



Australian Government

Chief Scientist

DR CATHY FOLEY AO PSM

**CONASTA 2022:
STANHOPE ORATION**

Teaching for the future

**Tuesday 27 September 2022
Online keynote address**

Good evening!

It's my pleasure to be joining you tonight, albeit not in person – yet it seems somehow appropriate to be beaming in to join you here in our 'Martian Embassy' here in Canberra.

I would like to begin by acknowledging the traditional custodians of the lands that you're on, the Ngunnawal people, and pay my respects to their elders past, present and future. I extend this respect to Indigenous people who may be in attendance today.

Tonight, I stand – virtually, at least – in front of a group of people whom I respect enormously: Australia's science teachers. And the cream of the crop at that! I'd like to extend my warmest congratulations to tonight's winners. You are a credit not only to your profession, but to Australia's education system as a whole.

In fact, I feel I need to start with a confession. While I stand here tonight in my role as Australia's Chief Scientist, I'm also something else: a failed school teacher.

When I was in high school I wanted to save the world. I worked with a range of young Indigenous people, in Wangkumara country near Bourke, as a way to address injustice and improve societal perceptions.

When the time came to finish my schooling, I decided I would be a high school teacher - a very eminent and important profession. I went on to study education, graduated with my teaching diploma, and was even offered a teaching job. But the world of science lured me back in, and I decided to do a PhD first – starting a whole new career in quantum physics.

Although I've loved the path I took, I've always felt a bit guilty about leaving the classroom behind. You – science educators – are such an essential part of our country's future. I don't claim to understand the pressures you are facing in the classroom. But I see you, and I see the enormous job you shoulder on behalf of our next generation.

And you're spread thin. In the news we keep hearing that both teachers and STEM skills are in short supply. If scarcity raises the value of a product, then that means that all of you here in the audience are jewels beyond price!

For once, the hyperbole is right. Science teachers, you are absolutely gems beyond compare.

Because without you, where would we be?

Science is the key to Australia's prosperity.

Just consider how far things have changed in your own teaching careers, however long or short a time that is.

Certainly, there were no rules against mobile phones in classrooms when I was in school!

But even in the last twenty years, we've seen chalk boards and translucency projectors turn into smart boards and online quizzes.

Computers were introduced, became a class, and got smaller. Laptops and tablets went from unheard of, to luxuries, to things some schools have issued to every student!

And over the last few years, many of you would have needed to become overnight experts in videoconferencing and online work solutions.

I'm a joey scout leader, and I was there alongside you during the Sydney COVID lockdowns – frantically learning how to continue my science nights with kits assembled and left on my driveway for families to pick up, and hosting zoom meetings as I showed them how to follow the experiments from their own homes.

But this march of technology serves as only as the tip of the iceberg when it comes to considering the progress enabled by STEM. And there's so much more exciting stuff to come.

Who here loves sci-fi? I do! But the line between sci-fi and reality is getting harder and harder to pick. I know that things that were considered the realm of science fiction when I was a child – even things that are still considered science fiction by most right now - are actually bubbling away very actively! And these are some of the key industries and opportunities that we need to be preparing our next generations for.

Allow me to share some examples.

The Hydrogen fuel industry: Shipping sunshine overseas as the newest clean, renewable fuel! By using renewable energy to crack water into hydrogen and oxygen, this industry aims to export hydrogen as a replacement for natural gas or fuelling vehicles. Once it's burned, the chemistry teachers in the audience will immediately realise that it

recombines to form water vapour once again. There's already two publicly-accessible hydrogen fuelling stations in Australia – one in Melbourne, and the other there in Canberra – with a third announced for Brisbane back in July.¹ It's an industry that's expected to create 8,000 jobs here in Australia by 2030.

Example number two: **Space!** Not just for astronauts. The Australian Space Agency is aiming to triple the size of the Australian space industry by 2030, with another 20,000 jobs.

How about **Artificial Intelligence and Machine Learning**? We've already come a long way –many of us regularly converse with Siri, Alexa, and Google, or can even be surprised to reach a real person in a call centre rather than an automated process. But with another 250,000 jobs expected in this area by 2024 there's so much more happening here, with the digital tech work force expected to be the largest work force in Australia within the next few years.

And of course, there's **Quantum computing and technologies**. We see huge potential for this rapidly emerging industry, which has the opportunity to create 16,000 new Australian STEM jobs by 2040.

By the time your current students graduate, they could be securing jobs in any of those industries, or a dozen more beside. Your challenge, as teachers, is to make sure your students understand that there's an incredible breadth of STEM careers that they haven't ever heard of, many that don't even exist yet.

But if they want to be a rollercoaster engineer, they need STEM. If they want to design the perfect perfume, they need STEM. STEM is all about doing, creating, discovering, exploring; STEM sets you up for a lifetime of curiosity.

Quantum is a particular focus of mine, and I'm really pleased to be leading the development of the government's National Quantum Strategy.

So as just one of those examples I outlined earlier, allow me to unpack this a little more, so you can really understand the scale of the opportunity that you – science teachers – enable through your day to day work.

Quantum is one of those areas where developments are happening incredibly rapidly, and there's little understanding of what it means outside of quantum circles. Which means you might be surprised to hear that Australia is very much at the global forefront in this area.

So what is it?

In short, quantum technologies capitalise on our ability to isolate, control and sense individual quantum particles (like electrons and photons).

Which means that lasers and transistors were quantum technologies.

So is the internet.

Tomorrow, we'll see quantum computers – it's another step on the spectrum.

CSIRO's Quantum Technology Industry Roadmap was released in May 2020. It predicted that Australia's quantum industry could be worth \$4 billion in economic value and create 16,000 new jobs by 2040. That's in the context of a global quantum industry estimated to be worth at least \$86 billion at that time.

Australia is already home to a number of world leading quantum technology ventures, including those across fields of hardware, software, cybersecurity, sensing, and quantum industry supply chain needs.

The holy grail of quantum research is the fully error-corrected quantum computer, and it's not as far off as we think.

Unlike classical computers, quantum computers can perform multiple operations simultaneously, which gives them a unique capability for modelling systems with many interacting parts. Companies are already developing software for quantum computers to model biological molecules and chemical reactions which are too complex to be simulated on regular computers. This work promises breakthroughs such as greatly speeding up pharmaceutical development, designing new catalysts for more environmentally friendly batteries, or better modelling weather events.

Imagine the potential for scheduling high school timetables – I am sure there are many deputy principals who would love to access better optimisation systems!!

But there are many other technologies coming that are equally brilliant.

Researchers at the University of Adelaide and CSIRO are developing **quantum batteries**, potentially a whole new class of energy storage devices. Quantum batteries take advantage of quantum mechanics principals and can reduce their charging time the bigger they get. Quantum batteries could significantly impact how we capture and store renewable energy, providing significant cost reductions.

Over at the University of Queensland, they've created a **quantum microscope** that reveals biological structures otherwise impossible to see. Current light microscopes use lasers, and fragile biological systems can only survive these for a short time. A quantum microscope uses the principle of quantum entanglement to view biological structures without destroying them, with reports of up to 35% improved clarity.

And Quantum gravity sensors are being developed that will be more sensitive and faster than existing sensors used in mining or construction industries. This could enable us to find ore deposits that are otherwise invisible through current techniques. In cities this could reduce the cost of construction and excavation, and the time that people spend living with the building works next door or roadworks blocking the streets. An example from my own research is CSIRO's LANDTEM system.

I personally liken quantum technologies to the internet; what **can't** we use it for? It's going to transform a whole range of industries, in ways that will seem obvious and brilliant and convenient to future generations but may currently escape us.

That was a lot to take in, wasn't it? And all of that was just **one** in-depth example of an emerging STEM industry. Just one. There are so many others, many of which are further progressed already. So I hope you were taking notes to tell your students!

I say again: science is the key to Australia's prosperity – and to unlocking the best future for our planet.

Thankfully, the world's population agrees. We trust in science to help us solve our problems.

The 3M global survey shows that trust in science and scientists rose during the pandemic, with 91% of people surveyed agreeing with the statement "I trust science", and 86% agreeing that they trust scientists.

But on a deep level, we also know that without science literacy – without science interests and skills – we can't unlock those benefits.

Just look at the fact that the same survey showed that 56 per cent of people don't trust science facts shared through social media – and for Australians, that went up to 65 per cent.

I think that's because we know that science is more than just blind belief; it's that unique combination of curiosity, investigation and verification. We don't all need to be scientists to understand science, but we do need to be taught how to navigate in a STEM- dominated world.

And that's where you come in.

I wanted to share one of my earliest memories that set me on the path to becoming Australia's Chief Scientist.

There was one particular teacher when I was in at high school, Sister Mary Keanie.

I'm dyslexic, and I was terrible at writing and spelling - the things a convent girl is meant to excel in. Rather than sentencing me to endless handwriting practice drills, she encouraged me to go in the annual science teachers' association experiment competition.

I loved the idea of understanding the world around me, answering the question "why is it so?" Engaging in school science research opened up my desire to be a researcher, even though I had no idea what that might be. Ultimately, that conviction led me to my PhD, a 36 year career at CSIRO, and now to my role as the federal government's chief independent science advisor.

So never underestimate the important role of an inspirational teacher!

Science teachers. Sparkers of curiosity, the Why is it so?-ers of the schoolyard.

We need you more than ever.

We need to inspire a curiosity in science for our next generations, encourage the pursuit of a science or broader STEM education, instil an attitude of adaptability, and above all, excitement for the future.

Unfortunately, the numbers aren't going the way we want.

When you look at babies, we know they are born scientists. What is this? How does that work? Why did that happen? And they investigate endlessly – usually by putting the item in question in their mouth, which is something we discourage in the laboratory.

But as they grow, their interests diverge.

I'm not going to stand here and say that every student must be an aspiring scientist. We need the full might of human diversity in **all** our fields of endeavour! But it breaks my heart to see the numbers showing us that children who would have loved to pursue STEM careers are finding themselves dissuaded along the path.

We know that students can fall behind and lose interest in mathematics in primary school, and that the number of secondary school students choosing to take physics and higher maths subjects continues to fall.

In 2022, the number of HSC students studying physics was 7700, down from nine and a half thousand just five years ago. That's a stark fall, and says difficult times ahead to those thousands of future industries hoping to recruit physics- literate graduates.

We need to work hard to address these barriers to creating the STEM workforce that Australia needs. To inspire children to study these subjects and to show them the possibilities; but also to show them that science isn't an exclusive club.

Australia's talent pool is massively limited by the underrepresentation of half of Australia's population – girls and women – in STEM education and careers.

The Federal Government's STEM Equity Monitor shows that in 2020, women made up only 38 per cent of university STEM completions and 19 per cent of VET STEM completions."

We need to access our full human potential. We need to be inclusive.

I know this isn't news to many of you here tonight; in fact, you are our fiercest warriors in the battle to see every child given access to follow their STEM dreams. But you can't do it alone; you shouldn't be asked to.

It takes the whole of society working together to address a whole-of-society issue.

I know that Australia's Women in STEM ambassador, Prof Lisa Harvey Smith, is a very active ally in this space. And as Australia's Chief Scientist, one of my key roles is to champion our science and research community, both here at home and internationally. As far as I'm concerned, this means paying attention to the science and research community of our future – making sure that it is vibrant and well-supplied with young people who have followed a STEM careers pathway.

So what am I doing?

Although I have a lot of different irons in this fire, there are two projects I'd particularly like to share with you tonight.

The first is open access.

As STEM educators, you know that trying to get to direct scientific literature is like trying to break through a brick wall – the paywall. If you don't belong to an organisation that pays for a subscription to a scientific journal, reading the latest breakthroughs in science is often an exceptionally expensive endeavour, with individual papers usually costing between \$30 and \$70 to access. Each!

When we teach our students how to do proper research and record their sources, we tell them to go past Wikipedia and back to the original source wherever possible. But that paywall means there is unequal access – not just in the classroom, but across the whole of the global science and research sector.

For those without the golden key, keeping up with research becomes a giant game of telephone. There's a stark divide between the haves and the have-nots. If your student is curious about the latest discovery or wants to check that 'weird science fact' from tiktok, they are stopped in their tracks.

The same problem applies to everyone, from government to industry and even university libraries having to pick and choose which subscriptions they can afford. In many cases people are effectively paying twice for the research, with government often funding the work in the first place.

Your ability to read about STEM breakthroughs or fact check with the source should not be limited by your pocketbook. That's why I am

working to develop an open access model for Australia, where everyone residing in Australia would have free access to international research literature, and research led by Australians would be openly accessible to the world.

It's a work in progress, and there's still much to do. But there's a lot of people with skin in this game, and progress is happening.

I said two projects, so now I'll move on to the second. This second project is working to embed more scientific capability at every level of the Australian public service, through a program my office calls the Science Policy Fellowships.

It provides a pathway for early-to-mid career scientists to become skilled policy practitioners so that they can bring their scientific expertise into government functions.

Fellows are employed as policy officers in Australian Government departments for 12 months – not as a chemist or a physicist or whatever their science specialty is, but as well-trained, science literate minds providing input to national policy decisions right from the start.

Their training and skills as research scientists means they can ask the hard questions when it matters the most, to ensure that Australia's future is built on evidence-based advice. Just as importantly, it means that Australia's policy makers are reminded of the absolute importance of having STEM skills and STEM literacy baked into programs and policies.

And it's been a huge success. I was delighted that the program was made a permanent feature of the Public Service last year, after a three-year pilot. Our graduates are highly valued, with the vast majority of them moving into permanent public service positions.

Australia's STEM teachers.

You are the absolute foundation of everything we are aiming for in the decades to come. Your passion, your dedication, and your service impact all of us – not just your students now, but also those that your students will interact with in turn over their lives.

As Chief Scientist I am in a privileged position where I see the science goals and ideas that are still on the horizon. And it's a brilliant and exciting vista.

With the power of science on our side, the outlook is bright.

You are the luminaries who will help light the way, for us now and the generations to come.

Congratulations again, and thank you – tonight is your night, and it's an honour to celebrate it with you.

ⁱ <https://www.drive.com.au/news/new-hydrogen-refuelling-station-for-brisbane/>