SHORT CIRCUIT

Newsletter of the Canberra Mathematical Association INC

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NEWS AND COMMENT

This edition of Short Circuit has expanded to seven pages to accommodate a longish read from author Tom Greenwell. The article, beginning on page 2, concerns an educational issue that certainly impacts mathematics education while actually being much broader in scope. Its scope, in fact, is nationwide and encompasses most of organised education. However, its implications go to classroom level, and affect individual students.

The article should reward a patient reading (or two), and the links it contains also lead to interesting places.

We have found space for only one puzzle question this month. It sounds modern but is thought to be from a very old Hindu source.

For something immediately useful, consider adapting the teaching idea contributed by a valued reader, on page 2.

MANSW

MANSW Regional Conference 20 May 2023 Batemans Bay

CMTQ 2023

The National Mathematics Talent Quest provides a venue to showcase the creative thinking skills of students in Australia.

Students throughout the ACT can enter their mathematics assignments and projects for the Canberra Mathematics Talent Quest 2023.

When successful, their entries are then eligible for the National level quest.

Details are on the CMA website.

IM²C

International mathematical modelling challenge: website.

2023 TRIVIA

If you lived in a country where things were measured in miles, you might like to remember that **20** nautical miles is nearly the same as **23** miles.

Coming Events:

MEMBERSHIP

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

The several benefits of Membership of CMA may be found on the website.

SHORT CIRCUIT

The CMA newsletter, Short Circuit, is distributed monthly to everyone on our mailing list, free of charge and regardless of membership status.

That you are receiving Short Circuit does not imply necessarily that you are a current CMA member.

CMA welcomes all readers.

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CANBERRA MATHEMATICAL ASSOCIATION

PUZZLES

Invisible game

Anna, Bo and Chris like to play a certain game where there is always exactly one loser. At the start of each game the players reveal how much money they have. When the game finishes, the loser has to pay each of the others the amounts those players started the game with. After playing just three games, each player has lost exactly once. They find, curiously, that they have ended up with $24 each.

What were the three amounts they began with?

HERE'S AN IDEA

Concepts, communication, affirmation ...

I am always on the lookout for 'easy' classroom activities that expose important concepts, give students the opportunity to verbalise their developing mathematical ideas, allow for cooperative group work, and encourage active engagement in a controlled learning environment.

Try this one. I think it could be used with students of any age. The aim here is for learners to explore mathematical concepts and procedures related to relative size or some other measurement-related words commonly used in everyday speech; and to do this in a way that calls for active student participation and that values the ideas of all students in the class.

Write the word 'bigger' in a prominent place in the classroom.

Ask students to write three things that this word reminds them of or thoughts that come into their head in response to seeing the word (2 minutes).

Arrange students in groups of three to share and discuss their three things with each other; and to select three of them as the 'best' or most interesting responses from the group. This can include new thoughts that arise from discussion of the original responses (10 minutes).

In plenary, have each group report their three collective responses and say a few words to explain each response; collect these in a visible place. Do not provide any evaluative reaction – just collect and provide encouragement (15 minutes).

Draw out strands and common ideas that come from the responses.

E.g. the need for measurement (of different kinds of quantities – such as height, length, weight – depending on the objects whose relative size has come into the discussion); the need for different units of measurement depending on the scale of the objects under discussion – such as mm versus km; the arbitrary nature of measurement and the need to establish standards of measurement for each kind of object to be measured; history info about the establishment, storage and maintenance of standards such as the metre kept somewhere in Paris; ...

Note: The activity can be repeated at other times with other concept words, such as: *Slower*, *heavier*, *brighter*, …

Ross Turner (ACER)

CRUISER SCHOOLS

From Tom Greenwell

On the face of it, Girton Grammar is the most successful school in the central Victorian city of Bendigo. *With our Year 12 students achieving the best Victorian Certificate of Education results in the region year in, year out*, the school's website boasts, *starting in Year 7 at Girton Grammar is starting on the road to success.* The school's NAPLAN results seem to back up the claim: compared with *all Australian students*, Girton's scores are shaded aqua and green, signalling they are above or well above the national average.

And yet, when you toggle to the *students with similar backgrounds* rating, things change dramatically. The aquas and greens start being replaced by a series of pink and red cells. Compared with schools that enrol a similarly privileged clientele, Girton's scores are often below, or even well below, average. As far as NAPLAN results can be relied on, the most that can truthfully be said is that students who are already on the road to success tend to start Year 7 at

Girton Grammar. The school's claims about its role in their progress seem to reverse cause and effect.

It's not just Girton. Any school that recruits lots of already high-achieving students will almost inevitably star in NAPLAN league tables and end-of-school awards lists. And those top-line results will help greatly in generating more demand for enrolment places. This gives schools a systematic incentive to focus on marketing their flashy buildings and state-of-the-art facilities rather than the harder, more complicated and more important work of taking students from whatever point they start at and helping them realise their full potential.

Girton Grammar is the kind of school that Melbourne University's John Hattie, the apostle of educational effectiveness, has termed a *cruiser school*. It clearly succeeds at enrolling already high-achieving and socially advantaged students (56 per cent of them from the top quarter of the Australian population) and excluding children from disadvantaged backgrounds (just 4 per cent from the bottom quarter). But in terms of adding value, and materially enhancing the trajectory its students are already on, the available evidence shows few signs of success.

Cruiser schools, says Hattie, are *a major contributor to Australia's declining educational performance*, a view endorsed by the second Gonski report on achieving educational excellence. In particular, cruiser schools are responsible for significant declines in achievement among Australia's most advantaged and high-performing students. In the OECD's PISA tests, for example, maths literacy among high-achieving students declined by around thirty-five points between 2003 and 2018, equivalent to a year and a quarter of learning. That was an even sharper decline than among low-achieving students. A successful strategy of attracting high-SES students at the individual school level, applied over and over again throughout the country, has been a recipe for national failure.

Cruiser schools are mostly, though by no means only, private schools, simply because we have decided that these schools should be exempt from the obligations imposed on most public schools. The elaborate enrolment application process for Girton Grammar, for instance, makes it clear that admission, as well as expulsion, is entirely at the discretion of the head. Then there are the tuition fees, which range between $12,000 and $15,000 a year, and that's before you add in the non-refundable application fee, the capital fee and the curriculum levy.

Girton Grammar principal Emma O'Rielly insists that *Girton enrols students from a wide range of backgrounds, from families where parents have made substantial sacrifices from their after-tax income to educate their children in a school that matches their needs*. The school, she told me, *offers a range of means-tested scholarships for students whose parents would not ordinarily be able to access a Girton education due to their financial circumstances*.

And yet the impact of the various barriers to entry is palpable. Ten minutes away at the government secondary school, Weeroona College, 55 per cent of students come from the most disadvantaged quarter of Australian families, a strikingly higher figure than Girton's 4 per cent.

Across Australia, private schools use their resource advantage to attract students from better-off families yet fail to add significantly to their students' overall educational achievements.Study after study after study has concluded that even though non-government schools have more income per student than public schools, their contribution to student achievement (adjusted for the socioeconomic profiles of students) is no higher. Despite much greater financial resources, non-government schools only manage to produce the same results as less well-resourced public schools.

Jenny Chesters, a researcher at the Melbourne Graduate School of Education, has gone further. Using data from the Longitudinal Survey of Australian Youth project, she found that there is *no statistically significant association between type of school attended and employment status, occupation or earnings at age twenty-four*.

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.

Sixty years ago

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 2023 CMA COMMITTEE

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Why do non-government schools need more resources — building, grounds, staff and marketing budgets — to produce the same output, in academic terms at least, as their public counterparts? And why, more generally, is Australia bedevilled by the problem of cruiser schools?

In a perceptive paper on designing successful school systems, the OECD singled out the harmful effects of allowing schools to pursue success, or the appearance of it, by cherrypicking already high-achieving students. *The international evidence suggests that schools that are selective in their admissions tend to attract students with greater ability and higher socioeconomic status, regardless of the quality of the education they provide*, say the paper's authors. They continue:

> *Given that high-ability students can be less costly to educate and their presence can make a school more attractive to parents, schools that can control their intake wind up with a competitive advantage. Allowing private schools to select their students thus gives these schools an incentive to compete on the basis of exclusiveness rather than on their intrinsic quality. That, in turn, can undermine the positive effects of competition.*

That sounds embarrassingly like what we do in Australia. While all schools receive taxpayer funding, some are allowed to pick and choose the students they enrol (and keep) and charge admission fees as they please. Taxpayer funding, meanwhile, gives the exclusive schools the significant resource advantage that helps them attract those who can afford the ever-increasing fees. Australia's *cruiser schools* don't exist in spite of public policy but because of it.

Critical to this dynamic is the fact that ever-increasing public subsidies have abjectly failed to improve the affordability and accessibility of private schools. The most recent research pointing to this reality came from the Blueprint Institute, a pro-market think tank with former Liberal ministers Bruce Baird and Robert Hill on its board. The institute's *Ensuring Choice* report revealed that *the average independent school has raised its fees by 50 per cent over the last decade ending in 2020 — far outstripping wage growth (29 per cent) and inflation (22 per cent) over the same period.*

The result: *middle-income families are priced out of contention for enrolment spots*. The institute could have added that the pattern of the last decade was a perfect replica of the ten years before that, or that Catholic leaders long ago publicly acknowledged that their schools now largely exclude the poor.

Australia has one of the most socially segregated school systems in the OECD. Students from underprivileged families face the *double disadvantage* of their socioeconomic background combined with attendance at schools where they are surrounded by similarly disadvantaged peers. An abundance of evidence indicates that concentrating disadvantaged children in the same schools only further stacks the odds against them.

Students from more privileged families, conversely, might be expected to benefit from the *double advantage* of high family socioeconomic status and a cohort of similarly privileged peers. But, as we have seen, this is not how it plays out in practice. Instead, these students are falling further and further behind their international counterparts, floundering in schools more focused on intake than output. Allowing and even encouraging some schools to cherrypick their students has succeeded only in undermining both equity and overall achievement.

All of the above might plausibly have provoked a series of questions among Productivity Commission staff as they wrote their recent report on the National School Reform Agreement, the four-year funding deal that defines how Australian schools are resourced, on what terms and to which ends. Why, for instance, does intense competition between Australian schools fail to generate the productivity gains economists might expect? Why has a huge increase in government funding to private schools yielded no discernible return in terms of either affordability or student achievement?

And then there is an even more fundamental question that goes beyond outcomes, effectiveness and productivity to the role of schools in the cultural formation of citizens. This question returns us to those two schools in Bendigo, ten minutes apart, that serve young people from completely different social worlds — a dynamic that repeats itself in towns and suburbs across the country in a pattern of segregation that inevitably includes a racial as well as a class dimension. What is the hidden curriculum embedded in these arrangements? What are the lessons contained in this organisation of learning and learners?

To the Productivity Commission's credit, its report acknowledged some dimensions of the problem. It reported evidence that *students from priority equity cohorts demonstrated, on average, less learning growth… if they attended a school with higher concentrations of students experiencing disadvantage*. It also recognised that these schools *tend to have less experienced teachers on average and are more likely to struggle with staff shortages and classroom management*.

But the commission didn't examine how concentrations of disadvantage and privilege have resulted from the way we resource and regulate our schools. Notwithstanding its broader preoccupation with competition, there was little attention to how it works in Australia's school sector.

In ignoring these matters, the Productivity Commission's work reflects a myopia that dates back at least as far as the governments of John Howard and Julia Gillard, whose respective policies are primarily responsible for the shape of our school system today. This narrow orthodoxy either takes Australian-style school competition for granted, as though there is no alternative, or assumes that all competition is good without contemplating the unlevel playing field on which it occurs. A similar silence descends when it comes to the failure of ever-increasing public spending to achieve its ostensible purpose of expanding school choice.

Outside this Australian orthodoxy, alternatives exist. Numerous comparable countries, including Canada, New Zealand, the Netherlands and Scotland, have arrangements in which all schools, government and non-government alike, are fully publicly funded on a common basis and universally prohibited from charging admission fees or applying selective enrolment policies, other than those strictly defined to support their special ethos.

As Chris Bonnor and I argue in our new report, *Choice and Fairness: A Common Framework for All Australian Schools*, it would now be surprisingly affordable to adopt similar arrangements in Australia — largely because so many private schools in this country already receive at least as much taxpayer funding as comparable public schools.

A framework in which all schools are eligible for full public funding, and are free to the user, would tackle the problem which the Productivity Commission — along with many others — has not. It would minimise social segregation, reduce the outsized impact of negative peer effects on student achievement, and ensure that schools compete not on their ability to attract additional resources and the *right* students but on their capacity to help each child achieve a full year of learning, every year, and to realise their full potential.

All schools receiving public funding would be open to children of all abilities and prohibited from excluding children on the basis of entrance tests and other similar discriminators. Non-government schools could continue to apply enrolment and other policies necessary to promote their specific religious or educational ethos, but if they are unwilling to accept funding obligations, they would forfeit their public funding.

The obvious objection is that a proposal like this is politically unthinkable. But there is a circularity in such an objection. The question is: *why* is it unthinkable to challenge the basic assumptions underlying Australia's unique — and uniquely bad — dual system of taxpayer-funded schools?

This complex question has many answers, but here

is one. Advocates for public education typically frame their argument in exclusively egalitarian terms, either ignoring the case for choice and competition or regarding it with active hostility. This approach accepts that there is an inescapable trade-off between choice and equity, and then vigorously argues that the latter should trump the former.

In political terms, this is a losing strategy, as a half-century of failed attempts to implement needs-based funding attests. There is just too large a constituency who like choice, either because they prefer something other than a secular, government-owned and -operated school, or because they place a premium on the capacity to opt out.

In embracing the choice-versus-equity dichotomy, champions of public education have failed to point out that we currently enjoy neither. Instead of offering meaningful choice, existing policies have created non-government schools that openly acknowledge they price out the poor. Instead of putting downward pressure on fees, public subsidies have enhanced the market power of exclusive schools. Instead of creating the competition that engenders diversity, dynamism and innovation, public policy has succeeded only in producing cruiser schools.

Rather than continuing the false debate between choice and equity, it is time to affirm the value of both and explore how each could be realised more effectively than at present. The first step is for critics of the status quo to engage in the task of reimagining how choice and competition could be shaped to advance the common good. If we think the choice for Australian schooling is between the unthinkable and the indefensible, it is time we thought harder. •

Tom Greenwell teaches history and politics in the ACT public education system. He writes about Australian education policy for Inside Story and The Canberra Times. He has explored a wide range of topics including growing segregation in Australian schooling, the history of Australian education, and contemporary trends and challenges. He previously worked as a research officer with the Australian Education Union.

PUZZLE SOLUTIONS from Vol 14 No 3

1. Impossible?

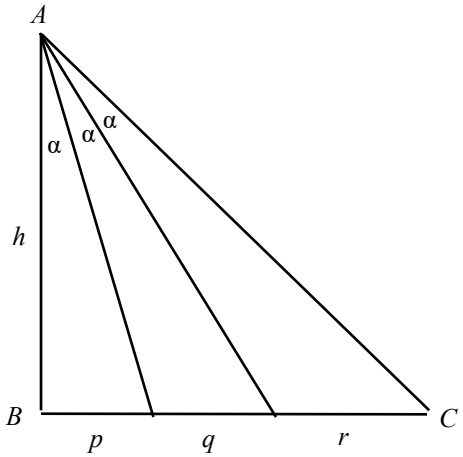
Without trying to find one, can you show that no solution in real numbers exists for the equation

$$\sqrt{1+\sqrt{2x^8+1}} = x$$

If the 1s and the 2 are erased from the expression on the left, we obtain the smaller expression, x^2. So, x must be greater than x^2. This is only possible if $|x| < 1$. However, the expression on the left of the equation has a least value $\sqrt{2}$ (when $x = 0$), and since this is greater than 1, x must be greater than 1. Hence, the statement is impossible.

2. A nugget

In a right-angled triangle ABC, the angle at A has been trisected.



Show that $r = \frac{q^2}{2p-q}$ If $r = 1$ and $p = \frac{1}{2}$, what is the value of q?

By means of expressions for tan α, tan 2α, and tan 3α, we can eliminate the terms tan α and h to obtain the required formula. Remarkably, when $r = 1$ and $p = ½$, we find $q^2 + q - 1 = 0$ with positive solution $q = 1/\varphi$ (where φ is the golden ratio $(1+\sqrt{5})/2$). Then, α = 18°.

3. Imagine this

Numbers a, b, c and d such that a and b are each 1 more than their respective reciprocals, and c and d are each 2 more than their respective reciprocals. Let $S = a^2 + b^2$, and $T = c^2 + d^2$. Find the value of T/S.

This is hard as a mental problem but easier using symbols. We can deduce that a and b are the two solutions of $x^2 - x - 1 = 0$, and c and d are the solutions of $y^2 - 2y - 1 = 0$. After a few steps, $T/S = 2$.