C O R R E C T E D V E R S I O N

EDUCATION AND TRAINING COMMITTEE

Inquiry into promotion of maths and science education

Melbourne — 6 May 2005

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Mr B. Stevenson, programs manager, Gene Technology Access Centre; and

Dr B. Crabb, Walter and Eliza Hall Institute of Medical Research.

The CHAIR — I declare open this hearing of the Education and Training Committee. This committee is an all-party joint investigative committee of the Parliament of Victoria. It is hearing evidence today in relation to its inquiry into the promotion of maths and science education. I wish to advise those present at this hearing that all evidence taken by the committee, including submissions, is subject to parliamentary privilege and is granted immunity under judicial review pursuant to the Constitution Act and the Parliamentary Committees Act.

I thank the Gene Technology Access Centre (GTAC) for having us here. As I said during our tour earlier, this is the third hearing the committee has conducted on this inquiry so it is in its early stages. We have been looking at the state of the art in terms of education and facilities, and promoting maths and science amongst young people as a good starting point. We are very pleased to be here to hear a presentation from you.

Would you please give your name and title at the start of your presentation. We will hear your presentation and then open up to questions.

Mr STEVENSON — My name is Brian Stevenson and I have the privilege of managing this operation for University High School. I am also a leading teacher at the school and I have been here since 1993. For the last five years I have been working with the school and with Gene Technology Access Centre's partners. It has probably been the most rewarding professional experience of a fairly long teaching life.

What I thought we could do to generate questions and explore a few issues is to give you an overview — an outline — of what GTAC is and how it fits into a broader view of education in Victoria. After I have spoken Dr Brendan Crabb from the Walter and Eliza Hall Institute of Medical Research (WEHI) will talk a little bit about GTAC from WEHI's perspective.

Overheads shown that supported the following comments.

Mr STEVENSON — One of our partners is the Department of Education and Training (DET). DET became a partner in what I call stage 2 of GTAC in around 2000, when University High School and the Walter and Eliza Hall Institute of Medical Research applied for a small grant from the Science in Schools strategy fund. University High School came on board with that initiative. It was an initiative between University High School and the Walter and Eliza Hall Institute of Medical Research. The director of that institute is Professor Suzanne Cory, who is one of the Australia's most highly decorated and renowned scientists. Prior to the school coming on board there was involvement from the Department of Microbiology and Immunology, Melbourne University, in particular due to the efforts of Professor Dick Strugnell. I will talk a little bit about how that department fitted into GTAC prior to the school coming on board.

For our purposes as a school, GTAC began in 2000. In the last five years one aspect of our main operation has been a willingness and ability to collaborate with like-minded institutions. There was so much ground to cover, and so many people doing both similar things and different things, that there was no point in taking somebody else's turf and reinventing wheels; it was better if we collaborated. We are in collaboration with the Murdoch Children's Research Institute (MCRI), particularly on matters of gene issues and gene ethics.

Five years ago I collaborated with the Melbourne Museum and with others. At that stage we instituted a program called 'Gene Tech', and I think the first one was Gene Tech 2002 and now we are up to GeneTech 2005. It is a three-day event which is held during education week. Biotechnology Australia is a federal organisation made up of five federal departments and within that there is the Gene Technology Information Service. We actively collaborate with them.

GTAC has been active and is increasingly so in relating to our colleagues in various professional associations, including teacher associations, and not just in Victoria; we have done presentations in South Australia and Queensland. We have attended meetings in Canberra with Biotechnology of Australia. Last weekend was really exciting because we had the pleasure of presenting to a group of Northern Territory teachers in Alice Springs. We were invited up there because they saw the tasks on our web site. So we will actively work with other associations.

Our sponsors are the Victorian government, which largely funded the construction of this building, and the Walter and Eliza Hall Institute. I seriously doubt whether GTAC would exist without WEHI. They have been enormously supportive not just in terms of intellectual property and willingness to give various in-kind support in so many ways, but also they have attracted significant funding, which allows students and teachers to enjoy some of the

equipment and the resources that you have seen in this building. Funding has been obtained by WEHI from the Colonial Foundation, the Pratt Foundation and from a personal donation of Dame Elisabeth Murdoch.

Here is a little bit of history of the GTAC evolution, but I have also given you a short, printed copy of the history of GTAC. Professor Suzanne Cory visited the Dolan DNA Learning Centre in 1995. That is the centre attached to the Cold Spring Harbor Laboratories, and the then director of it was James Watson, one of the co-discoverers of the structure of DNA. This learning centre was set up for teachers and students. Suzanne Cory came back to Melbourne and said to herself and to others, 'Why can't we do something like this in Melbourne?'

In 1995, or just after that, due to her interest in supporting teachers and students and enthusing them about science, WEHI established a summer school for teachers. This was in collaboration with the Department of Microbiology at Melbourne University and with people like Jim Pittard and later Dick Strugnell. I attended one of those summer schools I think in 1997, the second year of them being held. Those summer schools continued up until around about 1999. They were enormously successful — a week of intensive laboratory work — which certainly upgraded teachers knowledge of molecular biology and their skill base. However, over that time too the numbers declined somewhat from perhaps 30 or 40 people initially. The later ones may have only attracted about 20-or-so teachers in about 1999. This puzzled Suzanne, and rightly so because it was an excellent course and it was basically very contemporary.

At that stage University High School became involved. Suzanne said, 'Look, I think we should do something about students because the teachers seem to be drifting away'. So what the University High School did was to supply I guess the educational expertise to broaden the program. The program has diversified, and by that I mean that we are not just looking after teacher PD for one week of the year, we are looking after teachers and their professional development needs more often; and we are also developing programs for students, particularly the lab workshops but as you will see a little bit later we have other programs as well.

The key feature of, as I said downstairs, the learning environment is the fact that students or any participant can work with young scientists as their mentors for 2½ to 3 hours. We initially started those programs in the biology lab in the south wing of University High School. They were successful from the outset. Of course our space was limited, so we did lab workshops on Wednesdays and Thursdays during school time. In term 3 I also did lab workshops on Saturdays because of the demand from VCE students and teachers.

Our programs existed before the building existed. GTAC was known before the building was thought of. Funding became available in 2001 in the May state budget, announced by the then minister, Mary Delahunty. It took a couple of years to organise the building and design it, and the centre opened in April 2004. This year we would expect around about 5000 students from across the state of Victoria, from all education sectors, to visit GTAC. Since we began programs in February, and we are just two weeks into term 2, there have been around about 1500 students visiting GTAC, so we are well on target for that.

Goals — these were the goals from the outset. The management group comprises school interests — such as the principal, me, WEHI interests, such as Brendan and Suzanne Cory; and micro-interests, such as *Dick Strugnell — and the government's interests via its education people at 33 St Andrews Place. That comprises what I call the management group. There has never been any disagreement on what the aim or the focus of this project has been. It has been an absolutely harmonious project, and it is very interesting that it is considering the diversity of people, where they have come from and all the various agendas. But our goals are clear from the outset. We want to excite young people about science. We want them to have the opportunity to work with young scientists. We certainly want to help teachers to improve their skill base. We want to give them effective PD programs rather than PD programs. We want to give them resources, such as Drew Berry's molecular animations, and that has been possible. The thing I am particularly interested in, which so many teachers I have spoken to really do want, is the ability to sit down and listen to somebody who is a cutting-edge researcher and hear the stories. My definition of good teaching is good storytelling. One of our goals is to try to reconnect teachers to their discipline base, to the contemporary discipline base in molecular biology. I will come back to this.

If we do all that, obviously we are increasing the genetic literacy in the community. We are making it a more aware and informed community because there are going to be important debates about the societal issues which arise from applications in biotechnology, or what scientists are doing. It is important that the debates, as we would all agree, are informed.

I think if you ask anyone involved in GTAC, and you ask the thousands of students and hundreds and hundreds of teachers, they would say, 'Yes, we like coming to GTAC'. So I think there are some interesting points to make about why GTAC has been such a success. The strong collaborative partnership has been crucial. It is a true collaborative partnership and it is extremely strong. The diversified funding sources are important. That gives ownership and various groups can lay claim to supporting GTAC. It also helps the government economically.

There is no doubt we have had a highly committed and focused team of people. GTAC is recognition that individuals, or a few individuals, can make a considerable difference if they have funding, the drive and resources. The GTAC staff comprises now its full staffing component, which is 5.4 staff mathematically — the manager, two education officers, one laboratory head, 0.6 ICT coordinator and a 0.8 administrative assistant. That is the GTAC core staff. Of course our staff is much broader than that. It comprises people like Brendan Crabb and people in various science faculties or various departments — for example, at the science faculty of Melbourne University. It comprises all those other people in various collaborative roles who we rely on and work with. So the staff is very broad in one sense. We are certainly backed by eminent research scientists, so we have access to their intellectual property. We also have access to educational expertise that knows what works for teachers and students.

This a grassroots development in many ways. It has grown up from teachers and the insights to recognise what teachers need and how students learn. If you try to put it all together and what does it mean, it is really a fusion — my word — of secondary, tertiary and research cultures and expertise, all mixed up in one building, both physically and intellectually. You cannot get away from the unique geography. Could there be another GTAC somewhere else? Possibly. But this particular area of Melbourne, the Parkville educational precinct, was sort of crying out for it, in a sense, because all our resources are only minutes away from one another. The fact that young scientists can leave their own laboratory benches and 2 minutes later be working with year 8 or 9 students is a unique piece of geography. It is that immediacy which I think is so important.

We have already seen the learning environment. You have seen bits of that first hand, so there is nothing new in that particular slide: small group work, lots of animations, use of computer work, the best resources we can get our hands on, clear explanations and importantly, too, there is a reasonable hospitality aspect to all our programs. We really do see students and teachers as our special guests and they are treated as such.

Numbers talk. This is just a little visual to show you that programs did take off. As I said, in this year, 2005, the collective total number of students will approach 5000.

Mrs BUCKINGHAM — Brian, when you say 'middle school', is that year 8 to year 10?

Mr STEVENSON — Yes. There is the same sort of pattern with teachers. By the middle of this year we will collate data into terms of how many schools in Victoria have seen students or teachers to GTAC. We will have that sort of information by the middle of the year and I think that will be very interesting.

The CHAIR — Will that be by school?

Mr STEVENSON — Yes, it will show what schools came.

The CHAIR — Just out of interest, in terms of country, city, eastern, northern?

Mr STEVENSON — That will be the breakdown. We have a huge grid of all the schools and we are filling that in to show whether they have sent students or teachers.

The CHAIR — Will that be available?

Mr STEVENSON — We will make it available. Roughly speaking, about 66 per cent of students are from government schools and about a third are from non-government schools. Teachers attending PD are roughly fifty-fifty between government and non-government sector schools.

GTAC is a world-class facility. As I said before, the centre is designed around programs. The programs — the intellectual property — came first and then we said, 'What sort of a building do we need to make these programmes work best?'. I think by and large we got it. The building has a focus on what we call functional flexibility. We can turn labs upside down, we can pull out walls, we can retract seats in the theatre and we can change the function of rooms very, very easily. Importantly, and the thing which appeals to me a lot, is the fact that the design allows for simultaneous staging of programs. There is one example of that which is worth recalling. It

happened to be on 11 November last year. There was a researcher visiting from the US and there was a group of about 30 scientists from the Walter and Eliza Hall Institute in the theatre listening to the researcher. There was a group of year 9 students from Sunbury in the lab, working with their own personal scientists.

Then Jacinta, whom you met previously, had that group of teachers working with bioinformaticists and computational biologists in the computer room. Take a snapshot of GTAC at 12 o'clock on 11 November 2004 and all those groups were working within 3 or 4 metres of one another. That is a powerful statement as to what the centre can be like. All those different groups were working in the same building, basically at various stages of the same program.

Symbolic references to DNA: we wanted to make a few statements, so we had a helical staircase of sorts. It is a great staircase, easy to walk up and down. We can light it up at night, so you can see a helical pattern of light from Royal Parade. The architect searched the world for chromosomes on the carpet. This is the nearest we got to it, but it is not bad. The architect also wanted to know what a cell was so I tried to do my best bit of teaching. The ceiling on the first floor represents cellular shapes. There is even an optic fibre cable going around which glows blue in the dark and represents the cell membrane, the outer boundary of the cell. He sort of got it right; it was a good effort. There are lots of other things. The little bits of blue, yellow, red and green glass in the concrete everywhere represent the four nitrogen bases of the DNA code. There are lots of things, hidden little symbolisms, which amuse us, if they do not amuse anyone else.

Of course, the building offers an exciting learning environment — we know that — and really it sets a new benchmark in what can be done. The Victorian government should be extremely proud of that, because it is a special place. I will not go through all this but we will send you a copy, if you want to read it later.

Student programs? Yes. Teacher programs? Yes. Not just teacher programs for secondary people but teacher programs for primary teachers and, importantly, teacher programs for pre-service teachers.

Some time ago I was also teaching biology method in the faculty of education at the University of Melbourne under Rod Fawns and Kaye Stacey, from whom you will hear this afternoon. At that stage GTAC was just starting. What I did was bring all the biology students who were doing the dip. ed. course over to the GTAC lab. We introduced them to the sorts of tools and techniques that we introduce other students to. For three years I used to survey the dip. ed. students doing biology method at Melbourne University. We developed a program of peer tutors. To the ones who said, 'I know how to do gel electrophoreses or PCR', I said, 'Good on you; you can become a tutor for the others who don't'. About a third of the biology cohort in 2001 and 2002 — about that time — knew nothing about molecular biology, had never experienced the tools and equipment, and yet the next year they were going to be biology teachers and possibly teaching VCE biology in schools.

In 2006 the new biology study design — Brendan was on one of the expert committees and I have been on the committee that designed it — has a focus on more molecular biology.

Community education is also important. This is a diverse program and this is where collaborations come into their own. Interestingly, we did one program for the media professionals because I think we got a little bit tired of reading the wrong stuff about DNA in newspapers. We had about 20 young journalists and we tried to explain to them — I think, largely successfully — about DNA. They extracted it; they pretended they were from a crime scene and they could identify people. We are doing the same thing with some legal professionals during Education Week. That should be exciting. I think we have about 40 of them. I think Education Week also coincides with Law Week; an interesting juxtaposition.

We do specialist programs. If the Parliament of Victoria would like a specialist program, we can arrange that as well.

The CHAIR — We may do that.

Mr STEVENSON — Can students be wrong? No, not normally. Students are generally honest. They are generally fairly observant and they will usually see through things which do not work. You can read this, but over the five-year period — and these are only some scores pulled out of 2004 because most of 2004 was in this building. We get students to rate various statements as to, 'Yes, I strongly agree', or down to, 'I strongly disagree'. These sorts of scores have been consistent year after year and they speak for themselves. They love working with their scientists; even the kids who say, 'I do not like science much'. They all go away with a positive experience.

The CHAIR — Why do you have the final dot point in the negative, just out of interest, as opposed to, 'I describe myself as a student …'?

Mr STEVENSON — Because it is so easy for a kid to get so excited and run down the sheet with five, and you have to ask yourself the question, 'Are they reading it all?'.

The CHAIR — Good point.

Mr STEVENSON — So we switched to see how many 5's end up in the last box. It confuses Brendan sometimes.

Dr CRABB — I ask the same question every year. Does that mean we did badly?

Mr STEVENSON — I have read your terms of reference and Brendan will talk more and pick up on some of these things, but I asked myself the question, 'How does GTAC fit into your terms of reference?'. It really is the example of perhaps ideally what teachers and students would love to have in every school.

It is certainly a structured learning environment based upon teaching expertise and operational administrative expertise in setting up sub-schools, which it technically is sort of, with a high level of subject knowledge — scientists, eminent research scientists, they are all there — using research-quality equipment, which is the same sort of stuff as an honours student would use at Melbourne University. There are good ICT resources and the whole focus is to engage and encourage participation.

Yes, it has global connections, starting from Suzanne Corey's vision in 1995. But we have also checked these places out ourselves and, as I said, we have access to some of the world's best teaching resources, and you have a copy — which is not classified, Nick — of the DNAi interactive to take home and have a look at. By the way, that was made available by the Walter and Eliza Hall Institute. It has distributed those across New Zealand and Australia free of charge. In the US it is being sold; in the UK and across Europe it is being sold. But it is being given away to any teacher, any school who asks for it across the country.

Point no. 3 — and we have said this — the GTAC program is for all Victorian students and teachers. We have a focus on country Victoria. Last year we made some money available whereby we could help some Victorian country schools outside the 200 kilometre limit around Melbourne to get down to GTAC and to have a GTAC experience.

Donald High School is coming up here in a couple of weeks. We do a special program because they bring all their year 12s to Melbourne for three days, which is cost-effective. We fit in; we modify our programs to suit the needs of particular schools.

We also conduct wet labs in Mildura. We take our demonstrators, our toys, up to Mildura Senior College and we work there for a weekend. We try to give them as many experiences as possible. Mildura is too far for anyone to come to Melbourne so we go to them instead.

Programs involve all educational sectors — we have said that. They are backed up by direction, advice, intellectual resources from the research institutes — Melbourne University, WEHI and others. Young research scientists act as scientist mentors and it is their passion and expertise that the students really relate to. Importantly — and I am particularly interested in how you can reconnect teachers to their discipline, give them something new to talk about — give them new material for storytelling. That comes into it as well.

Point 6, I notice you are talking about gender balances. I think the GTAC learning environment breaks down scientist stereotypes very effectively. We face the problem that most of the PhD students who work with us and work with students are female and it is important, occasionally, to let people know there are male PhD students in molecular biology. But it is a particularly good environment where stereotypes are broken down.

As I said in the theatre, we are also interested in showing students who do not want to do lab work that they may be a graphic artist like Drew Berry, or they may have brilliant communication skills so they can be advising people through genetic counselling; a whole range of things. We try to point out that the career choices in science are diverse; they are not just test tubes and white coats.

Of course we also help PhD students. We give them an opportunity to clarify and to explain to others what they are basically doing; to a lay-audience if you like. We also give them the opportunity to teach students, and some of them have decided that teaching is a good thing to do. There are a couple I know of who have said, 'Okay, research is not for me'. Then they ring me up and say, 'Brian, will you write me a reference because I want to become a teacher'. I say, 'Are you really sure?', because the GTAC learning environment is not quite like a classroom and they can get a little bit excited, so I have to be a little bit realistic for them. But they are brilliant communicators and if that level of communication and passion was maintained they would certainly get students involved. That is enough from me.

The CHAIR — Brendan, could you give your name and title for Hansard?

Dr CRABB — My name is Brendan Crabb and I am a research scientist from the Walter and Eliza Hall Institute of Medical Research here in Parkville. I do not have any particular agenda here today. I just have a few things I would like to raise and many of them have been covered in what Brian just said. Really, they are just my own thoughts and views on GTAC from my own perspective.

As I said, I am a research scientist; that is what I do full time. My involvement in GTAC and in educational activities at GTAC is purely voluntary. That is one of the in-kind contributions that WEHI makes, and I guess I would say I am here representing WEHI today. I also have a connection with the University of Melbourne where I was a lecturer for five years and in fact in the department there is another partner here, so I have a connection to both academic partners in this joint venture.

I am a molecular biologist. I work on infectious diseases. These days I mostly work on malaria. I run a team of researchers, bachelor students and post doctorate guys many of whom contribute here at Gene Technology Access Centre, not just in my lab but across the institute, university and outside the contributors here at GTAC.

I am certainly not an educationalist. I am not trained in that sense. I will just speak from a scientific perspective. I have listed three things that GTAC does that I notice regularly that keep me involved. The first thing is that GTAC provides a direct contact, which is a no middleman type approach, between high-end working scientists and secondary students and teachers and primary teachers too. That might not sound particularly spectacular, but it is an innovative thing to have pulled off to have a mechanism by good luck or good management that has allowed that. You might come up with two to 5000 students and a reasonable number of teachers accessing high-class scientists in a given year. It is amazing. That means that is not just the privileged few that get that contact, but quite a large number do. This is not a specifically DNA biotechnology issue that I rank as the no. 1 significant thing of GTAC. This relates to the broad impact on scientific literacy on the community. A large number of our young people and teachers can get that sort of contact.

The scientists that I mean and am referring to are a quite large range, such as Nobel Laureate Peter Doherty who is from the department of microbiology and immunology these days and contributes to and supports our program for younger people through to PhD students. The point was just made about breaking down stereotypes. Perhaps one of the most significant impacts that this contact has had on students is that they see these people as normal non nerdy people. That is a tremendously effective tool. They are young people who are bright, enthusiastic but otherwise pretty normal. They like their weekends off and nights out. They like surfing and all the rest of it.

Those might sound like trivial things, but kids connect with this. This is very important, but they are also people who are completely driven and passionate about science, scientific discovery. They know the most recent things and can impart that to students. Again I stress, to a large number of students this is a broad impact on scientific literacy in the state. That will flow through into the longer term. That is the key reason that I am involved. Through that there is contact as well. There are tremendous opportunities to integrate real research applications into schools. This is something that our curriculum committee is really interested in, not just the curriculum we can develop here but what things can be taken back into schools. This is something that will be occupying a fair bit of our thinking in the coming years. The direct contact between scientists and students without the middleman is the first thing that I enjoy about GTAC.

The second thing that has mentioned is that we are specifically about education in biotechnology. I do not need to be telling this committee about the importance of biotechnology in today's society already. It is of the future. It is pure coincidence that we have the synchrotron on the way. The synchrotron is all about biotechnology which is a very important development in this state.

We want a crop of young adults coming up who are very comfortable with the idea of biotechnology development and words like 'synchrotron' and what it is trying to do. We think we can teach people about this emerging science and about the industries that are surrounding it in an informative way. We have many of the best exponents directly involved in teaching. We think we do it in an unbiased way because none of us has any commercial associations — that I am aware of — that we could benefit from in this regard.

In many respects we can sound like we are promoting it because we use it and we are excited by biotechnology, but in truth we are very interested and involved in the ethical issues surrounding gene technologies and gene ethics. They are integrated into our programs. Many of us are involved in gene ethics activities outside of GTAC as well. We can give a very broad perspective to students about the technical nature of biotechnology; the societal and ethical issues surrounding the use of it; how we think it will be used; how it is being used and, how it is likely to change society in the future.

As I said in my first point, the value I think it has is more generic than biotechnology. The topic itself is of crucial importance to the future of Victoria and Australia. That is the second thing we do.

The third thing is to identify, access and attract kids to science and science related professions before they have had a chance to go off to university. I often find that people get interested in science later in life. When I got involved in GTAC and science education in schools, the second most important thing to me rather than the gene technology aspect was to try and inspire kids about science before they had set their career paths not in stone but by choosing various university courses and pathways in their life. That is really what I try and do. What interests and motivates a number of us is to try and attract kids. We are not necessarily interested in the next brilliant scientist out there that might — heaven forbid! — go and do law if they did not know about science before that. I do not have a problem with law.

The CHAIR — You would be the only person in Melbourne!

Dr CRABB — We want them to know about the opportunities. With science there is a little bit of a learning curve to get over. Kids do well at science at school but I do not think they really know what it means to be a scientist or in a science related profession. Relative to other professions, it is a bit abstract. We want the brilliant minds to consider science before they enter university and — broader than that — science related professions and the teaching of science. This is a major reason why GTAC exists. That is linked to point 1 about scientific literacy in the community. It is a bit more targeted than point 1. It is really about interesting people and getting students at the end of their school life to consider science and science-related professions as an option for their careers. They are the things that I am inspired by and why I am involved in this activity in a purely voluntary way.

It is why Walter and Eliza Hall Institute of Research is so committed to it as well. I concur with all the points that Brian has made. It is a tremendous joint venture which is its secret to success. We get on very well and think very similarly in our goals, despite our different backgrounds and expertises. We are in an incredible location. You may not realise it, but this is one of the great biomedical precincts in the world in terms of the number and quality of scientists that are in Parkville area. It is very rare.

I think we take advantage of that very well; it is not difficult for us to get people in to contribute because there are just so many around of that quality. I will leave it at that and would be very happy to answer any questions you might have if I can be of help.

The CHAIR — Thank you, Brendan, for your presentations. They were very informative and quite thought provoking.

Mr KOTSIRAS — You said earlier that there are or are not some skill shortages in science? If so, and I asked you for two things that schools should do to encourage more students, male and female, to undertake science courses and maths, what would be those things?

Dr CRABB — They are good questions. I am certainly not qualified to say whether there is a skill shortage in science. Intuitively I feel that it is low down on the rung of choices for students at schools to choose science-related professions. That is an intuitive feeling — as I said I am not an educational teacher trained.

Mr KOTSIRAS — No, but you are part of research and with the brain drain, are we filling that vacancy?

Dr CRABB — No, I do not think we are filling the vacancy although we are producing lots of high-quality scientists which is another problem with the brain drain. We lose them to overseas. We cannot retain them and that is a secondary issue. But I do not think we are getting enough high-quality students coming through science and the biggest impediment to that is exposure to science before university or before they make career choices at the end of school. I do not think they are informed enough for whatever reasons about what a scientific career means.

I think there are very negative connotations around scientific careers with remuneration, for example, which is to a fair extent unwarranted. I would not say that it is a highly paid profession, but it is certainly nowhere near the lowest, and these very simple messages are what students are wanting answers to when they come through GTAC. They think, 'What sort of jobs can I get? How much do I get paid?'. Their impression is that it is the bottom of the barrel and that is simply not true. I think that it is their lack of knowledge about what a real scientist does and what science professions there are. It is not just basic research science like I do.

There are lots of commercial and semi-commercial opportunities and peripheral activity sciences like media science, law and so on that are associated with what is an enormous and growing industry. I think that is the biggest gap — that kids do not know about it. They do not know enough about it before they make career decisions and that was the point I was trying to make before, that I think they realise it later in life. Many people who have taken other professions up say, 'Had I known what I know now about what opportunities there are and what it means to be involved in science, I might have made some different choices' — I am not sure whether that is two things.

Mr KOTSIRAS — In choosing such a wonderful facility, it is possible that things you do here could be replicated in the teaching at schools? If you are saying that when kids come here they gain love for science and see what science is all about, should schools be looking at what you are doing here to perhaps do similar things?

Dr CRABB — Not necessarily, possibly but I think that the secrets to the success of GTAC do involve some unique circumstances that I have pointed out and they would be very difficult to replicate exactly. There are probably lessons in the partnerships that we have together and the direct nature of contacting students with those at the pointy end of the other side of the profession. That is the lesson which could be extrapolated to other schools, not necessarily gene technology but other scientific and non-scientific issues.

Now the space centre and the environmental centre are two cases in point where this is potentially going to happen. As I say there are some unique aspects to that work simply because of geography and perhaps because some of the personnel. There are a series of passionate people involved and Brian is one them — and that is really why it has happened.

Mrs BUCKINGHAM — I have two questions. Are all the science mentors and the work they do here voluntary?

Dr CRABB — Brian can answer that.

Mr STEVENSON — No-one tells them they have to do it. They get some pocket money from it. It is a little bit less than what the university would pay for an equivalent demonstrator job. As I said before, it is good for their own communication skill base and for their own curriculum vitae work to say, 'Yes, I have communicated my passion'. They all get a start. If they are interested, they come over and have a look at a workshop in action. I let them sit and watch others do it and say, 'Do you think you could do that?'. They say, 'Yes'. They really get into it. They work out their own little stories about explaining things to kids. For the first few sessions I tend to look at them as I would look at pre-service teachers on teaching rounds in a sense. They have got to feel comfortable; they have got to be able to communicate. They have to convey their passion and most of them do that, and they get paid for it.

Mrs BUCKINGHAM — How do you decide how to choose these scientists? Do you look at the work they are doing and find out if it hooks into the Victorian certificate of education course or into some other aspect of the science curriculum across the year levels and then decide to put a small program about that? How do you decide who to use?

Mr STEVENSON — The programs are largely based on the curriculum. The Victorian curriculum is the basis of programs because as I said before, we have to fulfil student need and teacher need. If we were doing something on a day-to-day basis which was not relevant to the curriculum in schools, teachers — no matter how

interested they would be — would not come. So there has to be a basis but that does not mean we are limited to the school curriculum, because as Brendan and I would agree, we would then want — once we have an audience — to expand on what is possible, to stretch the curriculum; to go outside the boundaries.

How do I select any of the scientist mentors who come across here? We give them the protocols. We tell them what the activities are going to be, so they get to know the protocols. They can talk to the education staff; they can talk to the lab head; and they can talk to the demonstrators who have done the same protocol previously. With the new protocols, we get them all together and we brief them on the educational aspects of the protocols, not on the sciences. They know more science than I do.

Out of that sort of process they self-select, they say, "Yes, when is the next workshop?'. Then I come back and look at them from afar as a teacher would with student teachers just to make sure that things are going right and that does not take very long. Remember we have the legal responsibility in a sense for their actions as well as student actions to them. They are protected, and as well the students are protected. It works like that.

Dr CRABB — Also all of those PhD students had supervisors as well. Of course it is a fairly small community, and we are all in contact with each other

Mr STEVENSON — We speak to each other about it, just the same as any teacher would speak to another teacher about students.

Mrs BUCKINGHAM — Brendan I have a question for you. In that third point you identified what this centre does in identifying and attracting kids to the science professions. I was a careers practitioner before I entered politics, and I have a particular worry about funnelling kids into careers very early on by their choice of subjects, because by the end of year 10 you have to have chosen what subjects you want to do to enter university courses. I wonder what you think about that, because I know Monash University has taken away all prerequisites for science. You can now get into a science degree at Monash without having done science right through your secondary schooling, which seems interesting, I would say! I wonder what you think about the need to have done science at a secondary level in order to go on to do it at university, or whether you think in fact that you are preventing kids by funnelling them into certain areas by year 10 when in fact they might get to university and find that they do have an interest that they never knew was there beforehand.

Dr CRABB — Having quite some knowledge of the US system and probably from my own bias anyway, I am very much against funnelling too early. To a fair degree, the later the better, and removing restrictions on university entry for science is a tremendous thing. It is not necessary to have done science in school. Obviously you get a head start if that is the case, but I favour having more generalised university degrees which involve science and other activities to cope with a style that says that you do not need to make early decisions about career paths. There is an element of science and science careers that older people develop an interest in. That is probably just related to maturity and to exposure to other things. Science is linked to life, and I think that people realise some of those things slightly later down the track.

In the US, where you do general degrees at university for the first three years, a lot of people choose science in those years and not before at high school, and that is how they head down their career. Science is booming in the US and it has been for some time, and I think this is a key reason why that is happening. Without seeing the facts and figures it is hard to be definite about it, but that is my experience. I travel to the US many times a year and for quite some years I have been exposed to scientists and science students, and that is my impression — that they benefit greatly by having a more general and less-focused educational experience in their latter school and early university years.

Ms MUNT — Firstly, I want to thank you for going through this with us. It is just so interesting. I had no idea that the science engine was sitting here working in this way. It has been an absolute revelation for me and I would like to congratulate you on all that you doing. I have written down a few points that I would like to explore a bit more fully.

The program has gone basically from 0 to 5000 like a rocket, which means that there is a lot of interest out there. There is a lot of demand for your product in effect. You were saying that there are particular things that make this precinct perfect for it. I wonder if there are any other precincts that would also be perfect because of the high level of demand. You did mention the synchrotron that is next to Monash University. Is that another precinct where all the factors would come together?

Dr CRABB — Quite possibly. The factor I do not know about out there — and I almost raised it — is the school situation. The biotechnology park out there, even before the synchrotron's time, is the other major focus in Melbourne. It would certainly have a number of scientists and university teaching academics to pull that off. The school thing is the uncertainty as far as I am concerned. But, yes, that is the other place in Melbourne that you can do something from a biomedical point of view. Perhaps gene technology would not be the way to do it; we could do it via another biomedical topic. Certainly that is the only other place I can think of that would have the concentration.

The CHAIR — Monash had plans originally for a private school in the middle of that set up there, which was not really all that inspiring. But I think it is also looking at education out there.

Mr KOTSIRAS — They were going to open up a maths-science school and were hoping it was going to be in Tuesday's budget, but it was not.

Mr STEVENSON — Just on that point, Wellington in New Zealand is an ideal place. Wellington Girls School is a government school in Wellington, New Zealand. It has been out here three times. It is very close to Victoria University in Wellington; it is a 10-minute travel time between the two campuses. Our model has become enormously attractive to them. But regional towns are good, like Ballarat. There are universities and schools that are close to each other in a town so collaboration is possible.

Ms MUNT — The other thing was that the Walter and Eliza Hall Institute is part of this collaboration and really involved in it, and as I am sitting here I am wondering, to put in bluntly, what does WEHI get out of it?

Dr CRABB — Nothing directly. Part of our charter can be broadly read as needing to promote science in the community. That is what we are about. We are a public good institution, and we choose to do what public good we can in a number of different ways. Obviously our primary product is scientific research output in the form of publications, and the things come from that are products and therapies and so on for people. But it is broader than that. Our charter is to promote science in the community in a broader way. We all do that in different ways. We all give public lectures and give our time freely in many forums, so this is just an extension of that. With GTAC it has become a more formalised extension. But the Walter and Eliza Hall Institute and university academics are exactly the same — they are all public good institutions, and it is very much a part of life for us all, not just for our institution.

Ms MUNT — I also noticed that the teachers who come in for their PD, basically come from a fifty-fifty ratio of independent schools and state schools. But that is not the percentage of state schools and independent schools. Are the independent schools taking up on this at a higher rate than the state schools?

Mr STEVENSON — They are. If you open a booking for a particular program, like a teacher PD program, the first flood of inquiries are from non-government schools.

Ms MUNT — Is there a particular reason for that? Are they reading their emails more?

Mr STEVENSON — That could be a reason. Seriously!

Ms MUNT — Yes, because they are so busy.

Mr STEVENSON — But it does catch up a bit. It interests me too, because I think there is a greater vigilance to see what is on. They seem to be more on the lookout for what is out there.

Ms MUNT — Is that actually translating through to the students who come in, Brian? Is there a higher take-up by independent school students than by state school students?

Mr STEVENSON — The student workshops, the lab workshops — as I said, about two-thirds of them are from government schools. University High School is a government school. It just happens that way.

The CHAIR — Brian, I wonder whether we could quickly speak about how you handle your recurrent budget. Is there a fee for service that you do for schools in terms of recurrent, in terms of staffing costs and in terms of equipment?

Mr STEVENSON — I was waiting for somebody to ask me that question. The funding from the Department of Education and Training is currently based on two education officers and a certain amount of recurrent funding. The rest of the staff and equipment money has come through WEHI. We would like the Victorian government to basically say, 'Here is the sum of money that GTAC will get for the next two or three, or four or five years'. That would imply some long-term commitment and some sustainability. Sustainability is a two-way street. If we guys are going to go to the trouble of trying to chase down the rest of the funding for staffing in the next few years, it would be nice to know that all partners are equally committed to the funding. Currently we get our money in six-month grabs.

The CHAIR — It is funded under the same program for the zoo officers — has it changed its name or is it separate?

Dr CRABB — No, it is the three centres — Bacchus Marsh, when Strathmore get up, and us. Currently we are under the learning, innovations and excellence group. I think Dawn Davis is the manager of that particular group. There was some indication that the three centres may be moved somewhere else, which is a little unsettling. Security of funding is a problem, and having commitment for a couple of years would be very nice.

Mr STEVENSON — I agree.

The CHAIR — Okay. So obviously it was not funded as a line item recurrent in the budget when the budget — —

Mr STEVENSON — It is described as a budget pressure.

The CHAIR — That is clear. Following on from what Nick says, what would you see as the most important reform outside of GTAC in terms of your ordinary schools science program to engender a greater passion and interest among students in science? Would it be curriculum, is it teaching PD, is it equipment? What are your big dot points that you would say from your years of experience?

Dr CRABB — Brian could much better answer this.

The CHAIR — You can put it to him.

Mr STEVENSON — It's a big answer. There are lots of aspects. Money and resources are all part of the equation. What we are really saying is, 'How do we keep teachers excited when they are learning about their discipline, and how do we keep their excitement and passion up to convey that to students over a long period of time?'. Without the resources and the facilities there is a drain on energy, but I am equally critical of the teacher who becomes the carrier of a text book, year after year after year as their only script.

Students these days have access to knowledge everywhere. There is no mystery about accessing knowledge. There may be some mystery about understanding the knowledge or having it explained to you in a particular way, hence my thing about teachers needing to be good story tellers.

I think kids understand teachers. A classroom teacher of year 8 science is not a science expert. A lot of them are text book carriers, carrying somebody else's script. Sometimes they read well from it and sometimes they read badly from it.

The CHAIR — By default, bad for teaching and encouraging students, do you think?

Mr STEVENSON — It is really complex and I think a lot of teachers end up being gatekeepers, looking after the gate and not really saying, 'How can I reinvent myself a bit? Where do I get the energy from to reinvent myself?'.

When I ended up, or finished off, as head of the VCE school here after eight years, I could have done two things. I could have said, 'I think I will go and retire totally', or as I said, 'I think I will play around with GTAC and see where it takes me'. I cannot quite explain how one can became reinvented and how I can get this enormous boost of energy to go on and do this, but it is still there. But I think there has got to be support for teachers. There are a whole lot of things like sabbaticals. How many teachers are given the task of writing something, going back to their discipline and writing something up so they have new story-telling material?

The CHAIR — Professional support, sabbaticals, greater involvement in industry, and better equipped classrooms and science rooms — —

Dr CRABB — Greater involvement with the practitioners in the discipline, which may or may not be industry.

The CHAIR — Yes.

Mr STEVENSON — When does a history teacher become a historian? When does an English teacher spend any time writing plays or poems? I do not know. In the same way with the science teacher — when do they have the luxury of looking down a microscope and seeing something new or seeing a new piece of equipment so they can then try and learn it and use that learning to enrich their own students' learning?

Dr CRABB — And whether professional development needs to be more formalised as a process.

The CHAIR — Yes.

Dr CRABB — And do not forget all the other jobs they have to do, but perhaps they should not have to do!

The CHAIR — Thank you for your evidence.

Witnesses withdrew.

CORRECTED VERSION

EDUCATION AND TRAINING COMMITTEE

Inquiry into promotion of maths and science education

Melbourne — 6 May 2005

Members

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Witnesses

Professor J. McKenzie, dean, faculty of science, also representing the faculty of engineering;

Professor K. Stacey, nominee of head, department of science and mathematics education; and

Dr R. Fawns, senior lecturer, department of science and mathematics education, University of Melbourne.

The CHAIR — The evidence and any submissions given at this hearing are subject to parliamentary privilege and are granted immunity from judicial review pursuant to the Constitution Act and the Parliamentary Committees Act. Hansard is recording all that is said. We welcome from the University of Melbourne Professor John McKenzie, Professor Kaye Stacey and Dr Rod Fawns. We will ask you for a presentation and then open up for questions, if that is satisfactory. Please introduce yourself for the Hansard officers.

Prof. STACEY — My name is Kaye Stacey from the University of Melbourne faculty of education.

Prof. McKENZIE — I am Professor John McKenzie, Dean of the Faculty of Science, and I occupy the position of Secretary (Education and Public Awareness) at the Australian Academy of Science.

Dr FAWNS — I am Rod Fawns, head of science education and coordinator of dip. ed.

The CHAIR — Would you like to talk to us first and make a presentation.

Prof. McKENZIE — I could start. Thank you for the opportunity of making a submission and speaking to you today. Clearly this is an area of vital importance not just to Victoria, but Australia. We are very conscious, in fact at all levels whether it is dean of science or the Academy of Science, that governments of both persuasions are continually making statements about the importance of a knowledge-led, technologically-led future. We obviously agree with that, but if you look at the actual underpinning in terms of the capacity of teachers to be appropriately trained from a scientific technical viewpoint and, as my colleagues have observed from educational faculties, pedagogically based, there is something of a disconnect between the rhetoric and the underpinning reality.

I apologise that I have only three copies of these, but the data are provided on the Australian Council of Deans of Science web site. It is a publication that involved independent surveying. The survey was conducted by the Centre for the Study for Higher Education at the University of Melbourne. They have surveyed teachers, schools and principals across Australia. The exercise is focused on the profile of teachers in biology, science, chemistry, physics and geology, which is relevant in some other states.

The CHAIR — Sorry, John, who is doing that?

Prof. McKENZIE — The Australian Council of Deans of Science commissioned the survey as it has done in a number of other components. This document is, Who is Teaching Science? Briefly for the committee — and I do encourage members to look through — the message that stands out is that if you are looking at the background qualifications in terms of discipline capacity of people teaching physics and chemistry, we are at a crisis situation as a nation. If you look at the age profile of the people who are well qualified in terms of their discipline background to be able teach those subjects, there are more people in the 45-plus age group than there are in younger age groups.

If you look at the difficulty that schools have in attracting and retaining teachers in science generally, but particularly teachers in science in physics and chemistry, if you are in a government school you have a much greater challenge than if you are in a Catholic school, which in turn has a greater challenge than if you are in a private school. If you are in a government school in a regional area your probability of attracting a physics teacher is very low indeed.

So there are real challenges. I should say that when one that looks at the data in entirety while Victoria does not do well; we actually do better than a number of other states. But I would say we are probably a size 7 Richter scale volcano waiting to erupt compared to a size 9 in some other states. The point is made by the Melbourne submission, and my colleagues will talk more generally in a moment, but a very strong belief is that to provide excellent teachers who in turn provide a passion for students to continue with science, you need people who are well trained in a discipline area, people who are superbly trained pedagogically so that they can communicate the skills and that passion for the discipline with students most effectively.

There are real consequences, as we have also stated in our submission, about a need for funding with respect to effective in-service training, for student enrichment in a variety of ways. Also — and I hope members of the committee will ask this question — I will ask Rod to talk about the nature of the profile of the dip. ed. at Melbourne at the moment; that in itself is very informative.

Ways of enhancing the likelihood of transfer of people laterally into the teaching profession are vitally important, as are ways potentially of encouraging students who have the appropriate discipline base, perhaps through studentships, to do a dip. ed., and perhaps through the encouragement at state level, again through students, for specifically the courses that are geared to producing teachers from the beginning in science, but with a science education component specifically focused on maths, physics and chemistry. That is a new initiative at the University of Melbourne, and some other universities have similar initiatives. You can sign up from day one for a combined degree in science and in teaching, but that combined degree specifically is constructed to allow people to gain the discipline base in maths, physics, and chemistry, because what the Australian Council of Deans of Science survey will also tell you is we are not short of teachers from a biological discipline background. That is something that Kaye will allude to as well, about how those people may, with the appropriate resources, be able to be reorganised.

Rod, perhaps I could throw it to you in terms of the profile of the dip. ed. group. I think it is important information for the committee to have.

Dr FAWNS — I think there is a long history of which the committee will be aware — a pattern in supply which is affected by the Australian economy. It is a biologically grounded economy, and in that sense there is greater flexibility for people who are thinking of science teaching, adding a second string to their bow in studying biological sciences. Pre-1945 it was not that pattern, but post-war it has steadily developed. Specialisations in biology have expanded, whereas the options within physics and chemistry have been more restricted.

I do not know what we can do but it is clear that we need to recognise this reality in Australia if we want to change it. The pattern varies, though it varies little from year to year. We have roughly twice as many students enrolled in biology — we have got about 80 in biology and method this year, we have 40 in chemistry, which is down from the previous year and in physics we will get around about 30 who will graduate.

We started with about 35 in physics but lose quite a few of them, which is interesting in itself. The number of people who start the course and do not finish in physics and maths is higher than any other area, and I think that is because they have other options even at that point. They also find, probably, that adjustment to schools is more difficult for a number of reasons that we could discuss. That is a consistent pattern.

We also have a science method which allows people who are mainly biology — have done a double major in biology — and they will be biology-science as opposed to biology-chemistry or maths-physics or maths-IT, which are other common combinations. The science method is really training for science coordinatorship. That is the way we handle it. I really cannot explain why we have had a slump in chemistry, but that is the area that worries me more than the physics at the moment, because there are more pupils who need to be covered. But overall the physics and the chemistry supply remains a major problem.

When people in schools say that they do not need a biologist, they mean they are finding it is easier to find a biologist but of course they could not staff the sciences teaching in the schools without those biologists. If they did not have them, they would have no science programs or they would be employing a history teacher to teach the science, which has happened in the past. So I think, in general, that is the way the science departments are organised and the physics is generally taught out of the maths department. The person who teaches the senior physics would usually be a maths major and would be organising the maths teaching in the school and not have that much connection with the science department.

Mrs BUCKINGHAM — How have those figures changed in the last five years?

Dr FAWNS — I would say the ratios change but the pattern is fairly stable. At Melbourne I think we are training about half of the physics total, and when you think that we are going to finish with about 30, then it is pretty awful, but that is in fact up on an average over the last 20 years. In the last five years the number of engineers and IT professions coming into teaching has increased. We have a problem there in relation to just how those professional people are to be welcomed and how they are to be sustained in the education industry.

It is not just a matter of getting them in; it is a matter of keeping them in. A major issue is the older entry age to teaching. The average age of 30. That is the new demographic. It is a statewide thing. It is typical of overseas trends as well. They have got not only a shorter potential long-term career in teaching but they also know what it is like to move between careers, so these are the people who are likely to be attracted out of teaching. I have surveyed my

own students over the years and I know that they have staffed the IT industry when that suddenly boomed. These are the people who were able to communicate the technology, to do the training.

They also left teaching to staff the TAFE colleges, because most TAFE courses are science based. They had done the teacher training, so they just took their teaching somewhere else. Every industry now has an educational wing, in which I find my former students. Banks have a training division. The Mining Industry Council has people. The Gene Technology Access Centre which has Brian Stevenson and other people who were trained science teachers —and so society — society want them in schools but it wants them everywhere else. It is a problem of creating a bigger pool as I see it.

Prof. McKENZIE — Just in terms of reinforcing the comment that Rod has made and for the committee members who have a copy of the *Australian Council of Deans of Science* report, if you look at page 10 you will see the profile, if you will, of biologists, in a sense. There are more of them who are younger and then as the age group of the teachers increases, biologists decrease marginally, whereas it is a very different trend in the case of teachers of physics and chemistry. Also if you could turn to page 15 you will get a feel of the nature of that profile in terms of senior biology, senior chemistry and senior physics teachers, and you will see in fact — as what I would suggest when you look at the profile with respect to senior chemistry — we have an impending challenge in the not too distant future where senior chemistry teachers simply move out of the system.

Dr FAWNS — There is a pattern in state schools, the state department people that I speak to about physics say one of our problems is that the physics teachers are often appointed as the 'timetabler or the daily organiser', so often that scarce resource is somewhere else in the school. Now, they can hardly be denied that career chance, but in a sense they cannot be in more than one place at a time.

The superior academic quality of the biology teacher group should be acknowledged. At Melbourne they have a double major in their discipline. More than half of the current crop have a postgraduate degree in their area, so they are five or six years trained in that, compared to a trainee who has not even done a full second year chemistry or second year physics, which is the norm. So the future of science education is with the biologists to a large degree.

That is why Kaye and I feel quite strongly that you will have to do something with this group to advance the future of maths, physics and chemistry teaching. They have the intelligence and the ability to become something other than a biology teacher, and you have to think about how these intelligent people can be retrained.

These are amazing people, they are absolutely amazing. I will just give you one example because I like to quote it, and I am sure it will impress you. Each year I have to talk to people about how they fill in a CV, which does seem fairly mundane and it is a routine thing. I said, 'Well, you need to address this to the person who is going to appoint you', and this student, who is now teaching at Brunswick Secondary College, Jenny Stewart, said to me, 'Yes. When I was running a mine for 380 people in West Africa, unless they put my name on the application, it went straight in the bin.' And what does she do? She goes to Brunswick as a beginning teacher. That is the jump — the schools will have to know how to hold these experienced people, because already she is talking about moving on.

Prof. McKENZIE — Kaye, maybe if you address the retraining or reorganisation of biologists.

Prof. STACEY — Yes, but just to start with, the Australian Council of Deans of Science did not actually look at the situation for mathematics. I am a professor of mathematics education. We have not actually got data like that, but I think that you would find it would be very similar to the physics situation, but of course we do train slightly more maths teachers than physics teachers, but of course we need a lot more because it is a main subject right through secondary school. So I think that you need to understand the mathematics situation is certainly very much the same, with the same ageing work force.

In this year in particular, as I have gone to schools, one of the things that I have noticed is that teaching out of field, where mathematics is taught by teachers who are not trained as mathematics teachers, has really been creeping up. Some years ago you might have seen teachers in years 7, 8 and 9 in secondary schools being taught by chemistry teachers or biology teachers in particular. Now you see that happening well into year 11, and I think that is really quite serious to have those senior mathematics subjects taught by people who probably have not done any mathematics at university and certainly have not done any mathematical pedagogy either.

Again, like Rod, I see certainly in the Melbourne context we have this fantastic group of usually biology trained people. I know what will happen is that we will give them a Dip. Ed. at Melbourne, they will learn how to teach

biology and science, because we have to train them teach subjects that they are qualified to teach according to the Victorian Institute of Teachers (VIT) — we have no option about that — but as soon as we send them out to schools, most of them will be teaching junior maths in particular or, as I said, some will be teaching year 11 maths. So somehow we are not able to address that properly within the system. I think that is something that we really could do. It is probably worthwhile targeting some of those people and giving them some extra training so that they are able to be really good junior maths teachers. Rod might choose physics or chemistry instead, but I would choose maths.

Within the constraints of the university andwe cannot do it in the year of training that they have, but we could think about some extended Dip. Ed. or something like that so we could give them proper training to do the job that they are going to do. It will require government money because we know that they will not come back and pay their own money to learn how to become maths teachers. The reason they will not do that is because people do not pay their own money to be trained for a job that they are already having to do. So we know that is going to require some government investment.

The CHAIR — I might start off with some questions, and I will start with a simple one. In the past when I went to school — and I am just looking at your age profile — someone like me did applied science. The standard applied science in the school was two maths — A and B, physics and chemistry and then for me there was biology and engineering — or something like that; some other option. But it was a pretty standard sort of course. That is what you would do if you were doing an applied science oriented course. Now of course, the structure of the VCE means that that does not happen. You do not do a commerce course, you do a compilation of subjects. I imagine that is part of what is happening in the age profile.

We had a briefing that indicated that large numbers of students in secondary schools are in fact doing maths methods in particular. About 85 per cent of students are doing maths at VCE level, and a large number — maybe 60 per cent — are doing maths methods. I would have thought that the natural link with that is maths and physics. Something must be happening when they go to university, because you seem to have a large enough profile of students doing a maths subject at the secondary level in schools, but there seems to be a shortage when you get to teaching courses at university.

Prof. STACEY — Can I respond to that? Although maths methods numbers have stayed fairly constant — —

The CHAIR — It has the highest ranking.

Prof. STACEY — What has not changed in absolute numbers is specialist maths which is the second maths. You talked about doing maths A and maths B, but in the second maths there are still the same raw number of students now as there would have been when you were at school. So as a percentage that has dropped quite considerably. Maths methods is now a subject that you would need to get into commerce, so it is a very wide subject.

The CHAIR — Algebraic — —

Prof. STACEY — I guess the other thing is that there is a lot more competition for mathematical skills around university. In particular, information technology and computer science has grown out of the same pool of people. So we are seeing it spread around the university, not just going into maths.

Prof. McKENZIE — If I could also make an observation in relation to what Kaye said. She is absolutely right. If you look at surveys across the country in terms of people studying science, the numbers have increased — not as rapidly as in some other areas — but maths is a good example. Compare real maths — that is, specialist maths — to adequate maths or maths methods and by comparison with a different sort of maths there has been a consistent relative downturn.

Mrs BUCKINGHAM — Further maths.

Prof McKENZIE — Further maths, and look at the break-up of how people are doing that, and likewise across the sciences, which is the same as well. So when DEST produces its figures they are absolutely correct, but they do not necessarily give the appropriate information about what is occurring.

I think there has been a series of things which have influenced the nature of a student's course and part of it has been the nature of passion for science, the perceived employability of science graduates, which actually turns out to be very good, but people's perceived attitude is somewhat different.

Honestly, university faculties of science have got a lot to answer for, and I continually beat my colleagues across Australia about that because the University of Melbourne is the only university in Australia that has genuine pre-requisites for science. We actually believe that you need science to do science. We know people do not cope in our courses if they do not have that background. Other universities have simply said that you do not need science to do science, and I think that has permeated through the system.

I think what has also happened to a greater degree, and it relates to the perception of the job market, is that the proportion of people doing maths methods who go on to do maths at university compared to what it used to be has stayed the same, but many of those people have seen courses in business, commerce and the like as being a more appropriate direction, and understandably our friends in economics and commerce regard that as being a critical foundation for what they want to do as well.

So it is not just a problem for science that people are not being educated, if you will, in science at the first level; it impacts upon people going into medicine, dentistry and a variety of other things as well as economics, commerce and business.

The CHAIR — Let me take a slightly different tack, so bear with me. The figures we have from the VCAA on this chemistry issue — and you are saying that there is a major problem with chemistry teachers — is that in 2004, year 11, unit 1, the rank in chemistry was above biology. It was pretty close but nearly 14 000 students in the state were studying chemistry; biology had nearly 13 000 students.

In the same year at unit 3 there were 11 500 biology students, so they had lost maybe 1000 students. But chemistry had dropped lower, and 8500 students were studying chemistry. I wonder if there is not something in the way that chemistry is taught in schools that is having a detrimental effect on students staying on from year 11 through to year 12, or whether it is something else at play. If you cannot keep them in the VCE how are you going to get them into university, and how are you going to keep them through to teaching?

Mr KOTSIRAS — Could it be the standard that students have reached at year 11? At primary school and in years 7, 8, 9 and 10 students like the name of chemistry. In year 11 they do it for one semester and then they find it a bit difficult and drop out — —

The CHAIR — It could be that; I just wonder if there has been any more qualitative rather than quantitative analysis that you would have to bring to bear — —

Prof. McKENZIE — Can I be controversial — —

The CHAIR — Absolutely.

Prof. McKENZIE — I think primary is critical. What surveys tell us is that primary students are fascinated with science, and often primary teachers are less than confident in terms of the nature of teaching of science. One of the things that the Academy of Science is doing with support from DEST is trialling across 56 schools across Australia, including five in Victoria, a new program called Primary Connections which builds science into literacy. The nature of the primary undergraduate makes it more difficult than it should just to focus directly on science, but literacy and numeracy are both very important.

The Primary Connections program is still in its early stages of its trial, but I was in this room a few weeks back looking at teachers from Victoria and Tasmania, and if you could turn them into the hydrogen economy in terms of bottling enthusiasm, you could have run a small provincial city on that enthusiasm for the program. The quality of work being done by kids up to grade 6 is terrific, but long term it provides an opportunity. I think there is a talent there, we need to work in maintaining kid's passion at secondary level.

I would controversially propose that one of the reasons people do not progress beyond year 11 chemistry is because they are being taught by people who perhaps do not have the appropriate background, and therefore do not have the appropriate passion.

The other observation I would make with respect to the biology number is that many people who are doing a single science subject in year 12 will be doing biology or psych. Biology went through a dip for a period of time because more people would have done psychology. That equilibrium has tended to re-establish itself in the last few years. So the biology numbers, if you will, are confounded to some degree by people who are not specifically seeing that they are going to progress in a science study area. I was saying that biology is their science subject, which does not occur to the same degree in chemistry.

The CHAIR — Why is that? Why would you not do chemistry, or can you not do that at VCE as a stand-alone, one-off subject?

Dr FAWNS — Historical patterns. Year 12 – units 3 and 4 — Biology has often been offered by schools in year 11. The biology number looks depressed because many are doing units 3 and 4 in year 11. In physics and chemistry students have to do the four units.

Mrs BUCKINGHAM — It is also the only science that is not sequential. You can do units 3 and 4 without having done 1 and 2, but you cannot do physics 3 and 4 or chem 3 and 4 without 1 and 2.

Prof. McKENZIE — That is a critical point, and it is true of tertiary studies in a sense. Biology can be a prerequisite to come into science at Melbourne. In terms of people who have not done biology, there is no presumption that people have done it, where the absolute building-block phenomenon that you are alluding to — chemistry, physics and maths — I believe is essential, and that is why I berate my fellow deans elsewhere, because I think they are doing students a disservice by not requiring that.

Mr KOTSIRAS — Is biology seen as the soft option in terms of the sciences?

Prof. McKENZIE — I do not think so by their teachers.

Mr KOTSIRAS — No, by the students. Is the perception there that, 'I will do biology; I do not like science, but I need to do a science component'?

Prof. McKENZIE — They have only got one science, and they choose biology for a whole lot of reasons.

Prof. STACEY — Obviously one of them would be that it would be seen as a good science for girls to do. Probably psychology is the other one.

Ms MUNT — I would like to take a different tack. You said the dropout rate for physics and science dip. ed. new teachers is the highest of all the categories. I was talking to the gentleman here a moment ago who said there was an excellent science teacher at his daughter's school, but because the class was so unruly he became discouraged. The thing that seems to stand out here is that there are very small class sizes and they have individual attention and they seem to thrive and really like it. I am wondering if it is a function of the actual class sizes — that is, if the teachers are trying to do practical experiments and there is someone swinging from the rafters, that smaller class sizes would make a difference to the quality of the teachers and the teachers who want to stay and teach something useful to the kids.

Prof. STACEY — I think that is a very important part of working conditions for teachers. People usually think about working conditions for teachers in terms of salaries, but that data is about their working conditions and their relationships with the children and the support that they will get from their schools and is absolutely critical to keeping good teachers. Anything you can do to improve those on-the-ground conditions for teachers is really worth while.

Ms MUNT — We will just split the classes up into more manageable sizes or something.

Prof. STACEY — But you do need more teachers too.

Ms MUNT — What other factors do you think are influencing this high dropout rate?

Dr FAWNS — Kaye worked on the 'trends in mathematics and science' study (TIMSS). She was associated with international comparisons, which showed that the science teachers in Australia thought that they were undervalued in Australia. There is quite a marked difference from other countries. Australia was lower than in

other countries in terms of that, so there is a cultural issue there. I think the physics and maths people often have a far greater theoretical commitment in the sense of their studies.

So in a way they find the disappointment greater quite often. In a sense it is something to do with the manner of their training perhaps. So in a way the subject is choosing the person and the person is choosing the subject in that respect. So in some respects there is a different sort of environment needed to support those people who come in to work in those sorts of subject areas, particularly in physics in my experience.

Ms MUNT — What sort of environment then?

Dr FAWNS — One in which their work is appreciated. I think you will find in the university too there is a feeling that there are fewer people staying with physics and people feel they are underappreciated in that context as well. It is something that if you are committed to it, it is obvious that other people should be, the need to support it is clear and other people are perhaps unaware of it. It is a broader case of why the maths and the physics, that mode of dealing with the world, is going to have to be worked on to make it more generally attractive. It is not just something that we as a group could decide that we are going to do. We would have to think very seriously about the way in which that might be approached.

Schools are playing with this all the time themselves. Some schools have gone into streaming, and accelerated learning programs are very big in state schools at the moment, as a way of trying to model taking academic learning more seriously. That is a really interesting move. Brunswick, for instance, has been a very strong union school in the past. The teachers thought their job was keeping the kids at school generally speaking. But in recent times with changes in their intake and demographic shifts they have set up academic streaming, and they have had amazing success.

The CHAIR — They have a SEAL program too, do they not?

Dr FAWNS — The staff and individuals are a good case in point. Just on the basis of a working relationship with us they now have staffing at Brunswick which is as well staffed academically as any private school in terms of the post-graduate qualification in all the sciences and mathematics. They have been in the right period of time replacing older teachers, and the success they are having with maths and science is remarkable. The school had to re-orient to do that.

Ms MUNT — Perhaps we should go out and have a bit of a look.

The CHAIR — It is an interesting school because quite a number of the students are from Moreland, the school that closed down, and the teachers went over there. There was quite a different culture there. It is an interesting one.

Dr FAWNS — It took leadership from the school to achieve that. It just did not happen. It was a strong change of direction led by senior staff in the school.

Ms MUNT — I have another question. It is off the subject a bit. My husband is a patent attorney, and his passion is research and development. A lot of scientists and people who have done technical degrees do go into research and development. A few years ago the tax breaks were changed for research and development and research and development came into hard times. I am not really up with what is happening at the moment with research and development, but I would imagine that if you have got a thriving research and development industry — and I remember that BHP had a huge facility out near Monash University that has virtually gone — then you get somewhere for people who do maths and science to go to and do their work. I am wondering what impact you think that still has on research and development and a career path for people who do these degrees. What is the situation at the moment?

Prof. McKENZIE — I will answer that laterally, in a sense, and then come back to the specific question. When you look at surveys, which are often presented, of what graduates are doing, those surveys are conducted three months after they finish their degrees, which is next to meaningless. There is also another independent Australian Council of Deans of Science publication called *What Did You Do With Your Science Degree?*, which looks at graduates. Once again, it is on the Australian Council of Deans of Science web site. It looks at graduates 3, 7 and 10 years post graduation. What is observed from that is that the typical science graduate is gainfully employed, they enjoy doing what they are doing, they have grown their career — so if you look over time their

career has progressed quite dramatically — and they are good community citizens. They involve themselves with things other than just their work. I hope we do not have any economists here, but even if there are, I would be very interested to see whether a similar survey occurs. And clearly there are exceptions to the general rule in terms of that involvement.

Ms MUNT — They go into politics and that is the end of them really!

The CHAIR — After they have made their money!

Prof. McKENZIE — One of the messages in terms of the employability of science graduates is that they do a variety of different things. I mean if I look at my own honours students — I am a geneticist by training — I have somebody who works for Woolworths because of the statistical end of genetics and who is involved with the introduction of bar coding and maintenance. I have somebody else who runs a scientific journal, and somebody else who has the worst job in the world — she is a senior editor for Lonely Planet publications. She has to travel the world.

Ms MUNT — As long as she is making money.

Prof. McKENZIE — But the skills and their science degree have all been relevant to what they are doing if not in terms of specific themes.

Ms MUNT — We have to keep our intellectual property because it is going overseas and we have to bring it back to work here.

Prof. McKENZIE — I may have to give my name and address for a paid political announcement here but part of the difficulty if you look at government investment in research and development is that it is actually quite good Australia-wide by Organisation for Economic Cooperation and Development (OECD) standards. Where we are falling down dramatically is in industry investment in terms of genuine research and development.

Ms MUNT — And that is generated by tax break.

Prof. McKENZIE — It is except that I am sure the feds were bitten by that previous tax scheme because there was a lot of corruption — this is under parliamentary privilege, isn't it? — but there was a lot of misuse — people gained. They really did play games to get a tax break that was not directly involved into appropriate research and development. I agree with you absolutely that if it is appropriate to produce the right sort of scheme, the right sort of tax break where it was not possible to gain; would have a huge impact on scientific work that is being done. BHP is an interesting example. BHP had a lab that used to have 650 scientists.

Ms MUNT — It was fantastic. It was the best in the world.

Prof. McKENZIE — They now have 100 .

Ms MUNT — I know — it was the best in the world.

Prof. McKENZIE — It has changed dramatically. If you got the right tax break system, I think it would have a huge impact. Can I keep going for just a minute?

If we are interacting with the federal government one of the things that all of us on this side of the table — certainly the Council of Deans of Science and certainly the academy — have been pushing with great enthusiasm is the nature of what we do with HECS for teachers. The circumstances at the moment are that Kaye has done an arts degree and Rod has done a science degree. They are both teaching in the same classroom or the same school and they are both being paid the same salary. Rod has a significantly higher HECS debt than does Kaye. I understand the reality of removing the HECS debt completely, but equalisation of HECS debt would have a huge symbolic impact. It is a matter of, 'You are a teacher; you have done science; we equalise your HECS debt providing you make a commitment to the system'.

The CHAIR — What happened to the double degree? How is that now? How does HECS apply to that?

Prof. McKENZIE — Basically HECS is based on a subject-by-subject basis at this stage, so some people doing a science degree would have arts costed subjects within the science degree.

The CHAIR — They would have a higher HECS debt.

Prof. STACEY — It is based on every subject you do.

Ms MUNT — My son is doing a double degree so it is basically double HECS.

Prof. STACEY — Could I just go a little bit further than John. When we look around the world we see that a shortage of good science and maths teachers is a common phenomenon even in countries like Asia which has not had shortages before. For example in the UK there is what they call their 'golden hello' for science and maths teachers which means that when people sign up to train as a teacher in science or mathematics they are given — I am not sure about the numbers, but I think last time I saw it was something like £4000 plus a laptop computer — this would be equivalent to taking over the HECS debt of a student who became a teacher. We think that every economy has difficulty attracting teachers and moving onto some sort of golden hello would be a good way to go.

Mrs BUCKINGHAM — In the submission, Professor McKenzie, you said that parental influences are important during primary school. You actually spoke about the importance of primary school and this new program Primary Connections, which I would be interested to hear more about. I am wondering what you would do to change the perceptions or make parents more aware of the importance of maths and science at primary level because also I share the notion that that is where it needs to be done — before secondary level — so I wonder how you do it?

Prof. McKENZIE — I think part of the line is that it really goes back to some degree to the absolute confidence that the teachers have in a particular area as well. There is no doubt in terms of the way in which, particularly at the young levels, the parents and students interact with the teachers — it is somewhat different as it progresses through the system. If we genuinely have teachers who believe that they have a structural format, a help guide that leads them through a process which is both good pedagogy but also good science, their confidence increases with the students and the parents.

I think Victoria and Queensland are probably the two states that have stood out of adding value in terms of being prepared to invest significantly in infrastructure. You might want to argue about the specific target areas that have occurred and I am sure that people could do that but at least there has been a message in Victoria that as a dean of science you can say — and it really has been across different governments as well where there has been an emphasis on the importance of science to the economy but it is not uniformly true across Australia at the moment. It has a touch of the Jesuits — if you get them young, you are likely to have them forever. But to get them young, the underpinning principles really do need to be enormously strong and focused. I hope Primary Connections is going to be a way of doing that.

Mrs BUCKINGHAM — Do you have to alter the teaching at pre-service education for primary teachers?

Prof. McKENZIE — I should defer to my experts in that regard. I think if you have a great resource base then in a sense the two interact together. For instance, if the people who are involved in the teaching of teachers can see that a particular resource base works in terms of the educational outcome that they are hoping to achieve, I am sure that would be incorporated into the training curriculum. It has happened in other programs in other states fairly effectively. As a supplementary answer too in terms of the support, Western Australia I believe, has gone down the route of offering HECS-exempt scholarships to science teachers so they have — I am not sure of the numbers — but they have made a step in that direction which is what counts.

The CHAIR — What would be the main universities that do science in Western Australia?

Prof. McKENZIE — Science is taught out of all of the universities in WA.

The CHAIR — So which is the best?

Prof. McKENZIE — I would have to say the University of WA which is a member of the Go8!

Mr KOTSIRAS — If you were able to change one thing in the schools, having taught students coming through to be teachers, what would you change to encourage more students to take science and maths? It could be anything. It does not matter about the financial aspect of it, just something you would change?

Prof. STACEY — We would go better training for their teachers to get better in-service support and better pre-service support, so I would vote for more money going into their teachers. If I am allowed to have one, that is it.

Mr KOTSIRAS — Just one.

Prof. McKENZIE — Given that that one is a really important one, I will have a different one but I think that is critical. If you expect people to behave as professionals you really do need to treat them as professionals. In-service training is critical. In everything else we expect that people should be life long learning and in teachers more than anything else, this life long learning has to be absolutely critical, so in-service is critical. But my single one would be to ensure that people who are going to teach science have appropriate discipline coverage in their educational training and appropriate pedagogical coverage to go with it.

Dr FAWNS — I want to say something about the question of primary school science because I am doing a fair bit of that at the moment. My big thing would be career structure. At the moment the leadership issue is a big one. At primary level we need specialist science teachers. That is an absolute necessity. Why do we have it in a whole lot of areas which are less important? Why? Because we can get them but we should go after them. We have had a program at Melbourne where we did run a certificate course for people to become science specialists and it was over-subscribed until the money ran out. It was supported by all school systems and by industry. BP was one.

Prof. STACEY — BP gave us three years of funding for that program.

Dr FAWNS — Three years of it, and then it was not picked up. But we were oversubscribed every year, and those people were the absolute salt of the earth for their schools, obviously. I think that is a critical issue, but I see that as being an intervention in career structure. At secondary level it is a major problem in schools generally that the person who is now the science coordinator will often have had only five-years experience, because the senior teachers have learnt that there is so much politics going on they are better to have a student that they tutor after hours to make the extra thousand dollars the coordinator receives. So they are not really in the school as far as organising the department is concerned.

As I have said already, we have a major problem because the physics side of science is often in the maths department at morning tea time. You can hardly get the physics teachers to the science meetings because the two departments often clash, so Physics is an absentee landlord. The physics teacher says this should be taught but they are often not there to say how it could be done. And there is only one of them in the school and they fill up the load teaching maths. You might have one physics at 11 and one at 12 and the rest is maths, so naturally they are needed in the maths department. They do the Specialist Maths, as Kaye was saying. The school is lucky to have one if they have got one. That is the problem. But it is something that has to be sorted out at that level. This is not just the science and maths, but it impinges on the social organisation of the school. There has to be some intervention there. We cannot just have a laisser-faire organisation which in the end responds to what teachers you have got, not the ones you need to have. Career organisations should support structures which will provide educational benefit.

The CHAIR — I have one last quick question. Brendan Crabb from the Walter and Eliza Hall Institute, who we spoke to earlier, advocated more of the US model where you have more general staff studies at an undergraduate level and people going to the sciences after they have done that on the basic guise that people often become interested in the sciences later in life, perhaps general studies as an undergraduate, then concentrating on the PhD level. He also advocated that for science teachers — answering Nick's question — that there needs to be far greater liaison with industry, and of course I think partly the model of having PhD students coming into the schools and teach and that sort of thing, sharing knowledge and experience. What do you think of that? Do you look at that at Melbourne University? There are two questions.

Prof. McKENZIE — Could I comment on the first one. I think this is an observation that a biologist might make.

The CHAIR — Good answer!

Prof. McKENZIE — And as a biologist I make the observation that a broadly based educationalist in science would make, partly because of the nature of the building block necessity — for instance, at the University of Melbourne we have a number of mature-age programs across the university. We virtually have no people in

science who come through such a route because they are so far divorced from the analytical training which is critical for large sections of our studies, so I think there are huge difficulties in that regard.

With respect to industry and advice, I think it is vitally important to have all levels of advisers. When I became dean of science we did not have an industry advisory group. That was one of the first things I did, and it is important for three reasons. One, it increases the breadth of sources that you can get money from, being pragmatic and cold-blooded — and with a name like McKenzie you would expect that sort of line. Secondly, it really provides teachers within the university and science with a better idea of what industry expects of their graduates, which is important. Thirdly, and this might sound a bit peculiar, it encourages people to understand the importance of deadlines within a process of a journey.

Many researchers in universities receive a grant from national competitive grants that gives them money for three or four years. They say they are going to do something and they review it at the end of that time. If you are dealing with industry you have deadlines every three or six months and you have to report then, so I think the industry interface really sharpens the nature and quality of the product that we are introducing. I think that is equally true of secondary load. One would hope that all secondary schools, and primary schools for that matter, would have people on their advisory board who come from an industrial base — at least some people. I am sure they would impress important things upon the culture of the organisation. They certainly have in science in Melbourne.

Dr FAWNS — Could I just say that it is clear to me that if we are getting people coming at a later stage into teacher education, that there is a group which even at a later stage would be interested in working in education from industry. I was talking to a toxicologist from a mining company last night and he was asking why he could not become involved with schools. I said he could, and he would not have to have the teacher training, which he said he did not want to do. What he was saying was 'How would I do that?', and all I could think of was that the government used to fund a scientist-in-residence operation with primary schools in particular, and that seemed to be quite interesting to him in a sense. He was not looking at this stage for another career but was saying there are a lot of people at his level who are quite interested in that possibility at a later stage. That could be something that could be looked at seriously and sponsored completely by industry, it seems to me. Some of those people could be quite useful. It is one of those initiatives that could be sponsored outside the system.

Mrs BUCKINGHAM — Just a quick question to Professor McKenzie. Melbourne University really does stand by itself with this notion of necessary prerequisites for science, where most other universities in Victoria have gone the other way. I would love to have a long conversation with you about that. When you look at the graduate medical degree that you can now do at Melbourne University, having a prerequisite science is not necessary to get into that. You do the graduate medical admissions test, I think is what it is called, so you can literally go there with an arts or engineering degree or whatever, and yet once you get in there there is science, chemistry, pharmacology, things that you need to do. So even though you are saying you need science to get into an undergraduate science degree, the university is offering a postgraduate course where it is saying there is no necessity to have undergraduate science to do the test, to get into the graduate course for medicine. So it is mixed messages.

I am just wondering how necessary it is to have done science at secondary level to get into university and do a science degree, if you want to encourage people to become scientists, if you want to ignite a passion and tell people there are great outcomes out there, because you began quite early today saying there is a problem with the perception people have about science careers. I am wondering whether you can alter perceptions. Part of altering perceptions might be to get people into university and enthuse them and make them passionate. Maybe that has not happened at the secondary level, but by not taking anyone who has not done science at secondary level maybe you are losing some of these passionate career people down the track.

Prof. McKENZIE — In terms of not taking anyone, Melbourne has prerequisites in terms of requiring maths.

Mrs BUCKINGHAM — Maths, chem or biology, yes.

Prof. McKENZIE — Except that if somebody scores above 92½ , I think it is, one of the prerequisite controls, there is a little flexibility.

I think in terms of medicine it is interesting that the nature of the test for graduate entrance is one that is heavily science-biased, and I think the experience in terms of people who are actually selected into the medical program, while it is theoretically possible to come from any background, the reality is that the vast majority come from

science. I know, for instance, there is one person at least at Melbourne who is an arts graduate who is progressing through the graduate entry program quite effectively. But if people are absolutely brilliant, they will cope with most things, because they will put the effort in.

The CHAIR — Thank you very much. I am going to close the hearing off here. I have a few other questions, and I know the research officer has some questions. Would you be happy if our research officer rang you in the future with questions?

Prof McKENZIE — Certainly. It is a critically important area and we will provide any assistance any of us can provide — and I am speaking also on behalf of the Dean of Engineering.

The CHAIR — Thank you.

Committee adjourned.