families and teachers, including videos of games, puzzles and teaching strategies.

From South Australia, MASA has a listing of resources, including an article from AITSL, What Works Online.

Queensland (QAMT) lists links for Classroom Resources for Online Learning.

And, check the AAMT resources.

NEWSLETTER OF THE CANBERRA MATHEMATICAL ASSOCIATION INC

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We're on the Web!
http://www.canberramaths.org.au/

ABOUT THE CMA

The Canberra Mathematical Association (Inc.) is the representative body of professional educators of mathematics in Canberra, Australia.
It was established by, among others, the late Professor Bernhard Neumann in 1963. It continues to run - as it began - purely on a volunteer basis.

Its aims include

* the promotion of mathematical education to government through lobbying,
* the development, application and dissemination of mathematical knowledge within Canberra through in-service opportunities, and
* facilitating effective cooperation and collaboration between mathematics teachers and their colleagues in Canberra.

THE 2020 CMA COMMITTEE

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http://www.facebook.com/pages/Canberra-Mathematical-Association/110629419011275

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PASTIMES FROM PAST TIMES

By Valerie Barker

From My Archives…

As a beginning teacher in rural New Zealand in the 1970s, I had little access to the breadth of resources that we take for granted these days. However, there was a surprising amount of print material available if we looked hard enough.

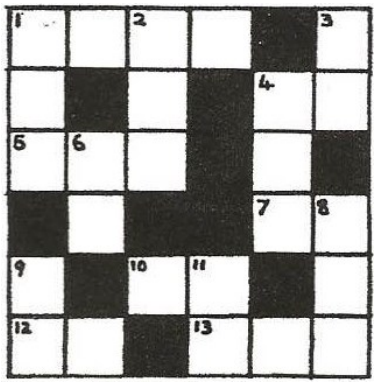
One such resource was a small printed 8-page black-and-white magazine, "Mathematical Digest", published three times a year. I still have those early copies from my first few years teaching, beginning with issue No. 39 - FIRST TERM, 1972.

They would have one or two feature articles, relating to some aspect of 'real life' mathematical interests or applications, a number of puzzles, problems or little mathematical curiosities, and always included two puzzles, usually cross-numbers, one aimed at Juniors (now NZ Years 8-11, Australian Years 7-10), and the other at Seniors (Years 10-12). Photocopiers were barely in use in those days so I would painstakingly reproduce these by hand on a spirit duplicator on newsprint paper. My students always really enjoyed an opportunity to get away from textbooks – that sentiment still has a familiar ring to it, I think. I continued to collect copies until the mid 1980s, by which time I had travelled the world, got married, and moved to Australia to live. However, those magazines have been used countless times over the ensuing decades, especially the cross-numbers!

You might imagine my delight when I discovered very recently that the magazine still exists, albeit in a rather different format. Check the website https://www.mathsdigest.net/. The **Mathematical Digest** still comes out of New Zealand, although now from Christchurch, in the South Island (where I did my teacher training and began teaching all those decades ago). As a website, it certainly lacks the sophistication and interaction of many of the sites that we currently go to for resources, but the problems, puzzles, worksheets and articles still have currency and relevance, and may well provide you (and your students) with something to consider using in your classroom.

Following are the JUNIOR and SENIOR crosswords from that issue No. 39. I hope you and your students enjoy them!

JUNIOR CROSSNUMBER



In each clue the answer is the next number in the sequence.

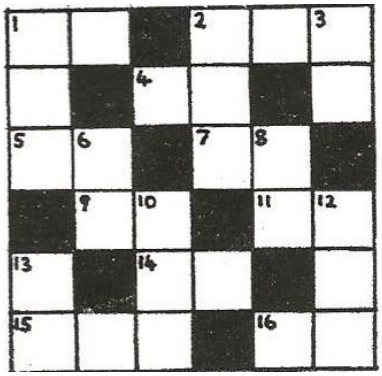
ACROSS

1.	40	80	160	320	640	...
4.	−4	4	−8	8	−12	...
5.	67	74	85	92	103	...
7.	11	13	10	12	9	...
10.	384	192	96	48	24	...
12.	135	110	90	75	65	...
13.	89	90	92	96	104	...

DOWN

1.	106	107	109	112	116	...
2.	245	356	467	578	689	...
3.	−1	4	3	8	7	...
4.	36	49	64	81	100	...
6.	77	64	51	38	25	...
8.	97	98	96	99	95	...
9.	2	2	4	6	10	...
11.	10	11	9	13	5	...

SENIOR CROSSNUMBER



$$a + b + c = 67$$
$$a + d = 6$$
$$a + b - d = 14$$

ACROSS

1. $3a + 3d$.
2. $8a + 8b - 8d + 1$.
4. $2a + b$.
5. $8(a + d) - 3$.
7. $3a + 2b + c$.
9. $\frac{1}{2}(a + b + c - 5)$.
11. $2a + 2b + 3 - 2d$.
14. $36 - 2a - 2d$.
15. $a^2 + ab + ac + ad + bd + cd$.
16. $2a + 2b + c - d - 1$.

DOWN

1. $2a + 2b + 2c$.
2. $100 + b - 2d$.
3. $a^2 + 2ad + d^2$.
6. $c + d$.
8. $2a + b + c + d$.
10. $2(b + c - d)$.
12. $3a + 2b + 2c + d$.
13. $3(b - 2d)$.

THE IMPORTANCE OF TEACHING MATHEMATICAL LANGUAGE TO IMPROVE LEARNING

By Heather Wardrop

For most students reading and using mathematical language is like working with a foreign language and often we let them down by not explicitly dealing with its complexities. In this series of articles, I will explain the difficulties with language and provide strategies that can be used in any mathematics classroom to enhance student learning.

Features of mathematical language

- It uses symbols.

These can be intimidating to the student, making them feel excluded from an elite club that understands them. An example is 5! which does NOT mean 'Oh my gosh, it's 5!' It means $5 \times 4 \times 3 \times 2 \times 1$.

- It often uses a graphical representation that requires interpretation. The student may be asked to change data into an appropriate graph.
- It has a distinct grammar of its own.

For example: "If $x = 4$, find the value of $2x^2$". I once had an international student, during an exam, ask the question "Is x equal to 4 or not?" The use of the word *if* was very confusing to him. Furthermore, students read text from left to right but in this case, you must square the variable first and then double it. Working from left to right gets the wrong answer.

- It contains specific technical words like *integral*, *square root*, *circumference*.
- It uses everyday words for specific and different purposes.

My favourite example is about a student when asked "What shape is this?" (next to a hexagon) replied "Barbeque, I think." Other examples are the mathematical meanings of *complimentary* and *supplementary* in geometry. They are not related to flattery or adding more of anything.

- Mathematical language is concise and non-redundant. It is dense with information and ideas, placing demands on the short-term memory.

An example is "Two cars, A and B depart the same position. A travels along a straight road due East at 30km/h. B departs 15 minutes after A and travels along another straight road in a North Easterly direction at 40 km/h. How far apart are the cars 15min after B departs?" By the time you finish reading you have forgotten the beginning. There are strategies that can be learned to deal with this.

- Mathematics often has long strings of descriptive words, as above!
- In mathematics, context is reduced, as above.

These features make mathematics difficult for many students to handle but it is highly desirable that they understand them and gain proficiency in their use both as readers and as writers.

The language of mathematics and the mathematics of language are interchangeable statements. Mathematical language is the language of success in today's society. It is the language of debate and is valued as highly if not more highly than other styles. As an example, the A.S.T. writing task is an expository form of writing. Such tasks often involve analysis of figures to support an opinion and a concise presentation of an argument.

This style of writing may be found everyday in the newspaper and many people would draw a literacy and numeracy baseline at being able to understand the newspaper.

We battle an attitude problem towards mathematics. Not many people are proud of being unable to read but many boast that they never could do mathematics, and many children expect to fail.

Ability in Mathematics is used as a social filter but essentially it is the construction of western, white, middle class males. Many groups who do not have full access to this culture are disadvantaged and it is the mathematics teacher's job to overcome this. It is tempting to appease students' worries by simplifying the language or restating the question. This act is disempowering. It assumes mathematical language

competence resides with the clever teacher. To avoid development of such language in the student is to deprive them of the understanding of a significant proportion of the written material they will encounter in their everyday lives.

The mistakes we make

- Confusing mathematics and arithmetic. Mathematics is creative and analytical. Arithmetic is a skill needed to achieve mathematical ability.
- Underestimating the need for appropriate language in order to think mathematics
- Paying too little attention to meta-cognition (thinking about how we think)
- Converting problems to "Plain English" for the student because "they can do the maths; it's just the language they have problems with."
- Encouraging avoidance techniques by always putting the worded problems last, so that students never get to them.
- Reading the problem for the student or just doing it for them because there are many hands raised. The student ticks your answer but soon their hand is up again for the next question.
- Stifling the development of mathematical language proficiency by providing few opportunities for students to read, write and speak mathematics. They listen to it.
- Presenting blocks of problems, all the same. This causes students to switch off and not have to think about the question they are answering. They often can't choose the appropriate technique in a bunch of mixed problems.
- Using textbooks as a set of exercises instead of a source of information which students should be able to read.

Strategies that help

- The Newman questioning technique
- Glossaries
- Three level guides
- Use of structured overviews
- Learning and revision journals – writing mathematics
- Exploring all of the text types in mathematics (*recount, report, explain, procedure, discuss, describe, persuade, narrate*)
- Strategies to unpack problems and develop mathematical thinking
- Explore the mathematics textbooks and occasionally ask students to read mathematical explanations for themselves.
- Group work that is carefully structured and monitored.
- Student designed tests and assignments that make them use the language.

Over the next few issues I will describe each of these strategies which, if applied consistently, will address the issues I have raised above. They can be used at any level and in any classroom and they should just become part of the way students learn. They add variety, relevance and interest to your teaching. These strategies foster an inclusive atmosphere in your classroom.

PUZZLE SOLUTIONS

1. Any two non-parallel planes must intersect in a line. If a third plane crosses this line, it does so at a point that belongs to all three planes. Thus, the dotted lines 1, 2 and 3 must intersect in one place.

2. By similar triangles and Pythagoras,

$$\frac{a}{\sqrt{a^2 - h^2}} = \frac{b}{h}$$

   etc.

3. There are 15 ways of enclosing four different animals. Fifteen is the fourth Bell number. For animals all the same, some of these possibilities are indistinguishable. I count 1 + 2 + 1 + 1 = 5 ways.

4. 68. There is a nice pattern.

My solution to the second problem in the last edition of Short Circuit was incorrect. Thanks to Peter Fox of Texas Instruments for noticing this.