



**Australian Government**  
**Chief Scientist**

**DR ALAN FINKEL AO**

**Mathematics Education Research Group of Australasia 40<sup>th</sup>  
Anniversary Conference (MERGA 40) Opening Address**

***Measuring up***

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**Australian Synchrotron  
MELBOURNE**

Your fortieth conference. A number to celebrate. And not just for conferences:

- There are forty squares on a Monopoly board.
- Forty in Italian is quaranta – and forty days was the duration that ships were forced to wait in harbour in the time of the Bubonic Plague to stop the spread of infection. It was the original... QUARANTINE.
- It took forty attempts to develop the answer to most of life's sticky problems: WD 40. Or, to give it its full name, Water Displacement, 40th formula.
- And forty is the highest number that Sesame Street counting has ever reached.

So there you have it – it's a milestone, whether you're a Muppet or a mathematician.

I'm marking a milestone of my own tonight: my first formal event since taking off my hat as Australia's Chief Electrician, and resuming my hat as Australia's Chief Scientist.

It also gives me the opportunity to tick off another big item on my bucket list.

I'm at a gathering of maths education researchers. And I'm going to begin with a pop quiz.

No calculators; no smartphones allowed! Pencils ready.

### **WHO AM I?**

- I was born in 1820 into a wealthy and well-connected British family.
- As a child, my hobby was building statistical tables, in which I captured trends in the vegetable output from our garden.
- At my request, I was tutored in mathematics for two hours every day.
- I became a maths tutor myself, before applying for a position as a Superintendent in the British military.
- I was deployed to the battlefield, where I collected extensive data on soldier mortality rates.
- This formed the basis of an 850 page report that I published in 1858, saving countless thousands of lives by prompting major reforms in hospital practice.
- I helped to establish the International Statistical Congress and served as a data consultant to the US Army in the American Civil War.
- I also invented the polar area diagram and pioneered the infographic.
- I was elected to the Royal Statistical Society [and here's a big clue...] becoming the first female member at the age of 38.
- I died a legend amongst statisticians in 1910.

I am, of course, FLORENCE NIGHTINGALE: MATHEMATICIAN.

Yes, Florence Nightingale – the Lady with the Lamp. It ought to be the Lady with the Logarithm. She saved far more lives by her grasp of numbers than by her gift for nursing. And she put data at the heart of healthcare as we know it today.

So throw out your textbooks, I'm correcting the record. Florence Nightingale is henceforth the patron saint of mathematics. And I'm paying my personal tribute by drawing out four lessons from her story for maths educators today.

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### *LESSON ONE: Maths is critical.*

Over the past few months I've asked audiences to imagine the world without electricity. You have to step back two hundred years. No electricity, but technology and sophistication were in abundant supply, with, for example, Britain benefiting from steam trains and the House of Lords.

It was already a life you could imagine.

But what if we lived in a world without mathematics?

You have to cast your mind back more than five thousand years, to a world barely crawling from the Stone Age.

Take away numbers, and you take away commerce, farming, medicine, music, architecture, cartography, cooking, sport... and every other activity we've invented since 3000 B.C.

The first thing you looked at today was probably the time. The second was probably the temperature. The third was perhaps your hotel bill.

There is nothing so disempowering as ignorance of the numbers we need to navigate the world.

Never forget, the weakest person in a negotiation is always the person who can't add up in their head.

If I had my way, we would go back in time and reverse the letters in STEM. Maths first – maths as the language of science. Maths as the language of progress! Maths as the pre-requisite for learning, and for life.

But maybe I wouldn't stop there. Maybe I would abandon the acronym entirely.

I consulted on this point with a Year 12 student on a work experience placement in my office last week. She tells me that, amongst students, it's still just as it was: science and maths. 'STEM' had never been mentioned in school.

Science and maths: they're still good words. But let me continue.

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### *Lesson TWO: learning maths is hard.*

It is hard in the sense that it demands our early persistence.

Learning in maths is a continuum – always building the next lesson on the skills mastered in the lessons before.

To fall behind is often to stay behind. And to drop out in school is to kneecap your opportunities in later life.

It is very hard to retrofit the lost lessons into students' brains after they start university, as you know all too well.

Like learning English, kids need to start maths early. And keep going.

I understand the temptation in schools to lighten the content in the maths curriculum, in the dubious belief that easy things are more attractive to students, and *any* maths is surely better than *no* maths.

I also understand the incentives that lead students to study maths at a level below their true ability.

But a lighter load is really a heavier burden: it is the burden of low expectations.

Florence Nightingale understood this reality from an early age. She did not consider herself to be naturally gifted in maths, but she did believe she had the capacity to learn.

And so she refused to settle for the level of maths education thought fitting for girls of her time. She demanded from her parents the support to raise herself to something higher: something that would make it possible to participate fully in public life.

She should be our model for the education of all students: regardless of gender, postcode, cultural background or family income.

And surely, the most effective way to raise expectations in schools is to start at the endpoint of the education continuum: with universities. That is, implement maths prerequisites in all the courses that need a grasp of maths!

At a stroke, we would signal to principals at primary *and* secondary level that they simply can't afford to drop the ball. Maths has got to be a priority for every student, from kindergarten to graduation.

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But that brings me to *Lesson THREE: compulsion is not enough.*

Some children seem to fall in love with maths at birth and, like Florence, are hungry to be taught.

Others need help to turn an arranged marriage with maths into a genuine passion.

That is the role of the teacher: to make a subject not just compulsory, but compelling.

But, of course, it is very difficult for any teacher to inspire a passion that they don't feel themselves.

It is also extremely disrespectful to the profession to assume that anyone can teach maths, as long as they stay at least one lesson ahead of the students in the class.

Maths teachers should, in the first instance, be experts at maths. It's that simple – and yet, it seems, that hard.

In far too many schools, out-of-field teaching remains the norm; peer networks are thin; and professional development is an impossible dream.

We seem locked in a cycle of poor outcomes and diminishing expectations: passing on to each generation of students, teachers and parents the frustration we feel ourselves.

Entrenched practices are hard to break; and demoralising to report.

But just because the problems run deep does not mean that we should shy from solving them.

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And that brings me to my *FINAL lesson from Florence: using evidence to make a difference*.

Imagine the situation Florence Nightingale confronted in the Crimea.

Everyone knew that, in a war, soldiers get shot.

Everyone knew that people who are shot tend to die.

What they *didn't* know was that the vast majority of deaths in the Crimean war weren't caused by wounds at all – they were caused by diseases like cholera and typhus. Thus military leaders didn't implement the basic sanitary precautions in field hospitals and military barracks that would save lives by stopping the spread of disease.

Florence Nightingale saw the problem – but she needed her own ammunition.

So she counted the dead, collected the data, and displayed it in a polar area diagram.

It was a credible, clear and compelling display of the causes of death.

And suddenly the problem was no longer too abstract to ignore. It was fixable.

That is how a woman – a nurse – took on the top brass of the British military and won.

Think of Florence Nightingale the next time you feel that arguing for education reform is like the Charge of the Light Brigade: riding nobly into the Valley of Death.

Evidence can give decision-makers in all these communities the impetus and confidence to act. But it can only do so if we present it in an actionable form.

It cannot be just a statement of problems.

It cannot be just a statement of demands.

It has to be written, and read, as a statement of opportunities.

In all my dealings with politicians, the education sector, industry and parents, I sense an enormous will to change.

Your research can be the springboard they need.

But the springboard has to be fabricated from evidence and solutions.

And it has to be fabricated to minimise the side effects that might cause it to break.

Before I finish, let me leave the specific world of mathematics and return briefly to the broader world of maths and science, and their embodiment in engineering and technology.

Two examples from my work as Chief Scientist. Some of you will know of these projects, either as participants or supporters.

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First, a project on the cusp of realisation.

On my first day in the job, I was handed a thick book. It was called the STEM Program Index, or SPI Guide, and it was a list of extracurricular programs available to students through third party providers, such as firms and universities.

It was a good idea and it patched a faulty connection: the link between providers and students.

But it was a patch of limited use. Being a printed book, the medium limited the message.

It was time-consuming to search. It was a one-way communication with no capacity for feedback from students. Of course, it was out of date even *before* we hit print. And it would be very expensive to hit print again.

The solution was obvious: an online portal. It would turn a temporary patch into a living two-way link.

The model: TripAdvisor – or AirBnB.

The challenge: to build it, test it and resource it.

Inspired by that challenge, we brought together a network of corporate sponsors – Telstra, BHP Billiton Foundation, Commonwealth Bank – and organisational backers – the Department of Industry Science and Innovation, the Australian Mathematical Sciences Institute and Engineers Australia.

We gave it a new name – the Star Portal.

It's now in widespread testing and almost ready to launch. We expect to go live in late July – watch this space. And give us feedback.

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The Star Portal project opened our eyes to another opportunity: to help industry providers to be more strategic with their resources.

We have anecdotal evidence that students and firms can both benefit from well-structured and targeted programs. But we have not collected the evidence systematically or filtered it back into program development.

So industry providers are constantly reinventing the wheel. Other interested parties are deterred by the fact that they simply don't know how to be effective.

How could we empower them to act and channel their enthusiasm in the optimal way?

The COAG Education Council had the same concern. They called for a national STEM Partnerships Forum to find out. And the Forum, which I chair, met for the first time in Parliament House in May.

The first task is to take stock of the current programs and their outcomes, to be presented at our next meeting in a few months' time. We will then be able to determine whether our ingoing assumptions about industry programs are correct; and base future investments on a far more solid foundation.

Evidence in place of intuition.

Florence would be proud.

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Indeed, a toast to Florence Nightingale, the Lady with the Logarithm. And to MERGA as it enters its *quaranta* year.

Let's remind this country there's strength in numbers.

Let's commit to starting maths education early.

To keeping it going.

To treating our education system as a continuum.

To keeping the bar of student aspiration high.

To helping students clear the bar.

To fighting the incumbency bias.

And above all, to taking our research beyond observations, into the realm of solutions.

Enjoy your conference.

**THANK YOU**