

# Mary O’Kane Transcript

Career pathway

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Interviewer: Welcome Professor O’Kane and thank you for agreeing to this interview.

Mary O’Kane: Thank you.

Interviewer : When you left high school was the career in science and engineering the path that you planned?

Mary:

No, not really. You know if I’m really honest, I’d tell you I was actually thinking of going to do law or maybe engineering. But this is a long time ago. This is in the early 70’s, and my father didn’t want me to do either of those. So, I knew I was good at science. so I chose that.

Interviewer : Was there something or someone that ignited your interest in this area?

Mary: Partly my father and partly my mother. My mother had been an accountant, but she was very good at mathematics and that gave me I think an early love of maths. And my father had been a science teacher. And we had, I think, we were an unusual family, but at the dinner table we talked about maths problems and science things, and it was a very, very uncool family. And so, you know, sort of my ideas were sort of sparked there. I had some brilliant teachers, not every teacher was good. I found that some teachers were great and inspiring and a few were pedestrian, I suppose, but some were great. And then I was really lucky – I won a prize in the end of about Year 9 – and I think it was a book, which I think was called ‘The Strange Story of the Quantum’, and it was about Quantum Mechanics. And I remember reading it over the hot summer in Queensland that summer. And I just loved the story of Quantum Mechanics, and the history of it and the brilliance of the ideas. And I was totally fired up with a love of physics and that, in a way, underpins all my love of science. As well as all the inspiring people including my parents.

Interviewer: What sort of mathematical background do you need in order to follow a career in Engineering?

Mary: As much maths as possible is the simple answer. The right; the absolutely correct answer, is you should do as high level maths as you can. But that said, the underpinning correct answer is, you really need confidence in mathematics. And even if you didn’t do the right maths at school, there are generally alternative pathways to pick up the maths later even if it slows down the time you take at university. But above all it’s feeling confident and enjoying maths. And sometimes that has to do with the teacher. And people might lose confidence a bit but it’s always important with maths to stop and think ‘What’s going on here?’ It’s not about a simple formula. It’s about the underlying issues. So, underpinning all of it really, is a love of symbolic reasoning. And for some people it shows up in being very good in foreign languages and, sort of even sometimes, in aspects in things like English grammar or in logic and philosophy. So it’s not always first apparent in people in maths, it

actually often occurs in other fields. So I always say to people, 'Follow what you love and you might find that you're better in maths than you realise'.

## Achievements

Interviewer : What advice could you offer to young women considering a career in engineering and science?

Mary O'Kane: Well above all, see if they... what they enjoy about things, and to follow what aspect of science do I like. What aspect of... well you don't see Engineering at school so much... but to see what aspects they particularly like. And that will influence what areas of science or engineering they go into. So, if you really love Biology, you might do the bio sciences or you might do medicine or you might do chemical engineering from the sort of biochemical side. If you really enjoy maths, you might end up doing maths but then you'd probably also enjoy the very electrical engineering, aeronautical engineering, those ends of things. If you like physics almost every area is good. But if you don't like chemistry so much you might prefer something like civil engineering or electrical to, say, the more 'wet areas' of engineering like chemical. So I always say to people, see what you really like and follow your dream in those areas.

Interviewer: What are some of the things that you have done in your career that have really given you a sense of achievement?

Mary: Sometimes they're not the expected thing. I'll pick a few. One was – I should explain my research area was automatic speech recognition. Teaching computers to understand speech and, these days, it sort of seems old hat but, when I started way back in the mid 70's, we knew very, very little about how computers would understand speech. It was a very exciting field and for me, some of the most exciting areas were learning how to, so called, word spot, where we very early on taught computers to understand big words in continuous speech. You know sometimes you're listening over a bad telephone-line and you can barely hear it, but you can pick out long words? We taught the computers to do that. And that was quite useful for a range of things because you could do automatic indexing of speech and so on. And it allowed you to work out, roughly guess at the meaning of things. So, well before they could understand the full run of a sentence, at least we could do that. And we found that a group in Japan had done almost the same thing by a slightly different method and it was really exciting for my group here in Australia to find this group in Japan and we all became really close friends. And to this day, it's been the basis of a great friendship between these two groups across the two countries. But another thing that was important to me, was outside being a scientist per se but being on science committees. I think I changed the way we think about the way we assess science for giving out grants. And in particular, as a joke, I invented a term. When I was talking about people... I noticed when I took over chairing one of the biggest granting bodies for the Commonwealth Government that very few women got grants. And very few people under 40 got grants under this system and I said to... I was chairing the committee and I said to the others 'While I'm the Chair, we're going to change this, we're going to make sure that just great research is rewarded and I think that means us concentrating...'. And I was just about to say, 'On young women' and I realised it was the days of high political correctness, and I said, 'On early career researchers.' That term is now used around the world to signify people who are relatively early in their careers, because they're not always just young sometimes they've moved and it doesn't discriminate between females or males. So, it's a funny little thing but the impact, a sort of a joking reference

had, and turned into big studies. It's been translated into many terms. It's funny, it's a big sense of achievement to know that lots of younger people have got great big research grants because the system was invented that allowed people to look at... to judge their careers differently.

Benefits of a science career

Interviewer 1: What do you see as the benefits of a career in the sciences or even engineering?

Mary O'Kane: To me there's one overarching benefit and that is the intellectual satisfaction of solving quite unusual and difficult problems. Things that people say you can't do and I just – somebody says you can't do something, it's almost like an invitation to do it for me. And it's been really interesting to tackle super hard problems and to do something that's useful for people and to me that's been the continuing satisfaction to be associated with science and engineering.

Interviewer 2: What is your role as chief scientist of New South Wales?

Mary: It's to encourage people to think about science, to think about engineering, it's to encourage young people to do maths and science at school and then hopefully to go on and to do it at university and then think about careers that are based in science, it's to encourage stronger relationships between our research entities in the state and the state government and business here. So that in particular the universities of the state but also the commonwealth entities here, CSIRO, ANSTO - The Australian Nuclear Science and Technology Organisation, things like the Australian Standards Laboratory to work together to really concentrate on the state's problems and issues and it's to try and get more research funding into the state. And they're the main things, but occasionally the Premier or one of the Ministers will ask me to look at a particular issue for them. So recently, I chaired an advisory committee on nanotechnology to prepare the government's response to the nanotechnology enquiry that the parliament did last year... or the Legislative Council of the parliament. So it can be there. But, you know, I could be asked about sharks one day and nuclear fission the next. It's exciting. It can be on any area of science but of course, I don't know all the fields. I mean, I know a few areas of science in depth and as I've said... I've chaired research committees so I have a dangerously small knowledge about a lot of fields. But in particular, what I do is call on eminent scientific colleagues to help me on things. So in some ways it's a co-ordinating role saying to people give me advice on this, you give me advice on that and then my office will bring it together and pass it on to ministers. It's great fun.

Interviewer 1: How do you think that we can encourage students to continue in the sciences and engineering?

Mary: Again, I think we need to do a few things. One is encourage them, as I said, to follow their dream. If they enjoy science, allow them to really explore that. I think we need very much to support our good science teachers and encourage excellent people to go into science teaching, and to make that a very high status profession. And, I think, what we ought to do is encourage the mums and dads to think about science really early. I always think... why I say it's really important to say to young girls and young boys when they're in kindergarten and below, you know when they're crawling, to think, 'You know, I want to be a fireman. No, I want to be a scientist.' So I think it's very much encouraging that, encouraging people to take their children to see museums; to allow people to sort of do science subjects and not be afraid of them; and to talk about science. I'm not

suggesting all families be as mad as my family of origin, but I think it's there. And sometimes it's also allowing people to do other things and then come back to science. And I find, you know, with some of my stepchildren, they weren't interested in science but they came back into it. So I think, as I said it always, to me, comes back to following your dream.

Interviewer 1: Thank you for speaking to us, Professor O'Kane.

Mary: Thank you and they were wonderful questions and you know I'm very impressed with your self assurance in asking.

Interviewer: Thank you.

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Scientific thinking

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Interviewer: Mary thank you very much for the opportunity to speak with us today about science and the way it's taught in schools. In schools, what we do is, we try to emulate to some extent, what happens in science.

Mary O'Kane: Yes.

Interviewer: Can you tell me why, you think, scientific thinking is such an important skill?

Mary: I think it's very important to... as a sort of underpinning; a reality check, if you like, on the world at large. At one level it allows us to interpret the natural world and the built environment, and to make sense of it. And, I think, that's important so that people have a sense of place in the world and a sense of, not exactly control, but a sense of being able to fit naturally and understand phenomena. I mean, to me, it's important when I see a great flash of lightning to actually have some understanding of what's going on. And, I think, a lot of people like some sort of understanding of things like that. So, I think, it's important in that regard. It does actually allow us to understand so much of what is happening. That said, to me it's also a great mystery, to me it's just something I love doing. So, sometimes it's a little bit hard to explain.

Interviewer: Teamwork is an important part of working and researching. How can teachers develop these teamwork skills in students?

Mary: I think part of it, is encouraging the students to work in teams when doing prac' classes and also, I think, to work in teams when building hypotheses. Since the development of a hypothesis, the testing of it, is such a fundamental issue and skill in science. Sometimes it's not just about the mad, lone scientist in a corner doing things. It's about somebody putting a hypothesis on the table and others discussing it and tearing it apart, and being able to debate and discuss, and then test it. But being able to do it in a way that's friendly, that is respectful of each other, and, I think, there's nothing like having to work in a team and come up with a result. Or if you're more in the constructive sciences like, let's say, civil engineering or something like that, or out to architecture, it's terribly important for people to be able to work as a team and again bring a critical eye to things, but not a carping eye; not demolishing the other person in the process of querying their ideas.

## Scientific method

Interviewer: Controlled experiments are one way that we teach about the scientific method in the schools. We change one thing – the independent variable, and we measure something – the dependent variable, and we want to try and make sure that all the other variables are held constant. Is this really the way that science proceeds?

Mary O’Kane: Yes, I think it does, I think that actually is a very, very good description of an awful lot of science and, I think, if I think into that question a little bit, it’s particularly about... we are doing that to try and understand the factors in any particular hypothesis. So, when we develop a hypothesis, we’ll say it’s this issue interacting with that issue, interacting with that third one, that fourth one. And to understand if these things really do contribute as our hypothesis suggest, we have to hold at any one time all the variables constant apart from one and modify that if we can. Sometimes of course, and of course there’s nothing like the Heisenberg Uncertainty Principle here, sometimes you can’t modify one without modifying the others and then you’ve got to find some way to measure a change in the system. And of course, all of this then goes back to, ‘Did we have the right hypothesis?’ So, it’s I guess... while it’s a great general approach to things of course, it all then turns on some underlying issues like our hypothesis or whether we truly have independent variables. But yes, it’s certainly a skill we need to know; is how to have a dependent and an independent variable. And you can’t get into the more complex things without understanding that.

## Scientific discovery

Interviewer: Is it true then, that sometimes science research does proceed, not down such a rigid path of simple independent variable and controlled variable?

Mary O’Kane: Absolutely and we both can think of loads of examples of that. And, I think, sometimes the greatest science breakthroughs come when things don’t proceed as you thought.

Interviewer: Serendipitously!

Mary: Serendipitously and also when you... the results are just so far from what you predicted, and you’ve got to go back and say ‘What’s really going on here?’ Or ‘What should I have constructed?’ if you were in the more constructivist side. And it leads you to think more deeply and often, much more creatively about things. And come up with a new approach to the problem and a new, more comprehensive hypothesis, or can start constructing again. And, I guess, when I think about it, that’s one of the great joys of science. You need to be very robust in the face of things not working, and to be constantly questioning and probing. And it’s right back to your first question about sort of why one would think of thinking about science or use science reasoning. I think again, it’s one of the real excitements, and particularly in the 20th and the 21st Centuries has been, to see the march of great theories, and their testing and what we’ve been able to construct on the back of them, and to see what science has really been able to contribute. Also to see the downsides of some science when we didn’t adequately look at all the results of what happened. And, you know, the great debate on climate change is the great example. Whatever the reality is the lesson we learn is we have to be constantly querying and looking at our hypotheses.

## Valid experiments

Interviewer: Making sure the results of an experiment are valid and reliable ...

Mary: Yes.

Interviewer: ... is an important part of the research process.

Mary: Yes, indeed.

Interviewer: How do you make sure the results of an experiment are valid and reliable?

Mary: My approach has got a couple of points to it. One is to generally repeat the experiment, two or three times. I find it's very important to do that and to be sort of looking at what things externally might affect issues. But I think, one of the great tests, when you're very secure about your own results in real science, it's quite important generally to try and get them replicated in a lab by another group that's independent of your own. And to have them do the experiment. And I always feel a lot more confident when I'm reading scientific literature if the experiment has been done by two independent or more groups, and there are very simple instructions in the paper for how you might replicate it.

Reliable information

Interviewer: Where would you recommend students get up-to-date information about science matters?

Mary o'Kane: If they're really keen, I think there's nothing like the science literature and, I think, you can read it at quite a young age. You don't have to understand every bit of it. There's the abstract end papers and I think, these days, with the web it's easy, relatively easy. Not all of it's there but quite a lot of science literature is available. If they don't have as much time, I do think, some of the great science journals like Science and Nature are very good for reading; even some of the more generalist journals that take a very responsible approach, like Economist. Its science pages are very good too. And, I think, things like that are good. There are some wonderful sites on the web. But again, you're got to read them with some care or you've got to find the right, right ones and, I think, that's where great teachers like yourself are good for pointing to students as to where to go.

Interviewer: How can we assess the reliability of scientific information that's presented in the mass media?

Mary: I think the thing to do is to always be critical and slightly sceptical. To listen and say, 'Now I wonder if that is true?... Should I go and read about that somewhere else?... Should I actually look at several sources?' I mean for me triangulation is one of the great things. When I'm interested in some topic, and I'm a bit doubtful about what I hear, I will often do even a quick search on things like Wikipedia to see what people said there to see if it reflects any debate on the matter. I'll look for divergent opinions then, if I'm interested, I will go into it... deeper and deeper literature, and read articles about it. But in science... science moves forward by people always querying aspects of the core hypothesis, and, I think, science is rarely finished, if you like. I think almost all areas are evolving. I mean just think of wayback with physics, sort of Newtonian Physics. People thought they understood about physics and then Quantum Physics was discovered. And we've moved into sort of new eras as... over the last hundred years has been extremely fast, in this. So I think, you should

always think that even, whatever you're reading, even if it's quite good for explaining things, there probably will be some other angle, later on.

Interviewer: Where would you advise students to get up-to-date information on science matters?

Mary: Well, I think in the first instance, I'd suggest they look at things like... well actually the newspapers are good for sparking things. And then you need to, I think, think about 'What's behind this?' And you might go to things, general science magazines like 'Science' or 'Nature'. But I actually say for anyone who's keen, go to the literature and I don't think you've got to be a grand, many year trained scientist to read it. Reading abstracts should be written, even in the most obscure of journals, in language that somebody at good high school science can read. So I encourage people to actually be very brave and go into the literature if they can. These days so much is available on the web and, sort of guided by good teachers like yourself, I think students can benefit a lot by seeing science in the raw if you like.

Science anarchy?

Interviewer: Mary, I think we were talking about the way that we teach science in schools is a fairly, fairly strict interpretation of the scientific method. And perhaps I might have an interpretation beyond the school context, that perhaps science proceeds somewhat more with imperial anarchy, rather than in a strict direct line.

Mary O'Kane: Absolutely, I just love that term 'imperial anarchy' and that's what I actually have found as in my sort of science and engineering career. It's never quite that simple. I mean I did think a lot about that question about dependent and independent variables, and I think that skill is so important to have, but in real life, it's often about a whole system. And it's often you prod and poke at one area and again... well it mightn't be down at the scale of the Heisenberg Uncertainty Principle, in real life often things are a lot more interconnected. And there are distinct second order effects going on. It makes me wonder how we should conceptualise that because we're both using the term messy and anarchist, but it really is real life, isn't it, in science?

Interviewer: Hmm.

Mary: And maybe we need to sort of say to students it's a bit more complex and you've... as I was saying before, you've got to be very robust in looking at results and saying, 'Am I seeing what I think I'm seeing?... Should I query this a bit more?... Should I set up another experiment to test it?' So the people understand there's a certain chaoticness to what's going on. Certainly, rarely a process is linear in science.

Interviewer: Well one thing that we try to do I suppose in science in years 7 to 10 is we do get students to take on research projects ...

Mary: Oh yes, yeah.

Interviewer: ... where students do have an opportunity to answer a problem or test a hypothesis themselves; designing their own procedure or designing an experiment. In that process students do get a feeling, an understanding or a sense of the experiment doesn't always go right. So there needs

to be a process of modifying the procedure, or changing the experiment entirely, so that they can perhaps better answer the problem that they're trying to investigate.

Mary: And it classically brings together science and design. Now I think challenging science projects of that sort are one of the most wonderful things and to me they've always been inspiring. And I can tell you a funny, personal story about getting the hypothesis wrong or getting the science quite wrong. I always went into science competitions all through my childhood, and at one point I was entranced by solar technology. I built a solar water distiller that actually... backyard one that worked well, just from a few packing crates and plastic bag, black plastic bags that was fine. Then I decided I'd build a solar cooker. And I found an old sort of parabolic shaped farm implement, something off a plough I think. And covered it, painted it silver, and shone it up, and it got to quite a good focal point and I decided I'd cook a sausage. So I cooked the famous sausage over the sort of centre point, which was a black pole going up in the middle of this parabolic shaped arrangement. And the sausage obligingly went black. I thought I was... this was a really cheap solar cooker. Took one bite of the sausage and it was raw. What had happened was the black paint had come off the central pole. So you always have to be willing to test your theories.

Interviewer: Mary, thank you very much for spending your time to talk about science and the way that we teach it in schools.

Mary: Thank you, it's been a great opportunity to talk.

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## Resources

These resources may be accessed via the Teaching and Learning Exchange [www.tale.edu.au](http://www.tale.edu.au)  
Science Talk 2007 features a range of masterclasses and interviews with national and international award-winning scientists. Science Talk 2008 featured four young Tall Poppies as well as famous astronomers Fred Watson and David Malin.

Science Talk 2008:

[http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/scitalk08/index.htm?Signature=\(d281ffd4-d9ad-40cf-8ad5-3291dd020f94\)](http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/scitalk08/index.htm?Signature=(d281ffd4-d9ad-40cf-8ad5-3291dd020f94))

Science Talk 2007:

<http://www.cli.nsw.edu.au/cli/sciencetalk/>

Fred Watson Masterclass:

[http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/fred\\_watson/index.htm?Signature=\(84667f6e-379c-4a35-a6b4-1080908a478f\)](http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/fred_watson/index.htm?Signature=(84667f6e-379c-4a35-a6b4-1080908a478f))

Science

This resource is based on outcomes from the NSW Board of Studies 7-10 Science syllabus and the Preliminary and HSC Science Syllabuses.

## Syllabus links

- BOS Science 7 to 10 syllabus link.

Stage 4/5 - Prescribed Focus Areas

Students will develop knowledge and understanding of:

- \* the history of science
- \* the nature and practice of science
- \* applications and uses of science
- \* current issues, research and development.

Students learn about:

4/5.2 the nature and practice of science

Students learn to:

- a) evaluate the role of creativity, curiosity, objectivity and logical reasoning in describing phenomena, carrying out investigations and in the devising and testing of hypotheses
- c) apply scientific processes to test the validity of ideas and theories
- e) use examples which show that scientists isolate a set of observations, identify trends and patterns and construct hypotheses or models to explain these

Students learn about:

4/5.3 the application and uses of science

Students learn to:

- d) give reasons why society should support scientific research

Students learn about:

4/5.5 current issues, research and developments in science

Students learn to:

- a) describe some recent scientific contributions made by male and female scientists, including Australians, and discuss the effect of their contributions
- b) evaluate the potential impact of some issues raised in the mass media that require some scientific understanding

d) identify possible career paths in science.

Stage 6 – Prescribed Focus Areas

Skills

P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources

H12 evaluates ways in which accuracy and reliability could be improved in investigations

H14 assesses the validity of conclusions from gathered data and information

Extract from Science 7 to 10 syllabus, and Preliminary and HSC science syllabuses July 2009, © Board of Studies, NSW.

Quality teaching

This resource provides opportunities to incorporate the following elements of Quality teaching in NSW public schools by:

- \* giving students an opportunity to discover the nature and practice of science (Deep knowledge, Connectedness, Metalanguage, Knowledge integration)
- \* stimulating thought about what inspires people to become scientists (Connectedness, Problematic knowledge).

## Websites

Visit these websites for more information on the work of Professor Mary O’Kane and what she speaks of in the interview.

[http://www.wisenet-australia.org/issue60/AGM\\_address\\_mary\\_okane.htm](http://www.wisenet-australia.org/issue60/AGM_address_mary_okane.htm)

Listen to a short podcast from The Science Show, as Professor Mary O’Kane is interviewed.

[http://mpegmedia.abc.net.au/rn/podcast/2008/10/ssw\\_20081025\\_1210.mp3](http://mpegmedia.abc.net.au/rn/podcast/2008/10/ssw_20081025_1210.mp3)

Professor Mary J O’Kane was appointed as NSW’s first Chief Scientist and Scientific Engineer in 2008.

[http://www.business.nsw.gov.au/newsroom/news\\_chiefscientist\\_20081023.htm](http://www.business.nsw.gov.au/newsroom/news_chiefscientist_20081023.htm)

Also in 2008, the first Chief Scientist of Australian, Professor Penny D Sackett, was appointed. This site offers information on the role of Australia’s Chief Scientist. The ‘media’ section contain videos and interviews with Professor Sackett.

<http://www.chiefscientist.gov.au/about/index.html>

Professor Mary J O’Kane advises that the best place to get good scientific information is at their source, in science journals like *Nature* and *Science*, even if this is only a reading of the abstract. Some Science literature on the net:

Nature.com (includes podcasts; *Scitable* worth accessing for Genetics) <http://www.nature.com/>

Science: <http://www.sciencemag.org/>

COSMOS: <http://www.cosmosmagazine.com/>

NewScientist: <http://www.newscientist.com/>