



**Australian Government**  

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**Chief Scientist**

**DR ALAN FINKEL AO**

**Mathematical Association of Victoria**

**Keynote address**

***The prerequisite for success***

**Friday 7<sup>th</sup> December 2018**

**La Trobe University  
MELBOURNE**

The organisers promised you a fiery speech on the importance of mathematics. I promise not to disappoint the organisers, after all they are providing morning tea for all of us.

But first, I want to take a moment to bask in the glory of this astonishing year of triumphs for Australian maths.

2018. A composite number composed of two prime numbers multiplied together.

But more to the point, a vintage year.

We began in January, with the Australia Day Awards.

Australia, meet the Head of Maths from Cherrybrook High, Mr Eddie Woo: teacher, YouTuber – and now, officially, our Local Hero.

Then it was May, and Australian mathematician Geordie Williamson was elected at the age of just 36 as the youngest living fellow of the Royal Society. And not just the youngest living Fellow in maths, the youngest living Fellow, full stop, barring only Prince William – who I think we can agree, is in a category of his own.

To July, and what brilliant news from Romania! Two golds, three silvers and a bronze for our students at the International Mathematical Olympiad, for an overall ranking of 11th – our best performance since 2015, and our third best of all time. And 40 per cent of the Mathematics Olympiad teams were from Victoria.

Also in July, and right here in Melbourne, an Australian Team of students took out first place in the International Mathematical Modelling Challenge for the first time.

And Nalini Joshi, the first female professor of mathematics at the University of Sydney, was elected Vice-President of the International Mathematical Union – the highest position in the global maths community that an Australian has ever held.

To August, and now it's the Fields Medal.

“What's the Fields Medal?” said every news reporter in the country.

Only the Nobel Prize for Mathematics, of course... with the difference being that you've got to wait four years for each announcement, and only 60 people in history have ever received it.

And we can now add a second Australian name to that honour roll: Professor Akshay Venkatesh, *also* just 36.

Then, and still in October, we're gathered again in Parliament House for the Prime Minister's Prizes for Science.

And Prime Minister Scott Morrison, in one of his very first speeches as PM, went to the podium and said these words – and I'm going to quote them, because I keep them on file:

*“Do you think intermediate level maths should be a prerequisite for studying engineering at uni? You'd think so. I would think so.”*

*“And as Vice Chancellors come to see me, asking me their usual questions ... I'm going to ask them: ‘What are your prerequisites for science and engineering courses when it comes to maths?’”*

*“We do need to reassert the importance of science and maths because that is essential if we're to have the pipeline of students that we require.”*

Also in October we heard the news that Alison Harcourt had been named 2019 Victorian Senior Australian of the Year, recognising her life-long, and continuing, contribution to mathematics and statistics.

At the age of 89, Alison continues to share her knowledge and passion as a tutor at the University of Melbourne.

And finally, to November, and who's in the news again but Professor Geordie Williamson!

He's getting on a bit now, he's 37; but he's clearly still in a hurry, because he's returning to Australia to head up our first specialist research institute for maths.

And then to December, and the news was seismic in scale, but bittersweet: Geoff Prince, the voice and heart and backbone of Australian maths, is stepping down after 14 years at the helm of the Australian Mathematical Sciences Institute.

Geoff, I can only say it's been an honour.

It's only 7 December. We've still got time for a few more wins.

And I know that there are many thousands of triumphs that I haven't covered.

I mean the sort of triumphs that happen in the classroom every day – when a student, who couldn't turn a decimal into a fraction, and was starting to think she hated maths, and was this close to ripping up the page and giving up – felt something click.

And so many things about the world just made sense: from the price stickers in the supermarket to the numbers on the kitchen scales.

Every time it happens, it's a win for maths – and every win for maths is a win for the nation.

So I acknowledge all those students, and I celebrate all their triumphs – with the teachers who brought them every step of the way.

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But December is not just a time for celebrating achievement. It's the time for reflecting on what comes next.

Teachers are knuckling down to the piles of school reports.

Parents are looking forward to receiving them.

And students might be turning their minds to their subject choices for the years ahead.

Now, it's been a long time since I was one of those parents, and even longer since I was a student.

But you don't forget what it's like to be young – and to feel like you're taking your future in your hands.

And every so often a parent or a student will write to me, seeking my advice.

I got one of those emails this year. And I am sincerely grateful to the family, particularly the student, Marty, for the conversation that followed.

It's one thing to be invited to conferences – which is a routine part of my role as Chief Scientist.

It's a different thing altogether to be invited into a family circle.

You can't squib. You can't agree to initiate a process to develop an outline for a blueprint for a discussion paper for a report.

You have to focus on what's important, and commit.

And it occurred to me that that's exactly what teachers have to do, every day.

So I gathered up my thoughts, and I communicated them to Marty and his dad. And I want to share my thoughts with you today, as my philosophy for what really counts.

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I began with the essentials.

If I could only pick two subjects that every Australian would study for as long as possible in school, it would be English and mathematics.

And there are three reasons why I say this and I trust that every parent will agree.

One, they're fundamental.

English is fundamental, because it's the way that we convey the thoughts and feelings from one human to another.

It's how we reason, and argue, and imagine, and connect.

On the practical level, it's how we write the cover letters that get us jobs. *You need it.*

And maths is also fundamental, because it's the universal language of the modern world.

Maths is the language of science. And economics. And medicine. And engineering.

It's how we describe the increase of the money supply in our economy and the flow of heat in an electric motor. It's how we work out the lifetime cost of a real estate deal and the thickness of steel to ensure that new buildings will not collapse.

So Reason One: English and maths are fundamental.

Reason Two: they have to be learned, and that means they have to be taught, by subject matter specialists, in schools.

It's true that the human brain is an astonishing thing.

And humans, left to their own devices, without education, will grapple desperately for ways to communicate, and to count.

But we don't learn calculus by watching a cup of tea cool down.

And we can't have any comprehension of what calculus is – let alone how we might want to use it - if we don't start laying down the maths foundations from Day One.

Now it might be that a child wakes up on Day One, and doesn't *feel* like doing her mental arithmetic.

But we don't let children starve because they say they don't feel like eating.

We don't let them go unwashed for a month because they decide they don't like baths.

And to my mind, it is just as cruel to give them the choice about maths, at an age when they cannot possibly fathom the consequences.

We have to make the choice today, so that *they* will have choices tomorrow.

That goes for boys, and for girls: they are equally deserving of our high expectations and our constant support.

And that brings me to Reason Three for English and maths: they're empowering.

They enable us to learn new things later on.

Here is a list of things I didn't study in school.

- Computer coding
- Neuroscience.
- Electrophysiology.
- Electronic circuit design
- Flying a plane.
- Writing librettos for a symphony orchestra.
- Scuba diving.
- Property development.

But all of those things were open to me as an adult, and I know, because I've done them.

And all because I had the essential foundations, from school, in English and maths.

Trust me – you don't want to fly with a pilot who can't count.

So start with the two basics – English and mathematics – and from there build up your knowledge of the world around us by studying subjects like History or Chemistry.

There are two other studies that I encourage everyone to keep up for as long as possible from an early age: a musical instrument, and a sport.

Music is sometimes called the language of the soul, the emotions.

And sport is the language of the body.

Just like English and maths, they are our shared inheritance, with their own rules and conventions and codes.

And just like English and maths, if you don't practice music and sport as a child, then you have to work incredibly hard to get half as far as an adult.

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So you can see – I said to Marty – that I'm approaching this question as a matter of stocking your mind.

Now let's talk about your ATAR.

Do not under any circumstances choose your subjects by deciding the ATAR you want and working backwards to the easiest way of obtaining it.

You will be told by people who pretend to be wise in the mysterious ways of ATAR that the higher the number, the wider your choice.

They are wrong. Ignore them. Stay strong.

Because those people are only thinking about the number that might get you into a university.

They're not thinking about the skills you actually need to come out of that university with a degree.

You need to know, I said to Marty, that there are universities in this country that will accept you into an engineering course, or a science course, or an economics course, despite them knowing that you don't have the foundation skills in maths.

You also need to know what happens to students who take that guidance in good faith, drop maths in Year 10, and turn up to university unprepared.

They drop out. They fail. Or they scrape through at the bottom of the class.

And then they're in no position to go out and compete for a job.

You think that's outrageous. I agree. The Prime Minister agrees. Almost everyone agrees!

And nothing changes. No, I can't explain it either.

But now that you know, you can avoid the trap.

Read into the course guides the prerequisites that universities have mysteriously left out.

Study to equip your mind.

In particular, take maths at the level of your true ability.

And rest assured that your focus and discipline will make your time at university far more rewarding.

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Another thing you'll hear, I said, is that specialising in anything is a waste of time.

All you need are skills like teamwork, and public speaking, and resilience – not chemistry, engineering or law.

But let me tell you, I've built a business. I've hired hundreds of people. I know hundreds of people who've done the same thing.

And that's how I know that the wrong way to build a business is with a group of capable people who collectively specialise in nothing at all.

If you want to be the best in business, then you need real experts, who can lift you above the generic thinking of everyone else.

You'll see them described in the business literature as "T shaped workers".



The pillar of the T is the discipline. It's the knowledge and skills that come as easily as breathing: the mastery you can only acquire through hard work and determination.

Climb that pillar, and you can develop the bar: the capacity to work with others and branch out in new directions.

When you're standing on that bar you look at life with a whole new perspective.

You see opportunities that no-one else can – and you trust yourself to take them.

So master a discipline, and give yourself the chance.

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And there our conversation ended.

But I couldn't get the topic off my mind. I felt the urge to call every high school student in the country, shouting "DON'T DROP MATHS!"

Of course, I'm a public servant these days, and I'm fairly confident that acting on that urge would be illegal.

In any event, much better than a phone call from the Chief Scientist would be crystal clear guidance from the education system.

So that students would always be nurtured in an environment of high expectation, with constant encouragement, and the message reinforced at every stage: *this is important and you are capable*.

I looked for those signals.

And I felt like the scientists working to rescue threatened species.

The signals are disappearing from university course guides.

The signals are not there in the popular culture or the media.

And the signals are certainly not there in the approach we take to those critical national assets: the people who specialise in the teaching of maths.

Why *would* you think that maths is important, if for every year of your secondary schooling you were taught by an out-of-field teacher?

In a country like Australia, it seems impossible that that could be true.

But we have the figures from the Australian Mathematical Sciences Institute: that's exactly what happens to eight percent of students.

Less than one in four students is supported by qualified, expert maths teaching professionals, all the way from Year 7 to Year 10.

And that's assuming a definition of "in-field teaching" that the Institute considers inadequate: one semester of study at university.

The dedication of out-of-field teachers to their students is not the issue.

The issue is the lack of commitment right across the system to the teaching of maths.

And even if we woke up tomorrow and made it our top priority, the Institute estimates it would take at least a decade to turn things around.

It's the chicken and egg dilemma.

Without great teachers, we don't develop confident students.

Without confident students, we can't train enough great teachers.

I put my concerns to some deans of engineering and one of them said to me, "But Alan, if we were to reinstate mathematics prerequisites the schools would have a problem because there are not enough secondary-school mathematics teachers."

"Of course there aren't," I replied, "that's because universities have stopped signalling the importance of mathematics!"

We are in a spiral.

So the question for me, and for this conference, is where and how to intervene.

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Let me leave you with three of my recommendations, with a focus on what we can do right now – today.

**Number One: Keep up the pressure on universities to be a connected part of the education system.**

The lack of guidance provided to students about their subject choices is unacceptable.

And until we see improvement, we will continue to send the wrong message to students, to parents and to principals.

Such as advising them to try to game the ATAR.

And then we blame the ATAR.

Wrong target.

ATAR is not meant to stand alone.

ATAR is intended to be a team player.

ATAR plays best as the goalie among the team of prerequisites.

We shouldn't have to tell universities to face up to their responsibilities as part of the education continuum.

For that matter, we shouldn't have to tell them that it's unacceptable to enrol students with a level of preparation that sets them up to fail.

But as regrettable as it is, that's the position we're in.

If this worries you, take heart in that you are in a position to express your concerns to Vice-Chancellors.

To let them know just how hard it is in the absence of a signal from the universities to persuade your students that yes, they really do need to take maths at a challenging level, all the way to the end of Year 12, if they want to keep the doors of opportunity open.

Let's make it impossible for Vice-Chancellors to be ignorant of the fact that their policies have human implications and costs.

It *is* possible for universities to change their position on prerequisites.

In 2016 the University of Sydney announced that it would be reintroducing mathematics prerequisites for 62 degrees, starting next year. I commend the University of Sydney for doing so and I am sure that every other Australian university will be watching closely.

**Number Two. We can do a much better job of celebrating those principals and schools and students who double-down on maths, and get the results.**

Australians have been told for a very long time that maths is in decline.

And Chief Scientists and heads of Mathematics Institutes have been some of the people saying it.

But too often the conversation stops short at “we have a national problem” – before we get to the second half of the sentence: “we can and will do better”.

Maths teachers know better than anyone that when you set out to do something hard in the belief that you’re hopeless and you’re going to fail, it’s amazing how often your prediction comes true.

That’s why great teachers create an atmosphere of high expectation – and pause to acknowledge success.

We can *all* learn from the wisdom of teachers.

And we don’t have to imagine what success would look like – we can find the examples and pick out the common factors in actual schools.

Earlier this year, my office published an Occasional Paper drawing on some research we commissioned from the University of Tasmania.

We didn’t look for the top *performing* schools – instead we looked for the top *improving* schools, which we defined as those whose NAPLAN numeracy scores had significantly improved over a two-year period.

We identified more than 600 schools.

What did those schools we surveyed have in common? Here were the top three characteristics:

- 1) Principals and heads of curriculum who understood and valued mathematics, and made a point of regularly including the heads of math in policy discussions.
- 2) In-school support for professional learning: structured, embedded, and obligatory.
- 3) A cohort of maths teachers with confidence not just in the subject, but in their school, and its commitment to their development.

And none of those things should come as a surprise.

But I want the message to school leaders to be absolutely clear: the responsibility for progress doesn't just lie on the teachers.

It doesn't just rest with the education departments and politicians.

True, we need the universities to step up to the plate, but we cannot wait for them.

Schools themselves need to address the problem.

There is no better time than now.

It comes down to the priorities and the policies of your school. And those are things within your power to improve.

That's not to say that you shouldn't ask more from the system – **which brings me to:**

### **Number Three. Elevating our commitment to teaching as a profession.**

When I think about what it means to be part of a profession, I think about the way that we train engineers.

That was my chosen degree.

Engineering courses are accredited. They have to meet international standards. And if you want to land a senior position, then you'll want to show your employer that your name appears on the National Engineering Register. In Queensland, it's compulsory to be registered. In other parts of the country, it's strongly advised.

Then you have to maintain your registration – and that means meeting the requirement for continuing professional development.

Currently, that's an average of 50 hours per year – with at least half focused on training that is specific to your discipline, such as civil engineering, or electrical or chemical engineering.

And your employers know this when they hire you. They factor it in to the cost of employing accredited, professional engineers.

Professional development is part of the package deal.

So that's how I think of a profession: people we inherently trust, who can trust in turn that their employers will prioritise their discipline-specific training.

Why don't education departments include a requirement for discipline-specific training for teaching?

I know that across the country teachers and organisations like the Mathematical Association of Victoria are already working hard to improve the professional status of teaching as a career.

As Chief Scientist, and as an individual who cares passionately about education, I ask: what more could the system be doing to support our teachers?

In the consultations undertaken for my report to the Commonwealth and state education ministers earlier this year, on optimising the partnerships between businesses and schools in STEM education, the issue of the composition of the 20 hours of professional learning that teachers are already committed to undertaking every year came up frequently.

As a result, in our report to the ministers, we called for the strengthening of teacher professional learning to make sure that the 20 hours required per year includes a proportion of discipline-specific material.

We also called for the discipline-specific training to be delivered by accredited providers.

To be fair, principals and education departments have to make sure teachers have the time and resources to undertake it.

And to be meaningful, it has to be part of the continuing registration process – just like it is for lawyers, just like it is for doctors, and just like it is for registered engineers.

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So there are three ideas I'd like you to think about: encouraging the universities to send proper signals to students and schools, taking responsibility in our schools to implement best practices, and supporting all our teachers as the professionals they are.

And if 2018 was a great year for maths, then 2019 can be even better again.

Enjoy the conference – and May the Force Be With You.

**THANK YOU**