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

Balwyn — 25 July 2005

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Mr B. Armstrong, principal;

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Mr C. Hopkins, former outreach coordinator;

Mr C. Walker, science teacher;

Mr A. Mark, head of mathematics; and

Ms L. Poor, Ms J. Dickenson, Mr E. Kumar, Ms D. Grant, Mr B. Potenzi, Ms S. Kumar, and Ms M. Barr, students, Balwyn High School;

Mr G. Lane, principal, Balwyn North Primary School;

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Prof. R. Crawford, dean, faculty of life and social sciences, Swinburne University of Technology;

Ms V. Steane, maths teacher; and

Mr B. Clarke, teacher, Kew High School;

Mr J. Jackowski, head of science, Scotch College;

Ms I. Kuehlich, eastern metropolitan regional representative for science, maths and design technology, Department of Education and Training;

Ms J. O'Brien, Gateway Local Learning and Employment Network; and

Dr L. Dale, retired teacher.

The CHAIR — My name is Steve Herbert. I am the chair of the parliamentary Education and Training Committee. I declare this hearing of the Education and Training Committee open. The Education and Training 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 advise all present at this forum that all evidence taken by the committee, including submissions, is subject to parliamentary privilege and is granted immunity from judicial review pursuant to the Constitution Act and the Parliamentary Committees Act. That is a formality which brings the Parliament into this fantastic auditorium and sets out the conditions of parliamentary privilege and the law that will apply for the duration of this hearing.

I am very pleased to be here today. Balwyn High School has an excellent reputation in maths and science education, and that of course is the subject of today's hearing. All evidence will be recorded by Hansard and will be available for people to have a look at in a couple of weeks. If you give formal evidence we will try to get a copy of the transcript out to you. For Hansard's purposes, can anyone speaking please give their name and title so we can properly attribute their comments.

The Education and Training Committee is a new committee in this Parliament — there was no such committee before this Parliament. It reflects the importance of education in our society, not just in terms of individual students, although that is pretty important, but in terms of the need to improve the educational standards of our whole society to make our economy more competitive and to ensure that we prosper in the future. Many countries around us are increasing their expenditure and effort in education, and we need to do the same. This is the third inquiry the committee has conducted. The first was on higher education and the second was on teacher training — we are awaiting a response from the government to that. This third inquiry is into ways we can improve maths and science and promote maths and science education in Victoria.

We have had a number of hearings around the state and interstate. This is the first of this kind of forum we have had for this inquiry. We are trying to get more of a hands-on feel for what is happening in schools and the importance of maths and science to students and teachers — the practitioners — and parent bodies and the general community. We will be holding a number of these forums but this is the first. In past inquiries they have been incredibly important in our deliberations because while getting evidence from various lobby groups and expert groups is very important, finding out first hand what is happening in the schools, looking at what is happening in good schools and good networks of schools, can form the basis of the sort of recommendations to government that will make a real difference into the future. That is what we hope we will get out of this forum and this report.

Before I hand over to the principal of Balwyn High School — the school has been very generous in letting us use these facilities — I acknowledge that Andrew McIntosh, the member for Kew, in which seat the school is located, is present here today. We also have representatives of various schools from around here, both public and private. We have department representatives, people from the local learning and employment networks (LLENs), people from Swinburne University and representatives of community groups such as the Royal Society for the Prevention of Cruelty to Animals, which have a great interest in education. Welcome, thank you for coming. I am sure we will learn from what you have to say here today. I shall now hand over to the principal.

Mr ARMSTRONG — Thank you, Chair. It gives me great pleasure to welcome the members of the Education and Training Committee to Balwyn High School — to Mr Steve Herbert, Mr Nick Kotsiras, Mrs Helen Buckingham, Ms Anne Eckstein and Ms Janice Munt. Welcome also to Andrew McIntosh, the member for Kew. Distinguished guests, members of the public, teachers and students, it gives me great pleasure to welcome you to Balwyn High School for this parliamentary forum. As outlined, this is an important process in informing education policy at the government level. We welcome you and thank you for holding it at the grass roots — that is, in schools.

Overheads shown.

Mr ARMSTRONG — Australia's future depends on a high-quality and dynamic school education system to provide students with the foundation skills, values, knowledge and understanding necessary for lifelong learning, employment and full participation in society. There are important economic goals but also importantly to create a civil society, one that respects our democratic institutions and one which creates the skills, dispositions and attitudes for students to engage to their full potential throughout life. Science and mathematics education is an essential part of the education of students.

As the quote says, science is part of the human quest for human understanding and wisdom and reflects human wonder about the world. What an important thing wonder is and how often in schools we might extinguish that. Science is an important component in creating that sense of wonder. The study of science as a way of knowing and a way of doing can help students reach deeper understandings of the world. Mathematics is seen to be a gate and a key to the sciences. I would also say that mathematical literacy is an essential gateway to be able to cope with life in a modern technological society. It is an essential and important life skill.

What do we know of Australia's progress in teaching and learning science and mathematics? Two important studies provide a frame of reference for our discussions today. The first one we will have a look at together is the Organisation for Economic Cooperation and Development program for international student assessment (PISA) which surveys reading, mathematics and scientific literacy levels every three years. The trends in international mathematics and science study (TIMSS) surveys student achievement in mathematics and science, also every three years.

While PISA and TIMSS have much in common, they provide different but complementary information about levels of student achievement. I am sure those studies would be known to the committee. PISA looks at 15-year-olds, who in most countries are approaching the end of the compulsory years of schooling, and asks how well they are able to apply basic understandings and skills in reading, mathematics and science to everyday situations, so the focus there is on the application of knowledge. TIMSS, on the other hand, looks at how well year 4 and year 8 students have mastered the factual and procedural knowledge taught in school mathematics and science curricula.

TIMSS begins with a detailed analysis of year 4 and year 8 mathematics and science curriculums as its starting point and then tests curriculum content common across all participating countries. I am pleased to say that Balwyn High School has participated in the studies. Every 12 years PISA and TIMSS align and their results are released almost simultaneously, as occurred in 2004. The results allow students' performances to be compared across more than 40 countries and over time. In Australia samples were drawn from all states and territories and included government, Catholic and independent schools.

So what are some of the results from the studies? The PISA assessment focuses on young people's ability to apply their knowledge and skills to real-life problems and situations rather than how much curriculum-based knowledge they have. That is the focus. The latest results show that Australia's 15-year-old students have a mathematical and science literacy among the best in the world. Australia's results were above the OECD average in the four mathematical literacy subscales as well as in problem-solving and scientific literacy. While there were no specific gender differences in overall mathematics literacy, boys were overrepresented in the upper levels of achievement while girls appear to be less engaged, more anxious and less confident in mathematics than boys. So there is some gender differentiation there. I will return to the issue of anxiety in the study of mathematics later.

The results from TIMSS. TIMSS assesses mastery of factual and procedural knowledge. PISA is about the application; TIMSS is more about the nature of content and procedural knowledge taught in school mathematics and science curriculums. TIMSS 2002 tested students in year 4 and year 8. The results of TIMSS described a less positive picture of Australian students' achievements in mathematics and science. Australian students performed moderately well, with the average mathematics scores achieved in year 4 about the same as the international average and significantly higher than the international average for year 8. Among 25 countries testing at year 4 in 2002 Australia ranked 16th in mathematics and 11th in science. In science Australian students achieved above the international average.

The next bit is important too, on which countries outperformed us and perhaps an investigation into what is going on. The countries significantly outperforming Australia in either year 4 mathematics or science included England, the USA, Latvia, Lithuania, the Russian Federation, Hungary and Cyprus. Worse, over the past decade achievement levels in Australia remained largely static, while achievement levels in many other countries increased. The result is that some countries which were below or equal to Australia a decade ago in school science achievement — such as Hong Kong and England, and school mathematics in England and Hungary — now outrank us.

The next one has the results from PISA. Among the 46 countries testing at year 8 Australia ranked 14th in mathematics and 11th in science. Countries significantly outperforming Australia in year 8 mathematics or science included England, Belgium, the Netherlands, Estonia and Hungary. While our performance in year 8 science

improved over the past decade half the countries we outscored for in year 8 mathematics in 1994–95 improved to perform at the same level as Australia in 2002–03. So the other countries that were behind us are picking up and we have remained largely static over that time.

PISA and TIMSS provide information about different aspects of students' mathematics and science learning. PISA assesses careful reading, logical thinking and the application of general mathematical and scientific processes and principles to everyday problems. TIMSS assesses mastery of the factual and procedural knowledge taught in school mathematics and science curriculums. While some students in some countries such as Hong Kong and Korea perform very well in both these areas, students in some other countries perform better in one area or the other, which is the case in Australia.

In Australia and New Zealand students performed better on average in applying general mathematical and scientific principles and skills to everyday problems than in recalling and using curriculums based on factual and procedural knowledge. As an illustration, Australian high school students significantly outperformed students in the United States in the first of these two areas but performed no better than students in the US in the second. An obvious question that follows from these observations is whether Australian schools are placing sufficient emphasis on the teaching of factual and procedural knowledge in mathematics and science, particularly at year 4. Perhaps Graeme might have something to say about that later on. That is a wonderful illustration there.

What are some of the implications from these findings that we are not doing as well in factual and procedural knowledge, particularly at year 4 in mathematics and science and in year 8 as well and at the end of schooling as well, for the application of knowledge? Some might argue that you if you are unable to apply it to everyday problems it may not have been worth knowing anyway. That is a debate you could have about the nature of content as opposed to skills and being able to apply those skills.

From these observations, the tendency for governments might be to set higher standards and implement more standardised testing and benchmarks. However, we should proceed with caution, as experience in other jurisdictions internationally has shown problems and pitfalls associated with this approach. As the saying goes, it is not how often you weigh the ox that fattens it. So investing heavily in testing regimes in schools across the nation or indeed within the state without the commensurate funding to address the issues that are raised by such assessment measures is not particularly helpful. Measurement has its place. It provides benchmarking for schools and for systems. But other, more complex strategies are needed to improve student learning that are focused on the improvement of the quality of teaching and the positive relationships that support learning. I know that our teaching staff who are to present will talk a lot about that.

So very quickly, what are the things that make a major difference to student achievement across the disciplines and in science and mathematics? John Hattie at the University of Auckland looked across doing a number of meta-analyses of all the studies that have been done internationally across the world. He looked at the effect sizes of certain strategies for teaching and learning that have a dramatic effect on student learning outcomes. So what does it mean by an 'effect size'? An effect size of 1.0 means an increase of one standard deviation, advancing a student's achievement by the equivalent of one year, improving the rate of learning by 50 per cent or a correlation between the variable being tested and student achievement of 0.50.

Let us have a look at some of the things that make a big difference in the life of a student in one year or in the improvement of test results or achievement standards. What are they? They are the big ones. I could talk to you about some that do not make much difference, like audio-visual presentations, computer-assisted learning and a whole range of other things — reducing class sizes, retention at school and so on. But these are the big ones. Quality instruction is right up there — the type of teacher that is in front of the students and how skilled they are at engaging students in their learning through a range of learning and teaching processes. Another is providing high-quality, meaningful and timely feedback to students in an ongoing and progressive way, not just at the end of the semester in a formal way, but feedback that is meaningful to the learner about how they are going and helping them to self-assess and set learning goals. Another is cognitive strategy training around thinking skills and thinking dispositions, helping students to have the skills to be independent learners in classrooms, directing their attention, directing their thinking within the content. Another is home encouragement. You can see the importance of home support. Another is Piagetian programs — that means the stages of learning, making sure that the curriculums and pedagogical approaches are relevant to the age of the students that are in particular levels of study. Cooperative learning comes up very high there as well.

The issue of the social exclusion of students in classrooms, particularly in science and mathematics, is a really important one for the committee to give its attention to. How inclusive are the classrooms? How much participation is there in the classroom? Study skills augmenting what is happening in the classroom, self-assessment providing part of that feedback process for students and creativity programs are all really important. That is very significant research. It does have a direct bearing on the teaching of science and mathematics. They are some of the things that we have been focusing very heavily on at Balwyn High School over the last three years through our professional learning program, which you will hear more about from our teachers.

The quality of instruction is right up there. This was also the outcome of a DEST investigation into effective mathematics teaching and learning in Australian schools, which found that teacher practices were consistently the most powerful predictors of mathematics and scientific achievement growth and with the growth in effective student outcomes — that is, the effective domain, how students felt about approaching the subject and what social competencies they were building up through these domains.

Teacher knowledge in the mathematics and scientific educational background is positively related to teacher effectiveness. The effectiveness of mathematics and science teaching in a school is related to the strength of the professional learning community in the school. I know that Colin Hopkins and other teachers — Corey and Alex — will talk about how you create that culture of professional support and learning for each other. The development of teachers' confidence and competence in teaching primary school mathematics and science will also need to be addressed.

The focus on the curriculum — what is taught — will also need to be accompanied by a greater emphasis on how the subject is taught, the pedagogical content knowledge, how well the teacher understands the nature of the discipline they are teaching, and then being able to work out the appropriate strategy and repertoire to be able to bring that content to the student and create learning for them. Assessment and accountability systems need to provide more diagnostic tools about individual learning difficulties and needs that will inform and guide the teaching and learning process.

I will come to an end, and I will close with this particular issue, which I think is really important. If you look at those cartoons, you may not be able to see it, but there is an enormous mathematical problem being put on the board, the teacher is looking bewildered and the students are working away on the end there, on the right. The teacher says, 'Here is where you made your mistake'.

I am a parent, and I know about helping my daughters with homework. If you have a look over to the right you will see 'Homework helpline? I need to have you explain a quadratic equation in roughly the amount of time it takes to get a cup of coffee'. I am not sure who experiences the anxiety, the parents or the students or both, but I know that in the teaching of mathematics you only need to talk to students to find out how much anxiety centres around the learning of mathematics.

Maths anxiety is an intense emotional feeling of anxiety that people have about their ability to understand and do mathematics. People who suffer from maths anxiety feel that they are incapable of doing activities and classes that involve math. Some maths people even have a fear of maths. It is called maths phobia. That is a bit scary, isn't it? The incidence of maths anxiety amongst secondary school students has risen significantly over the last decade. Many students have even chosen their courses beyond school on the basis of how little maths is required to undertake their degree.

Maths anxiety has also become so prevalent in universities that many schools have designed special school counselling programs to assist them. So there is an emotional domain to learning that needs to be taken into account in the teaching of mathematics and science rather than just being an intellectual problem, because this anxiety interferes with a person's ability to learn and engage with maths in particular, and it can result in the intellectual problem coming. There is no direct or single course, but it is an important thing that needs to be attended to in the teaching of teachers who may be focused very heavily in the secondary schools on their subject discipline, but not necessarily on the student and their needs.

In closing, at Balwyn High School we have a clear, strategic intent to improve the quality of learning for all of our students by focusing on creating a strong professional community of learning focused on improving the quality of teaching. As a community we have collaboratively developed a shared vision for learning based on the UNESCO Delors report *Learning: the treasure within*. If it has a futures focus, our mission is as a community of learners here

together — teachers, students and parents — to equip our students to become resilient, independent learners and responsible global citizens.

Through our professional learning community we are creating a reflective community of educators who are collecting data and working together to improve their practice. You will hear more specific detail about the school science program from the head of science, Mr Alex Leahy, and from the head of mathematics, Mr Andrew Mark. I would also welcome back Mr Colin Hopkins, who is responsible for the innovative outreach program in physics across the state, and Corey Walker, who will be doing that joint presentation and is also a teacher of science at the school. Welcome, Corey. We wish the parliamentary committee all the very best in its deliberations and hope that today provides useful information related to the terms of reference. Thank you.

The CHAIR — Thank you. We will have the presentations and then open it up for a discussion session. I saw Alex Leahy's class earlier — an excellent class.

Mr LEAHY — What we have planned to do today is basically talk about the history of the science faculty in how it has actually developed over the last few years. Throughout its life Balwyn High School has had a strong reputation for having passionate teachers and interested students. However, in the science faculty the area where we feel that we have made the most contribution has actually developed over the last few years, and that has made a significant difference to how things have occurred.

I should introduce myself. I am Alex Leahy. Next to me is Colin Hopkins, who is a previous teacher at Balwyn High School, and Corey Walker, who is a science teacher also at Balwyn High School. We are presenting this together, and we are going to be talking about various aspects over the last few years.

I would like to focus on the factors that we felt have actually developed at Balwyn High School over the last few years. One has been on teamwork amongst the teachers, being able to share the teaching practices throughout our teachers and through the outreach program to the wider teaching community, and also the incorporation of ICT into our teaching, which we feel has actually greatly improved the quality of learning that is taking place in our classes. First up, where we feel that things started to change was back in 1999, and Colin will continue.

Mr HOPKINS — The changes that really began in 1999, which I think have led on to where Balwyn is at the moment, were that the ageing staff in Balwyn meant that there needed to be some employment of some young people. Some beginning teachers were brought into the school, and then the school was fortunate to have a mixture of very experienced teachers and some beginning teachers. That led, with the different skill sets that the experienced teachers and the beginning teachers had, to an environment where there was a lot of sharing of information. The first science beginning teacher that we had was given a year 12 physics class as a first-year-out teacher. Not many schools do that, but there were three physics classes and he was given one, and there were two experienced teachers either side of him. The rationale was that we could mentor the young teacher through the process and introduce him to what we need to do. It turned out that he mentored us more than we mentored him, which was a really wonderful and exciting prospect. He was IT trained, and he was aghast at our lack of knowledge of using IT in the classroom and how to do it. One of the real strengths we had with him being IT trained was that it gave us an excuse to have more than one teacher in the classroom. He would come in and be our IT expert for us as we were fumbling our way through using technology, and as we still fumble our way through using technology as an educational process.

He got us started, and the IT was a great excuse to get more than one person into the room. So we then began this process of team teaching and of sharing resources and things like that. Initially we shared resources via floppy disks, and fortunately we have moved on. What happened then was that we started to realise what a very privileged position Balwyn was in terms of the number of staff it had in the school and in terms of a school. At one stage Balwyn had seven physics teachers in the school. There are schools around the state that cannot find one and Balwyn had seven.

With my experience of being a rural teacher out in the country and with the ability that some younger people have to use IT we decided, and we have the process, to share our knowledge and mentoring with people around the state. With the experience the other physics teacher and I gained from mentoring young physics teachers, we stretched out and started mentoring others around the state. The beginning teachers had their mates, and they said to their mates, 'Look, here are some resources. We will share them with you'.. We began to share resources. We developed an outreach program for teaching physics around the state — which still runs to this day.

Mr WALKER — Two thousand and one — that is, four and a half years ago — saw the arrival of more fresh blood to the science faculty of Balwyn including myself, and hence a new phase in this mentoring. Team teaching became more frequent, and this was facilitated by timetabling, it and was brought on by a desire of all of the teachers to learn from each other. Whilst the classroom is the most enjoyable place for any teacher, the science faculty staff room in 2001 contained a group of like-minded, like-inspired, like-focused, passionate and reflective individuals. This gave birth in the end to the innovations that were in the classroom. In particular the staff room was the base for this informal mentoring; it was based around conversations. There was peer support, not only the more experienced teacher and the less experienced teacher, but also the more experienced teachers with each other and the less experienced with each other. At the end of every lesson there was a loose discussion on whether the lesson went well, what aspects were good and bad. Around morning tea, over coffee, the discussions were about pedagogy and how to improve the learning that was taking place in the classroom. The team teaching was facilitated by the timetable, and that meant for me at least that I was able to coincidentally be free and not teaching when my mentors were teaching, so I could go in with them. Sometimes there might be three of us teaching, and that was probably a highlight in terms learning on the spot, learning the trade.

Mr HOPKINS — In 2002 we were very fortunate to win a couple of awards and a grant. The federal government's National Innovation Awareness Strategy was the first one we applied for, and were successful in doing that. That gained us some money to do what we had been doing but with some sense of resources. We started sharing our resources and notes. We were emailing people all over Victoria; we were supplying CDs to physics teachers throughout Victoria with our notes, with our examples and with our solutions. We really started to try to gear up the quality of teaching throughout Victoria. The use of ICT was really critical to what we were able to do. The skill-sets of the younger teachers coming in and their ability to do programming meant instead of just using IT as a presentation device we were able to use it as a teaching tool.

Mr LEAHY — Many of you will be familiar with how ICT is actually used in classrooms, but we thought we would show one particular example here. This is one of the pieces of software that was developed at Balwyn High School. We can show scientific models. Much of science is dynamic and animated but too small to see. Before ICT we would have to discuss this through diagrams and looking at chemical reactions without being able to see what was really going on. Bringing in ICT enabled us to look at models of what was really taking place and simulate it. We have an ability to interact as well — for example, we could increase the temperature and see what would happen as the increase effected reactions. We can see the particles would move faster.

At the moment this scenario is showing two different chemicals separated by a barrier. If we remove the barrier we can see how they interact and chemical reactions take place to produce precipitates. By changing the factors such as the amounts of various substances, the temperature and so forth, we can look at the length of time a chemical reaction takes place in. You can do this in a real sense by having the chemical reaction in the classroom and also by seeing it on the ICT as the reaction is going on. The concepts in science are no longer some idea that people have to try to infer; they are now very visual. People can actually see and interact with them and get a full understanding of what is taking place.

Mr HOPKINS — So IT became a teaching tool we were able to teach to. We were in a position where we could then share these teaching tools with people throughout the state. We focused on country schools, because there was a lack of resources in general terms for country schools and certainly a lack of being able to sit around in the staff room and discuss physics and have those sorts of ideas just as part of your daily conversation.

The next stage of our process was that we started running revision lectures for kids around the state before the exams. We were out giving lectures in about 8 to 10 venues around Victoria to kids who would not normally get to that sort of thing. At some of the schools we went to there might only be three or four kids from the whole district who turned up to the revision lecture, but our belief was they were the important kids. It was those three or four kids who could not get anywhere else who could make it to St Arnaud and spend a Sunday afternoon having revision lectures.

We were also fortunate that year to win the Victorian education excellence award, the curriculum innovations award, which was a very pleasant recognition of the work of the science faculty and in particular the physics faculty had been doing here.

Mr LEAHY — In the years that ensued science moved into a new building; we had a new staff room and more science teachers, and we were also located much closer to our science classrooms. From that point on we had

a high concentration of science teachers in one small area being able to communicate and discuss things over coffee. We could casually just walk into another teacher's classroom and be able to interact in the classroom quite happily with no hindrance to the other teacher's style or anything like that. As a result the sorts of techniques which had originally started in physics started to develop into the other areas of science. Nearly all of us were teaching junior science, so being together we were able to share resources.

As Corey mentioned, young teachers were sharing ideas amongst one another; people were looking pretty much to everyone around them in order to be able to share these resources. ICT made sharing even easier, because we could just email across amongst ourselves some particular resource or a lesson plan or anything like that. Also during that time younger teachers started teaching the other areas of science, such as chemistry and biology, and so these sorts of habits began to develop into those areas. The crux of what was happening there was this concentration of science teachers, similarly-minded teachers with a mixture of different levels of experience, all coming together and being able to discuss and share these sorts of things, and those sorts of techniques have basically been developing over the past few years in order to get us to the point where we are today.

Mr WALKER — The history lesson now over, it was under good leadership that the science faculty thrived in the period just highlighted, and we have come to see that good leadership is not just important but essential to successes in innovation. Being part of this process personally, it is strange to talk about an element or any amount of risk involved. However, this is because it was in an environment where risk taking was the norm, and it was a very comfortable and supportive environment, which we have described.

I think we have seen today that the use of ICT has many risks associated with it, just by standing up and having all of this around: team teaching; being viewed by another and taking part in a dialogue not just with the students but with another teacher in the classroom and changing the way you teach; being forced to consider other ways of teaching with someone else in the room or outside that room; and self-reflection is encouraged — but definitely just to undertake that process is a risk. It was the leadership that harnessed and facilitated the different individuals and encouraged each of these risk-taking processes that made this period so successful.

Mr LEAHY — But of course none of this could have really worked without the enthusiasm of the students as well. We were trying to bring something quite passionate to all the students and impart our passion to them, and the result was the students reflected that back towards us with positive energy and were able to absorb that very well. Paramount to all of this is to make the science real to the students as well, and so there has been a lot of effort put into involving the students in things outside the school. This is just a list of some of the things that we expose our students to. In particular, one of the things that I am quite passionate about is the opportunity for students to be able to go out and work over their holidays in a scientific lab. We have had some students working in the CSIRO Student Research Scheme. We had one student who was doing a project on monoclonal antibody production, and he has come back saying that he actually had to use his chemistry and biology in order to be able to work in that environment. They can actually see the application of the science that they are using.

All of that is necessary for the students to be able to get an idea and a vision of how real the science is and the wonderment that Bruce was talking about before, with the perception of the world, it is important that that link is actually made. We have put a large amount of effort into encouraging students to take that up as well, and that also could not have happened without the leadership that was effectively the driving force for all that was happening in our faculty. That pretty much says that we feel what we have to offer is quite significant to teaching science in Victoria. Thank you very much.

Mr MARK — I would like to start by giving a bit of a snapshot of mathematics here at Balwyn High School. As in most schools, it is a compulsory subject in years 7 to 10, and it is in year 11 that students can first make choices. This year in year 11 we have 10 classes of students who have volunteered to do mathematical methods and 12 classes have volunteered to do general mathematics, so there is quite a high participation rate. In year 12 this has continued on, and we have 8 classes of students doing mathematical methods, 4 classes doing further mathematics and 4 classes doing specialist mathematics. So we have lots of students choosing to do mathematics in the non-compulsory years, which is very pleasing, and we have 37 staff teaching at least one maths class. A number of those teachers are full-time maths teachers.

Other highlights of the program include the accelerated learning program, where students are accelerated in every subject, and they complete years 7 to 10 maths in three years. We have also an accelerated mathematics program which starts in year 9 in which students are accelerated in mathematics only. They complete years 9 to 10

mathematics in one year and are able to start their VCE maths in year 10. The accelerated mathematics program is quite popular with students. Usually at least 100 students would try to be selected for that program, and we can only take 30. Sometimes we have had up to 150 who have put their hands up and said, 'I would like to be considered for that'.

When speaking to students and asking them why they choose mathematics we get lots of reasons, but some of the more common ones include their enjoyment of the subject. Lots of our students here at Balwyn will say they like the challenge of solving problems and they like that feeling of success. A lot of them will also say it is because of tertiary prerequisites; they have looked into courses that they might be interested in or possible career directions and they choose maths methods in particular for this reason because it seems to be a prerequisite for lots of the courses that they are interested in. Another group says that they will do maths just generally because they feel it will help them to get a high ENTER score and by doing one or more maths subjects this will help them maximise their overall score.

I would like to talk about the enrichments, some of the activities we offer to students as well as the normal curriculum to extend them beyond what they do in the normal classroom. Our students participate in the Australian Mathematics Competition. We ask for volunteers only to go in this, but we would always attract a minimum of 650 or 750 competitors, sometimes up to over 1000 students who want to have a go at that and just rise to the challenge and see how they go competing against other students. The Mathematics Challenge for Young Australians is a national, three-week problem-solving competition for years 7 to 10 students and always attracts a substantial number of entries. The students seem to enjoy the problems set and applying their maths to a real-world situation.

The University of Melbourne School Mathematics Competition is a very challenging competition and some of the most talented students really like pitting their wits against some of these problems. Other activities which we offer to groups of students are the Macquarie Business Mathematics Competition, which is unfortunately not operating this year but it has been going for a few years. That is an online competition in which participants have to apply their mathematical skills to a real-world business scenario. In a recent competition students had to imagine themselves as the manager of a sporting identity who was earning big money at the time but always had the risk that he might suffer a career-ending injury. They had to give advice to that person using their maths skills.

I refer to the Australian Mathematical Olympiad. In 2005 one of our students, as a result of his performance, was selected to attend the Olympiad selection school in Sydney. From this school the international team was to be selected to represent Australia in this year's international Olympiad.

We have had a number of students represent Melbourne in the Tournament of the Towns competition. It is an international problem-solving competition, moderated in Moscow, in which teams are handicapped in proportion to the population of a town or city. We have had teams in the Maths in Industry and Technology Challenge — that is where teams of students are presented with a real-world problem and required to establish a solution approach within a few hours. They then have to present their findings to a panel of judges drawn from industry and academia, which is followed by a question period. So while offering these activities to our brighter students, our aim is to interest and extend the whole cohort of mathematics students throughout the school. We would like to offer something for everyone.

I refer to mathematics support. Sometimes through AIM data, to assist us in identifying some students for whom there is some need for additional reinforcements and assistance, we have been able to allocate some teaching resources to a team-teaching situation with the specific aim of giving more intensive one-on-one help to those students experiencing some difficulty. We have had a homework assistance program, which is a program run out of class time — at lunchtime or after school, and before school on some occasions — in which teachers, and some students, have volunteered to assist students seeking help with their mathematics. We have also had a highly successful community volunteer program, in which some parents and other community volunteers have come into the maths classes and assisted students, with special attention being paid to students who need a little bit more individual help. What we are trying to do is to build the students' confidence. We have been very fortunate in that we have had some excellent people, including several trained maths teachers and several retired professional people, who have really helped the students. Having the extra person there to give them the one-on-one attention has been very valuable.

We are proud here of the excellent VCE results, the AIM results and the feedback we get, such as the Australian maths competition results, in which our students typically achieve prizes, high distinctions and distinctions at a rate

three or four times the state average. I want to highlight that we are very proud of the achievements of all the students — not only those at the very top of the group, but all those who are able to achieve personal bests.

I would like to briefly comment on some factors affecting the teaching and learning of maths. We have a highly motivated student cohort here at Balwyn. Shortly you will hear from some of our students, and you will see for yourselves what delightful and enthusiastic young people they are. I feel very privileged as a teacher to work with students like these. We have a supportive parent body which values education and has high hopes and aspirations for the children and supports the values of the school. We have a high-quality teaching staff, and I cannot overemphasise the importance of the relationship between teacher and student in the learning process. I think that is a critical factor. We have teachers with strong subject knowledge and understanding of the pedagogy related to mathematics and a knowledge of how students learn. This has been something where our knowledge base has increased over recent years; there has been quite a focus on professional development.

I feel that we are fortunate here to have a large number of maths specialists, similar to what Alex was saying about the science specialists, who are passionate about the teaching and learning of mathematics. I really think it is important; I cannot overemphasise the importance of having highly skilled and passionate teachers in the learning process.

I will make just a few observations about the curriculum. We are continually trying to make improvements and respond to MYRAD data. We try to make it interesting and relate it to the specific interests of the students. We try to use hands-on activities and activities which incorporate technology, both of which especially appeal to boys. An example is Mathematics 300, which is an excellent online resource to which we subscribe. The aim of this resource is to build up a bank of 300 best-practice maths lessons with associated resources and software. We are trying to incorporate thinking skills to assist in the acquisition of a deep understanding of mathematics. We want students to be able to reflect more on their own thinking. Other factors relate to the culture here at Balwyn High School, where we are guided by our vision and value statement and the pillars of learning: learning to think, know and understand; learning to live together; learning to do; learning to be. We focus on one pillar each term in our attempts to create resilient and lifelong learners.

We have an extensive professional development program with a number of different types of PD. We have the professional learning teams, the PLT. These teams are sometimes based on a common class taught or are subject-based teams — for example, there might be a group of maths teachers working on a project or there could be an interdisciplinary team of teachers from various faculties working together on a specific issue. We have what we call PLPD — professional learning, professional development — where teachers at Balwyn share their particular expertise with groups of their colleagues. We also bring in outside experts to facilitate sessions. For example, the well-known maths educator Charles Lovitt has come on site on a number of occasions to inspire and challenge the maths teachers at the school. We also have what we call PLKLA — professional-learning, key-learning-area — sessions where groups of teachers from the same faculty meet to plan, implement and evaluate programs. We have had a number of these meetings where groups of maths teachers have got together to talk about how we can introduce the essential learnings framework for the next year.

The performance and development culture is a culture which has been introduced and which encourages reflection on and continuous improvement in classroom practice. We endeavour to seek multiple sources of feedback about the learning of students. This includes feedback from the students themselves to help evaluate our practice.

I refer to the development of a leadership team. Under the direction of our principal, the leadership team includes leading teachers and principal class members. The team meets regularly and attempts to build a shared leadership capacity. The focus of the group is on student learning and how we can improve it.

I will turn to just a few other issues and go to the middle years. It is a continuous process, and we are attempting to respond to MYRAD data about the needs of students in the middle years. One example of this is the formation of teacher teams in years 7 and 8 to decrease the number of teachers that each student has contact with. We are hoping this will lead to increased student connectedness, because we want each student in the school to know that there is a group of teachers who know each student and care for him or her.

Girls: we have many girls who do maths in the VCE years at Balwyn, but the proportion of girls is less than that of boys. We are always looking for new ways to increase the participation rate of girls in senior mathematics and to provide them with appropriate support.

Industry: we have had experts come in from industry and academia, such as Professor Con Stough, who has worked with us on emotional intelligence and 360-degree feedback processes. We have also had Andrew Fuller work with the leadership team on the latest brain research related to providing optimal learning environments for students. I can see that this is an area that can be developed. Industry experts can show us how maths is used in the workplace and also provide more information about the multitude of careers that require a good understanding of mathematics. I feel that industry experts could certainly give us useful ideas in this particular area.

Promoting greater interest in teaching mathematics is, I think, a difficult issue, especially with the global market for talent. Unfortunately I do not hear our most talented young students talking of going on to teaching maths as a career. But we have been fortunate here at this school; we have been able to attract some extremely bright young teachers to the school. It is very helpful to have such high-quality young teachers joining us, as Alex spoke about in the science context.

I refer to the role of parents. Parents who are supportive of the school and who value education make great partners for the school. Teachers, parents and students can work collaboratively, and the students will benefit. We are also fortunate because we have a highly educated parent body. We are fortunate that many of our parents can directly assist their children with their mathematics as well as provide encouragement and optimal conditions for learning.

The CHAIR — We are now moving to the education and training of students from the middle years.

Ms POOR — Good afternoon distinguished guests, ladies and gentlemen. I am Llaaneath Poor and this is Ezra Kumar and Jacqui Dickenson. We are just three of the middle school leaders. We are here today to answer the question put to the middle school: what makes a great maths or science class?

From our own experiences we believe there are various factors that contribute to a successful maths or science class.

Ms DICKENSON — Teachers have a big influence on the students in a class. Teachers who listen to their students and have open discussions usually find that students enjoy turning up to the next class and the one after that. From our experiences, these discussions with a number of people really lighten up a class and encourage students to have input and voice their opinions. Those students who have not really been interested in the subject before gain an incentive to go out and reach their maximum potential.

Ms POOR — Being patient with a class is vital to a student's development in maths and science. These subjects require you to use problem-solving skills. Patience is one skill you need to have when you are completing a problem. Because science students find it difficult or hard to begin with, it is important that they receive support. Through continual guidance and support from a teacher a student will see improvement in their grades, and with the enthusiasm of the teacher and students there can be a very positive and rewarding learning experience.

Ms DICKENSON — Having good equipment and aids enhances the teacher's skills. Improved technology, which includes overhead projectors, DVDs and PowerPoint presentations, broadens the way in which a teacher is able to present material, which is beneficial to different student learning styles. Hands-on activities also engage the students' attention by positively involving them in the subject, creating a pleasant work environment for both students and teachers. Interesting topics are very important in making students think and understand. Students who do not enjoy all subjects say they like science. When asked why they tell me it is because of how many topics we cover. Although some students may not like one particular topic, there is always another one that brings enjoyment.

Maths is exactly the same. One student may find one topic hard to cope with and may have problems, but they might find another one pretty easy. This gives the student a sense of achievement.

Ms POOR — Small class sizes are vital for success in the classroom. A teacher is able to communicate and assist students on a more individual basis if the class size is not too large.

Mr KUMAR — A variety of teaching methods is also important for students to achieve maximum results. When a teacher assigns students to groups it not only excites the students but makes them very organised and proactive in the sense that they have to organise among themselves the time to get together and finish the work.

Incursions and excursions also generate some enthusiasm among the students as they get to learn about the subject outside of school and generally get to learn about the topic when it is related to the real world. Although we have been talking about what teachers can do to enhance students' learning, the students have to cooperate so they can enjoy a great class. A student should be positive towards learning. If they look at the subject and say they dislike it before they even try it, when they do try they will not achieve as well as someone who has a positive attitude towards the subject. A positive attitude contributes to a desire to do well, and when a student has that desire generally they achieve what they set out to do — and even better.

An inquisitive mind also aids in making a class more enjoyable. A student should be asking questions about the topic they are studying and not just accepting what they hear. This helps to broaden their mind and gives them a greater understanding of the topic.

Ms POOR — Balwyn High School has recently introduced the four pillars of learning. The pillars include learning to think, know and understand; learning to do; learning to live together; and learning to be. These four pillars are a great way to understand the world around us, which leads to our students growing to love learning and become lifelong learners who are confident, generous, reasonable global citizens capable of facing the future with resilience and optimism. All students use these ideas in each subject to help them become better people. We believe these points are significant in having a positive and successful class, and that is what makes science and maths great at Balwyn High School.

Ms DICKENSON — You will now be hearing from Dominique Grant about her perfect class. Have a nice day!

Ms GRANT — Hello, my name is Dominique Grant. Today I am going to reflect on my perfect lesson in an effort to convey what makes a good science or maths class. My perfect lesson was a period of science this year. As soon as we walked into the classroom the teacher held our attention. He was surrounded by test tubes and beakers filled with an assortment of powders and acids. It was our introductory lesson on chemical reactions. We started the lesson by having a class discussion to brainstorm questions we had relating to the topic and on the facts we already knew. This opened up our minds to the new topic by making us compile what we had already learnt and think about what we wanted to learn. It also motivated us to find out more about chemical reactions and gave us the driving curiosity to answer the questions we had posed.

The next activities were experiments done by the teacher while we reported on the results and recorded our observations. Ordinarily this may have been boring, however, with a science teacher as passionate as my own and with students with a newfound thirst for knowledge, the activity was not only informative and productive but stimulating and enjoyable.

In the final part of our lesson that day we were divided into groups of three to investigate and answer one question. We had to answer the question by using our textbooks and notebooks and conducting certain experiments relating to a specific question to not only complete the task but also justify our response. The thing that motivated us even more, though, was when the teacher announced that the first group to answer the question would get a prize. This activity not only offered hands-on experience but also released our competitive spirit, gave us invaluable investigative skills and allowed us the freedom to explore science. It was the highlight of not only the lesson but also the whole day. It was the perfect conclusion to an excellent lesson.

As I said before, the aim of my description and in fact the whole presentation is to explain and give feedback on what makes a productive, fun and stimulating science or maths class. However, it is all very well for me to stand up here and talk about my own perfect lesson, but I want to get other students out there to think about how they like to learn and what works best for them.

Successful learning is about having a safe environment, passionate and dedicated teachers, an abundance of information and motivated and involved students. By increasing the involvement of a student through encouraging the student to think about the learning and not just process the information, classrooms will become more productive and students will learn how to understand information and not just memorise it. In effect, reaching established goals represents learning for life.

Mr POTENZI — Hello ladies and gentlemen, I am Bradley Potenzi. I am music captain at Balwyn High School. I have put together a PowerPoint presentation, which is behind me, to show the benefits of choosing science subjects in high school, particularly for VCE.

Science is a very broad, useful discipline for high school students. It gives the opportunity for an extensive selection of university courses and jobs. It is the focus of competitions and other extracurricular initiatives, and it teaches a method of logical thinking no other subject can teach. Studying science has many benefits. The subjects often overlap information, so doing one helps with doing another. The Lessons are designed to thrill, with many enjoyable practical activities to challenge us students. The courses may seem difficult to some, making science subjects a bit ostracised from other classes, but they are an essential part of school and they help us understand the rules of life.

Obviously I think science is our friend. I have studied or am studying at the moment five of the major science subjects: physics, chemistry, biology, specialist maths and maths methods. I have found that there are links between subjects I have studied and these links are important connections that make learning science less stressful — for example, specialist maths and physics share two whole chapters, kinematics and momentum. Biology and chemistry share the chemistry of the body. This makes studying multiple science subjects much easier. Also, as I mentioned before, I am a bit of a music buff. There have been many studies showing the link between the scientifically educated mind and musical ability. As a dedicated saxophonist, I know my training in science helps my music and also vice versa.

It goes onto opportunities. There are many original science-based competitions out there that test and challenge our young minds. Myself, I have been part of all competitions on this slide behind me and many more, including the titration competition, the national chemistry quiz and the Australian maths competition. However, the different and most important aspect to science-based competitions in my view is the extended project based ones, such as the CSIRO CREST award and the Science Talent Search, which at our school all students are encouraged to enter. The workload is bigger and they certainly take longer to complete, but they are very much worth the effort.

Work experience: throughout high school students are expected to undertake at least one week of getting experience in a career they are interested in. I chose scientific research and after some researching, and some help from teachers, I was accepted into a both week at the CSIRO lab in Parkville and the Murdoch research institute on the top floor of the Royal Children's Hospital. These links directed me and were an important part of choosing a possible career.

This Wednesday the 2005 undergraduate medicine and health sciences admission tests will be held. This is the entrance test and is part of the selection process to some different science-health-based courses such as medicine and dental science. Universities require science subjects as prerequisites to the scientific courses and high scores in these subjects are a major factor in being accepted into these programs. We are lucky to live in a city which excels in scientific research and job opportunities are around. The newly developed Clayton synchrotron is an example of the expansion in this area of work.

I have done many exciting things during my study here at Balwyn and the majority of them were brought about by science pracs or excursions. As you can see by that list over there, I have loved every minute of it, and these moments bring something to the area of science that is truly distinctive.

In conclusion, why do a science subject? Hopefully I have shown you the opportunities science has given me and the enjoyment I have gotten out of my classes. These subjects link with each other. They help to develop a different type of thinking and they are just plain fun. Thanks for listening.

Ms KUMAR — Good afternoon, ladies and gentlemen and distinguished guests. As Brad said, I am Shakira Kumar and I am also one of the year 12 leaders. I am the vice-school captain of Balwyn High. My subjects for this year are English, chemistry, biology, maths methods, further maths, and psychology, which I completed last year. As you can tell, basically all my subjects are maths or science, and it was a relatively easy decision for me to pursue these subjects in my final year of secondary school.

The main things influencing me and in this order were: what I enjoy, prerequisites of possible university courses, and finally what I excelled in. All throughout high school science has fascinated me. It was the subject I always looked forward to even if I found it challenging sometimes. I could not envisage myself taking more business-oriented or humanities-related subjects. For me, junior science has always been great fun and I favoured it over subjects like commerce and geography. What furthered my interest was some of the opportunities science presented me with. For instance, in year 10 I was sponsored by Rotary to attend the Siemens science experience. This consisted of three days at Monash University, or any other host university, and I partook of science-based

activities and tours. In my three days I visited the maths faculty of Monash University, investigated the angular properties of bubbles and got the opportunity to take part in many other similar hands-on activities. Also that year I attended the national youth ANZAAS (Australian and New Zealand Association for the Advancement of Science) residential conference. This is a three-day camp in which young science students meet in a major city of Australia and explore science initiatives in centres around the city.

I visited the Walter and Eliza Hall Institute for Medical Research, had talks from synchrotron representatives, Australia's NASA liaison, presentations on quantum computers, black holes and even a trip to the Melbourne sewerage farm in Werribee. All this only fed my interest in science and maths as it showed me that there were so many facets of it, no struggle for job opportunities, and I was not wasting my time if I indeed chose to pursue it.

As mentioned, another reason for my selected subjects was prerequisites for university courses. The course I hope to pursue has chemistry as a prerequisite, so it is just as well that I enjoy it because I do not know whether I could put up two years of a subject that I hated. Biology and psychology are not prerequisites for any courses, but I know that some students undertake them to get a head start in their preferred tertiary course. For instance, even a course like kinesiology, which has no prerequisite subjects listed, requires you to learn year 12 biology, chemistry and physics in the first year. This would definitely be an incentive for some students to undertake VCE science subjects so they do not have to learn all this from scratch.

Mathematical methods is also the key to opening a huge array of courses at university, so taking it keeps your options open. This is a reason that the subject is completed by so many students, and those who are conscientious and are wary that they may suddenly change their mind and decide to pursue a course where it was a prerequisite. It is better to be safe than sorry. When choosing year 12 subjects I also considered what I was good at. It seemed to me that due to my interest in science I was most likely to have an enjoyable year. While I do not doubt I could have probably scored equal in subjects I did last year like health and human development, I do not think I would have enjoyed it as much.

I approached numerous peers and asked them why they chose their subjects, and came up with a variety of answers. Here is a sample of a few:

Student 1: their subjects were English, physics, maths methods, specialist maths and visual communication. They hoped to pursue visual design. It is pretty different to what they hoped to pursue in university and their reason for their choice was to help obtain a high ENTER with their scaling.

Another student: their subjects were English, maths methods, further maths, chemistry and biology. They hoped to pursue medicine. I asked them why and they responded they were interested in the subjects and hoped to pursue them in the future.

The final student had subjects of English, maths methods, specialist maths, physics and chemistry. Their prospective course was commerce-law. I do not quite see how these two correlate, but this student found those subjects easy and thought it would also enable them to get a high ENTER with the scaling.

The second part of my talk is 'Science and maths: friends or foes?', which Brad touched on earlier. That is, does one hinder or help the other? For the sciences that I do — chemistry and biology — basic mathematics is essential. For instance, with chemistry there are a lot of concepts — for instance, stoichiometry — in which formula manipulation is crucial, but I do not believe that maths methods is necessary to complete these sciences. In this way VCE chemistry and biology are quite distinct from methods, as they do not hinder one another, but do not specifically complement each other either.

However, chemistry and biology do complement each other quite nicely. There are a few common topics even though you are looking at them from different perspectives — that is, a biological and a chemical one — so it does benefit doing them in conjunction. For example, in biology at the moment we are looking at DNA. It is easy to grasp from a chemical point of view that the nitrogenous bases in the double helix bond the way they do because of their chemical properties. Vice versa, in chemistry we will soon encounter food chemistry, most of which we have already looked at in biology but from an in-practice perspective. Regardless, this familiarity helps students grasp concepts more easily than if completing the subjects alone.

I will now hand over to Megan Barr. Thank you.

Ms BARR — Good afternoon, ladies and gentlemen, and distinguished guests. As Shakira said, my name is Megan Barr. I am one of the school captains of Balwyn High School. Today I will be sharing some of my personal experiences with you. As a year 7 student I was certain that I was going to be a teacher or a lawyer — nothing could possibly change my mind. If someone had told me that as a year 12 student I would be an aspiring physiotherapist, studying chemistry as well as maths methods and psychology, I would have simply dismissed it as nonsense. From a young age I have had a passion for working with people and wanted to pursue a career that would allow me to help others. However, it was not until I was in my middle years of high school that I began to seriously consider a science-based, not humanities-based, approach to achieving this goal.

When I looked at the question which we as senior school students are here today to address, three main factors dominated my thoughts on what influenced my subject selection: past experiences, prerequisites, and enjoyment. I will touch briefly on each of these three aspects. I have never been a naturally gifted student. Over the years I have found that my success has been the result of persistence and determination, not talent. I often doubted my capability in subjects in which understanding concepts was essential. When it came to parent-teacher interviews, my maths and science teachers often reported a lack of understanding. However, my year 8 teacher, who happens to be here today, took a different approach. He put my performance down to a lack of confidence. Mr Hopkins understood that I was not naturally gifted but I had determination and the will to succeed. He took the time to teach me the basic concepts and worked through my difficulties with me. This helped change my negative, scared attitude into a positive and disciplined one and as a result I began to perceive maths not as a hard, tortuous subject, but a challenging and rewarding one. This positive experience made me believe in my ability.

Unfortunately, many students progress through their junior years without having a similar experience. Over the past week I have asked many students why they did not choose maths or science in VCE, and the most common response was, 'Because they are hard'. It is essential that this attitude is changed during the junior years of high school to ensure that maths and sciences are not dismissed as subject options purely because they are challenging. It is only now, several years later, that I can look back and see that positive student-teacher relationships are central to eliminating this attitude.

I can genuinely say that I chose my VCE subjects purely because I enjoy them and felt that I would succeed in them. In an ideal world, where prerequisites did not exist, I would be studying biology, English, maths methods, psychology, business management and PE, which I completed last year. Instead, my subjects are chemistry, English, maths methods, business management, psychology and PE, so there is only one subject difference. I was certain that I would enjoy biology. However, I was adamant that I wanted to be a physiotherapist and therefore accepted that if this goal were to become a reality I would have to study chemistry. As Brad and Shakira both mentioned, prerequisites play a fundamental role in subject selection.

Finally, what I believe is the most important factor to consider when selecting subjects is enjoyment. I have a relatively balanced choice of subjects: business and psychology involve a lot of theoretical learning; maths is full of concepts and formulas; and chemistry is extremely hands on, with 10 out of 12 internal assessment tasks for the year being practical experiments. This range provides a large variety in what I learn every day. I look forward to coming to school because I know that I am studying a diverse range of subjects.

The best advice I was given when choosing my VCE subjects was, 'Choose what you enjoy. Do not let scaling, friends or even parents deter you from choosing subjects you want to do'. Enjoyment is a key factor to success. Although this is continuously reiterated throughout high school, I personally believe that many students underestimate the importance of selecting studies which they will enjoy. At times maths and science do seem like battles which will never end. I understand partially why people who do not require these subjects do not select them. However, I find it disappointing when people select other subjects purely because maths and science are difficult. They may be challenging, but they are not impossible. Unlike in many other subjects, when you finally understand something which at first glance looked unachievable it is extremely rewarding and motivating. They teach you lifelong skills about problem solving; they help instil a disciplined, strong-minded attitude; and, most importantly, they prove that success is the result of commitment and perseverance, not necessarily skill or talent.

We hope that we have been able to provide you with a different and insightful view of why students choose what they choose. I am sure Brad and Shakira would agree that it is extremely difficult to sum up our thoughts and experiences in just a few minutes. However, we will be joining you for lunch, where we look forward to further discussing our experiences with you.

The CHAIR — On the issue of lunch, we are running a bit behind so we might try to move along. We have two more speakers. Graeme Lane, from Balwyn North Primary School, is next and then I will open it up for discussion with other people.

Mr LANE — I am Graeme Lane, principal of Balwyn North Primary School. It is very pleasing to see these young people here today, some of them products of my school. I am just blown away by how eloquent they are now from not so long ago.

Best practice science teaching in primary schools is a difficult thing to talk about because primary schools traditionally are about reading, writing and arithmetic. Many of you in the room will know that because they were the tenets of teaching 30 years ago. Now we see that primary schools need to be involved in a much greater range of subjects than just those, including the way that our young people interact today with their world. Science is now paramount in a primary education. The scientific method of inquiry, in which children hypothesise, question, organise, collect data, think and reflect on their work, record their findings, draw conclusions and hypothesise again, is now not only an important thing for the schools to be teaching but, as these young people have told us today, a life skill that they need. If we are not teaching science in our primary schools we are disadvantaging our young people to a huge extent.

Science needs to form a major part of the curriculum. For that to happen in a crowded curriculum with eight key learning areas, it needs to be part of the teaching in every cycle of the curriculum. In my school in particular that cycle runs over two years. It contains eight units of work. We make it a focus to have science as the host in at least one of those units of work — in other words, as the major focus of that unit. We ensure that at least two other units of our work have science as a sub-major strand. In all other units of work covered in the two-year cycle science forms at least one part. It takes determination and leadership in a school to make that happen. That leadership does not necessarily come from me or a principal of any school; it comes from the passion of the teachers who want to do that.

To make that happen at Balwyn North, in 1995 we constructed a dedicated science teaching centre. The purpose of the centre was to encourage teachers to undertake science — to take their children to the room and actually set up their experiments and work with them. The reason we set up the specialist centre was because it was difficult for staff to conduct many scientific experiments and so on in the confines of a regular classroom in the way that most primary schools are constructed. So there is an issue of construction of the school and facilities behind the good teaching of science.

The emphasis in science in the primary curriculum tends to be on either the environmental or biological, both important aspects of science. Again I draw to the attention of the young people who today talked about the importance of chemistry and physics that it is not an easy thing for a primary teacher to undertake the teaching of either chemistry or physics, first, because of the physical limitations of the primary school and second, because of their own often poor background in science. In his talk earlier Bruce mentioned maths anxiety and science anxiety. Many primary teachers are cast in that mould. That is not being disparaging of my colleagues. It is just a simple fact that most primary teachers come from either a literacy or a minor mathematical background. To find a primary teacher with a major study in science is almost impossible.

Many of my teachers had not undertaken a scientific study since year 10 — and then we were expecting them to teach in our schools. To get that to happen the staff at the school took on 22-week after-school study over two years, working with Deakin University to improve their science skills. They undertook professional learning as a team of people supporting each other and developing units of work.

At the same time we were involved with Professor Richard Titler from Deakin University and his third and fourth year students. He was working with our school in developing scientific tasks for the kids to undertake; scientific unit boxes and dedicated activities around a variety of science materials. The agreement with the university and our school at the time was that we would buy the materials and they would provide the expertise. That program ran for four years in our school. Sadly, it does not run today for a lot of reasons. However, I now have a staff of teachers who are able to undertake the teaching of science in a highly professional way. That does not occur in a large number of primary schools.

What is important in teaching science in primary schools is that we focus on the magic aspects of science — and we heard some of the children talking about that. They respond in wonderment and awe, particularly at things like

chemical reactions and so on. For instance, making volcanoes — kids will know about that one; they will know what I am talking about. Something occurs that is unexpected and then the kids want to know why. That opening of a mind to looking at the world in a different way really only occurs through the teaching of science. I know of no other subject matter that inspires kids to think broadly of their world than science. We certainly need to be doing a lot more of those types of activities.

What do we need to do for primary teachers to improve the teaching of science? We need to improve their personal and professional knowledge of science. We need some high-level science professional development. We have the Science in Schools program. It is an excellent program, but access to that is not available to all primary schools and it needs to be broadened. We need to have a requirement — and I think Steve got this one from us under the previous inquiry — on teacher training that primary teachers undertake a science and maths major study as part of their course because we need teachers to inspire children to higher learning.

We need to have the children in our schools and our teachers understanding scientific literacy. Bruce mentioned before that we have some fairly high-level scores at year 4 for children with scientific literacy but it is not an aspect that is taught well in our schools. The notion that we can have a vocabulary and a specialised knowledge around the area of science that children know and understand would go a long way to improving their understanding and ability in science as they move through into secondary school.

Passion — how do we build a passion for science in our teachers when they are anxious about the subject? The way we went about establishing that at Balwyn North Primary School was through that science program with Deakin University. Giving teachers time to both reflect and share their learning with others at the time went a long way towards building that passion for science and their feeling that they both understood and could further teach scientific concepts. We need time; we need training.

As a closing remark I would like to quote Professor Michael Barber from the UK; an adviser to Tony Blair. In terms of curriculum change and implementing improvement in schools his thoughts were quite simple: we need to provide intervention in inverse proportion to the need. We put a simple quote on that — please send more money.

The CHAIR — We have the president of Balwyn High School council here, Wayne Heathcote.

Mr HEATHCOTE — Thank you very much for providing the opportunity to put a parent's perspective on maths and science education.

How important are maths and science? The answer could be the standard answer — it depends. It will depend on many factors, like what you want, what you do, how you live. However, irrespective of everyone's individual circumstances, I would suggest that maths and science are important, very important, or crucial. It does not matter what you do, you cannot avoid the fact that you will use both maths and science in all aspects of your life. They are appropriately included in the curriculum as key learning areas. A question that students and parents could quite rightly ask when the students are learning a particular concept is, 'When are we ever going to use that?' Answering that question is a challenge for those designing the curriculum. Obviously not everyone is going to use everything they are taught, so what do we as parents want for our children in maths and science education?

We know that at the very least basic maths and science are a crucial part of everyday life. We therefore need to have the basics taught. But the most important thing is that the students are taught how to think, how to use maths and science and their application to everyday life. For example, a 10 year old doing fractions might ask, 'When am I going to use that?'. You could say to them, 'You have 11 of your friends around for a birthday party. How do I evenly divide the cake because you know everybody is going to look for the largest piece? If I cut it in half then cut it into half again. I now have four pieces. How many 4s fours go into 12? Wow, I am using fractions. Before we even got to cut the cake, think of how much basic science was involved in mixing the ingredients and baking the cake'.

Science is such a diverse subject it permeates all aspects of life and is extremely important — from baking a cake to being a doctor to DNA testing in forensics or policing to hairdressing — and I will come to that later — to drug testing in sport. As an example, just think of scientific developments and their use in sports and sports training. Look at the phenomenal results of Lance Armstrong who overnight won his 7th in a row Tour de France. Whilst he is an outstanding athlete, science has also played a great part in his life from curing his cancer to developing him physically and mentally for the task, as well as the technological advances in the bike he rides. Here is a practical example of the use of biology, chemistry, physics and psychology. Add things such as hairdressing and beauty

therapy with their extensive use of chemicals and other products and you can see that science is everywhere and is going to continue to be an important part of our life.

We also use maths in most things we do, but are we learning to use it properly? Last week I went to the corner shop to buy two large bottles of milk and I still do not know whether they were large bottles of milk, large plastics of milk, or plastic bottles of milk. They were $3.60 each. The young shop assistant did not even bother to try and work out how much it would be, she immediately picked up a calculator. When I gave her a $10 note she again used the calculator.

We seem to be relying more and more on technology when one of the most technologically advanced things is the human brain. We need to be taught how to use it. We need to seek to meet the challenge expressed by Eric Hoffer when he said that in times of change, learners inherit the earth while the learned find themselves beautifully equipped for a world that no longer exists. What we need to do is ensure that we have a robust curriculum to continue to provide the depth and breadth of maths and science subjects and at the same time teach subjects in a manner such that students are learning to think.

Parental involvement in maths and science varies markedly. Factors that will influence the level of involvement include whether it is primary or secondary and basic maths and basic science, or specialist maths or VCE chemistry or physics. There are a number of challenges facing parental involvement in maths and science education, not the least being that subjects are taught differently to the way they were taught last century when most of us were educated. However it is still a question of looking at the underlying concepts. Parents may not know the answers but they may be able to ask the questions which will help the children think which in turn may lead to the answer. Parents should be involved more with their children's education, but in today's society time challenges are becoming more of a hindrance, particularly in single-parent families or where both parents are working.

Other things that will impact the involvement of parents will be their own ability, desire and opportunity. It very much becomes an individual thing, but we need to develop a culture of all being lifelong learners and not just leaving teaching and learning to the teachers and students. Parents can be involved in helping their children with a particular maths or science problem by looking at the concepts and the practical ways they can be applied in the working or home life. In this way both children and parents are learning, and learning to think.

A challenge for everyone is to remember that we have teachers who learnt in the past and who are teaching children in the present how to live in the future, and in a lot of cases they are being taught for a job that has not yet been invented. I raised the question earlier: when are we going to use that when we are looking at maths and science? A partnership with industry or a tertiary institution is often a good pathway towards answering that question. A practical example of how things apply in everyday life particularly in business is a very powerful tool in education.

Industry partnerships are often formed on the basis of a common philosophy that will be built and enhanced where there is an actual or perceived benefit for each party. Often these are clear benefits to the school and students but not so clear to business. Our challenge is to show industry the direct and indirect benefits that can accrue to them through being part of such a partnership. These benefits may vary from providing an awareness of a particular kind of fact or philosophy or awareness of the business or a product of the business, through to providing industry access to potential future employees — and we have seen some great ones today. We must nurture these external partnerships but they must be focused and appropriate.

Many schools have outstanding maths and science programs, combined with a demonstrated ability and commitment to developing and sharing exemplary practices in education, and Balwyn High School is one of those. But to continue these we rely on government funding. However, schools are finding that the government funding alone is not sufficient to provide for the development and ongoing functioning of these programs. We also therefore rely on funding from the school community and we also rely on staff who are prepared to work over and above their normal workload to ensure the operation of successful programs. If the government funding, parental funding or teacher dedication falters then the program is placed in jeopardy.

I am not sure what is to happen with this committee's report, but no doubt its findings and recommendations will provide a great platform for opportunities to promote maths and science in education in Victoria. The state and federal governments need to commit to supporting these initiatives, which includes funding or quite frankly this committee and those presenting submissions to it are potentially wasting their time or at the very least the process will not achieve the desired outcomes. What we are hearing and what we have heard today is very powerful, and no

doubt this committee's report will include recommendations that if implemented will provide a great path forward. We need a commitment to funding the committee's recommendations. The funding also needs to be adequate and appropriately targeted.

Where you have schools with strong or innovative maths and science programs these should be identified and nurtured, if necessary with additional funding, so that these successful programs can be shared with other schools. This can be achieved by schools mentoring and sharing their exemplary practice with the other schools. To do this the funding needs to be provided to those schools that do not have the programs so they can develop and implement the innovative initiatives that promote the teaching and learning of maths and science, and additional funding needs to be provided to those schools that have the programs and are prepared to share them. If the funding is not provided, these programs will slowly implode and fall apart.

Any introduction and implementation of the programs into schools that do not have these programs must not be to the detriment of the existing programs. I congratulate the maths and science staff that have done so much outstanding work, and I look forward to not only seeing the committee's report but seeing the real benefits for our children that flow from the teaching and learning of maths and science.

The CHAIR — Thank you very much for those presentations; they were extremely detailed and were very useful. What I would like to do is open up the forum to comment, discussion or questions from people. I know there are a number of people from various institutions. We do have a roving microphone and I ask that you give your name and that of your organisation to the Hansard reporters.

Professor CRAWFORD — My name is Russell Crawford. I am dean of the faculty of life and social sciences at Swinburne University of Technology. I am also Swinburne's representative on the Victorian Council of Deans of Science, and as a result I am also on the Australian Council of Deans of Science. I would like to congratulate the Balwyn High School principal on the school's science programs. Clearly I am just hoping this parliamentary committee does not go away thinking that science in schools everywhere is as good as it is at Balwyn High School, because it certainly is not. This high school is to be congratulated. I would like to just draw your attention, in case you have not seen it, to the report of the Australian Council of Deans of Science entitled 'Who is teaching science?'. There were some pretty alarming results.

A few of the more significant findings are: nearly 43 per cent of the senior school physics teachers lack a physics major, and 1 in 4 have not studied physics past first year; amongst senior school chemistry teachers 1 in 4 lack any sort of chemistry major; and 14 per cent of senior school biology teachers lack a biology major. There are several concerns with this and one of the interesting ones for the physics area is that more than one-third of male science teachers are at least 50 years of age.

We recently met with Jacinta Allan, the Minister for Education Services, and presented to her this report which makes certain recommendations. We, as the Council of Deans of Science, really do believe that attention must be paid to rigorous workplace planning to ensure there are sufficient numbers of suitably qualified teachers of science and the disciplines, and not just in Melbourne. I am wondering whether if we had this particular forum out at Robinvale High School, we would be feeling so warm and fuzzy about the good work that is being done in science — I am sure we would not be. I would just like to bring that to your attention, and if you do not have a copy of the report on who is teaching science, I can certainly provide that to the committee.

The CHAIR — Thank you, and we do have a copy. I would like to comment on a couple of things you said. The committee will put a report to Parliament. We are an all-party parliamentary committee, representing all the various parties — National, Liberal and Labor — and we will lodge that in the Parliament hopefully by the due date. What happens is that this government has six months to respond to each of the recommendations. We made 50 to 60 recommendations in the teacher training inquiry report and the government is now having a look at trying to determine a position on each of those recommendations. That is formally what happens when we put a report in. Of course it is pretty easy to just put in recommendations, and we are hopeful the government will take up every one of them, but sometimes there are things in the pipeline that we are not aware of.

Just on the teacher training and the qualification of teachers, there were recommendations in our last report also concerning the point you make, so thank you very much. We will be going out to other schools. We thought we would start off with a school that has such a high reputation in maths and science.

Ms STEANE — My name is Val Steane and I am a working maths teacher at Kew High School. I think today we have been hearing a great deal of powerful stuff about the good things that can happen in schools, and particularly science and maths teaching, when teachers have the time to work together, get together and talk about what they are actually doing in the classroom.

We have heard a lot about the power of mentoring programs, team teaching, working in teaching teams together and working in KLA teams. I think it is so important, if we are going to improve teaching across the board in Victoria and in particular to improve science and maths teaching, that teachers have the time and resources to get together and talk about what they are doing in the classroom. One of the major recommendations that I would like to make to this committee is that we are given extra time, we are given more PD days where the focus is not just on the big picture. We do a lot of work at the moment on the blueprint, and on VELS, POLT and performance development reviews. I believe those things are very important, but they are big picture; they dovetail into this. We also need more time to be able to talk about our teaching, about strategies and about pedagogy. It is one of the things that consistently come up in schools among ordinary teachers. When you are in a school it is very hard on a normal school day to find the time to have a meaningful discussion about these things, and that is what we really need.

The CHAIR — My son and daughter go to Kew High School. My son is studying maths methods. I am sure it will get a bit easier there once your construction program is finished. It must be quite difficult right now.

Mr JACKOWSKI — My name is John Jackowski. I am head of science at Scotch College. We have heard about a lot of the great things that are happening here today, and for sure right across the state there are a lot of great things happening, but there are some issues that need to be addressed as far as science is concerned. Firstly I think more needs to be done to encourage universities to interact with schools. That is happening, but a lot more needs to be done to get university people — and also some of the things they do — into schools. That would be very helpful.

Professional development needs to improve greatly. There should be more opportunities for teachers to visit other schools and to meet experts. More should be done to encourage networks, both local and national, including the awarding of overseas bursaries to teachers so they can bring back ideas from overseas that can be used in classrooms here, not only in Victoria but right across Australia.

Another issue is the development and support of ICT initiatives. Our ICT is developing, but it still falls a long way short. We need experts. Years ago we appointed lab staff to help us with preparation of materials, but we have not thought about appointing ICT experts in the science departments at schools to help them develop improved ICT material. How many schools, for example, use Foxtel as a key teaching device in classrooms? And yet kids are looking at that at home and wondering perhaps why the school does not have it. So it is those sorts of things. Another is the use of video material, videotaping demonstrations, videotaping practical classes for practical work, and the use of cameras in classes to take shots that can be used to promote the teaching and learning of science.

The last thing I will mention is perhaps the reduction of allotments to the science teachers. The issue is that science is extremely complex to teach. Science teachers often finish their classes very late, in recess time, lunchtime and after school, and then packing up and cleaning up. I think to teach effectively science teachers need to have a reduction in their allotment. I do not think we need more days off from school, but I think if we got some reduction in teaching allotments — and that basically means increasing staffing within schools — that would certainly help. These are some of the things I thought I would mention today. Thank you for the opportunity.

The CHAIR — Thank you. Are there any questions?

Ms KUEHLICH — Yes. Good morning. I am Ina Kuehlich. I am from the Department of Education and Training. I am the eastern metro-regional representative for science, mathematics and design technology. First of all, I would like to congratulate Balwyn High School, and I was particularly intrigued to hear from the students their views and perspectives. I would like to make a mention of the science and schools research project, which was briefly mentioned by Graeme Lane, who said it is a shame that more schools cannot have access to that. That program has since developed into the school innovation and teaching in science, mathematics and technology, and then also formed the basis for the whole principles of learning and teaching. The actual program was conducted here at Balwyn High School, and I would be interested to know, because it has two parts to it, firstly, the effective pedagogies that relate to the teaching of science, and secondly, a strategy that promotes the implementation of

change within the school. I was wondering why that was not mentioned when it was implemented here at Balwyn High School.

Mr ARMSTRONG — I can answer that, in that it was probably in a handover from a faculty coordinator who is now at another school, and Colin having left. The Science in Schools program as supported by AIM was an excellent project within this school, and the teachers of science here would know that there was an extensive survey undertaken of students' attitudes to the teaching of science and looking at curriculum content and pedagogy and looking at teachers' attitudes to the teaching of science, and it was quite instrumental in shaping and forming the way in which the programs were developed for years 7 to 10.

I am sorry if it was not mentioned, but it was quite instrumental in creating quite concrete data to reflect particularly upon pedagogy and the nature of teaching science. I am not sure whether there is another science teacher who would want to comment, but Sue Brand, our previous activity coordinator, oversaw that with Lynne Bartlett. It was very important and quite instrumental when those reports came up through our education subcommittee of the school council to the school council. We are now using similar instruments in terms of the MYRAD feedback on looking at student attitudes to teaching and learning. So it was very, very important.

The CHAIR — Ina, do you have any documentation on that program and how it went that you could forward to the committee?

Ms KUEHLICH — Absolutely. There have been a number of evaluations conducted also. This year there are 100 schools that are continuing into the program extension into mathematics and to design. Those reports were put out through Deakin University, and they also support really strongly the idea that for effective science and mathematics to occur in schools leadership is a key element, effective coordination is a key element and a willingness for staff to change. There is also no doubt that within the strategy that was developed the schools who participated had access not only to an in-school strategy for change which included an audit and teaching professional development networks with other schools but also to development of community partnerships — for example, through GTAC or the zoo or the museum. They were actually part of that strategy, and there was also the development of resources such as STEPS and Science Trek. Those were all key elements that drove that program and that continue on now.

It is worth noting that of course the funding has decreased considerably. Schools at the time when Balwyn High joined the program represent 10 times the amount that schools now receive. That ensured that teachers could undertake professional learning schemes, discussions, trialling new curriculum and teaching learning strategies. It enabled that. It is a lot more difficult with less funding and with less key personnel who now drive those programs.

The CHAIR — Thanks. Would you please give that information to the secretariat?

Ms O'BRIEN — I am Jacquie O'Brien from the Gateway LLEN. I think maybe we have always thought about education as being the three Rs, but today for me at this session it has been at least four Ps — that is, the discussion has been around pedagogy, and I would like to underline the work of Howard Gardner on multiple intelligences and how important that is considering working with students.

Importantly, one I have not heard is vocational education and training, especially in the area of maths and science. It is often considered the poor cousin, but there is an opportunity for students to map across to vocational education and training courses in laboratory operations, for example, or food technology. I think we have perhaps less than 30 students across the state doing this certificate IV in food technology, heavily based in chemistry and physics, which would give two lots of 10 per cent final increment on their ENTER score, so there is definitely a need to consider the discussion around what can vocational education and training bring to this maths and science teaching discussion.

Richard Tease spoke this week about his engineering students at Melbourne University. They had a high enough ENTER score to get into engineering at Melbourne uni — very prestigious — but were failing the maths component. A number of them went to Kangan and Batman TAFE to do an intermediate course and learnt from the TAFE very special skills and knowledge that they could bring back to their engineering degree. So I think we need to be aware that the vocational educational and training sector has something to offer this discussion as well.

More importantly, I heard about the passion of teachers, and that cannot be overestimated. That is a very important component. Professional dialogues and partnerships — for my final comment I think partnerships with industry is

one really important area we need to be able to work on to get the best result for industry students and the community. Thank you.

The CHAIR — Thank you.

Mr KOTSIRAS — May I ask the maths department about the time for the acceleration program? Could you tell me how many years it has been going? Have you any idea?

Mr MARK — Which program?

Mr KOTSIRAS — Acceleration mathematics.

Mr MARK — The year 9 accelerated maths program?

Mr KOTSIRAS — Yes.

Mr MARK — It has probably been going about five or six years.

Mr KOTSIRAS — Have you done an evaluation on the program?

Mr MARK — Yes.

Mr KOTSIRAS — Have you found those students do better in terms of year 12 results than students who did not take up the accelerated program?

Mr MARK — What we have found when we have tracked the student progress is that there is a real need for it in year 9, but with those students who are bounding ahead very easily with the work at that stage we have had to counsel them very carefully in the senior years, because we have found the step to doing year 12 maths in year 11 is a difficult one, and not all the students are able or prepared. They might have a good grasp of the basic techniques, but they perhaps lack a bit of intellectual maturity for the problem-solving approach. So our experience has been that it works well in the middle school but we have to carefully counsel and evaluate the student progress. Some students can proceed to year 12 maths in year 11 and do very well, and some other students perhaps need an extra year to consolidate their skills by taking a range of other maths subjects before they do their year 12 maths.

Mr KOTSIRAS — And one for science: you talk about team teaching, which is fantastic, but many schools have not got the luxury of having five physics teachers to be able to team teach, so in the absence of many science teachers, what is another alternative?

Mr LEAHY — With the professional program that we have developed in the school which is encouraging teachers to get together and meet — and some of those groups are actually getting interdisciplinary team teaching going on — we have actually looked at developing courses where science and English are being worked together or combined together into certain areas within subjects, so there is actually team teaching taking place across disciplines as opposed to just dealing with one discipline.

The CHAIR — Thanks a lot.

Mr CLARKE — I am a classroom teacher at Kew High School. I was a maths coordinator in my previous transmogrification when the VCE came in. I was a science coordinator at Kew High School when the CSF came in. I am now doing the reporting — I am in my third incarnation. I have a bit of a hodgepodge of ideas.

Firstly, the CSF was laughed at when it came in, but it has given us a fairly good structure for junior science years 7 to 10. I would hate to see with another PLT or POLT — or whatever you want — they are suddenly going to make us throw all this up in the air. I know they say they don't, but it takes so long to get an accurate and good science program at junior levels, one that is sequential and challenges kids. I hope science teachers are not forced to reinvent the wheel yet again with the new ideas we have coming in.

Secondly, ICT in science can be overrated. I am happy playing with my computer and doing ICT stuff, but I use it very rarely in junior school. I do presentations with the computer, but so much hands-on stuff demands the simplest materials for kids to know what is going on or they do not see the forest for the trees.

Thirdly, there is a lot of navel gazing being done by staff with their own PD plans and narrow PLTs and VELS. I do not know the acronyms — I forget them from one week to the next. I am too busy trying to teach, and the last thing we need is some more navel-gazing approaches. We know how to improve our teaching. Teachers have had very little time over the last five years to actually get together and improve their own classroom structures. It can be done; we do it. But the amount of time we are spending doing things that really do not matter at the coalface to improve teaching, I think we could do without the number of top-down policies that virtually make no difference to what happens in the classroom — I am not talking about stagnating, I am talking about getting programs that work.

Lastly, I wonder from a previous speaker who would be a science teacher. You do have more work to do than most other faculties. Every other faculty moans about how dangerous their subject is or how much they have got to move around, with science you can tick the box for every one of those particular criteria — not to mention the fact that teachers who come into a classroom say they could not teach science or maths. I am sure most of them could make a fist of most subjects, but they crawl under the table when they have to come in for a maths or science class. There is an added challenge there that most teachers outside the classroom cannot do. I think we need to look at the kind of remuneration we give our teachers if you want to get teachers who are willing to continue. I think I have said enough.

The CHAIR — In terms of the four days professional development teachers have a year, how much of that is central and how much is school based? Do you know that?

Ms KUEHLICH — The professional development?

The CHAIR — The four pupil-free days. Is that central or is it school based?

Ms KUEHLICH — My understanding is it is actually school based. Schools do shape and certainly have an input into how those days are shaped. Is that what you are asking?

The CHAIR — Yes. I am trying to work out whether we have a central problem regardless of the quantum or whether it is an individual school's decision.

Ms KUEHLICH — The centre has not committed any additional time to release teachers to implement those standards.

The CHAIR — That is not my question. The question is: is professional development in the schools up to the school to determine based on its priorities or is it a central thing? Are there central days?

Mr ARMSTRONG — There are four mandated days you are allowed at a local level. What you do with them is determined locally.

Ms KUEHLICH — So schools determine them. Could I just make a very quick comment?

The CHAIR — Quickly.

Ms KUEHLICH — I am very interested in what Alex Leahy had to say about Balwyn teams and partnership. There are a few models that have been used quite successfully. This year there are some teachers working with the University of Melbourne. They have developed a program whereby teachers who do not have great confidence in physics — and I know that is a real area of concern — are working with graduates and postgraduates from the physics department and gaining skills and background so they are able to tap into them as an influence in the school and they are also connecting with each other. There is a big place for IT and teacher-to-teacher collaboration. Teachers cannot always be released. It is a very expensive process to go through but the use of email and mentoring programs can work very successfully not just in high schools, but also in primary schools. The Academy of Science is currently developing a primary connections program which develops primary school science literacy, and there, teachers have come from right across Australia to work together and remain in contact again using ICT. That is just another thought.

Dr DALE — I do not quite know where to start. I am Les Dale. I have worked in science education for 30-odd years. I started primary science education at Coburg Teachers College. Before that it was all nature study. I worked at ACER for seven years on curriculum development. I worked on the early international science studies — in which by the way Hungary was always ahead of Australia.

But I would like to say two things: one to our local member, Mr Kotsiras. Team teaching can be carried out in a small school. We carried it out at Morwell High School. Our total science staff was four. We handled all physics, chemistry and biology to year 12. We had a school of over 1000 students. But we had three primary school teachers who came and taught at years 7 and 8 because we could not get science teachers in those days. So we ran team teaching right through with that small group, but particularly in biology where we had two who worked together for certainly the practical sessions and, from memory, the theory sessions.

The other comment I would like to make is that for goodness sake do not regard Balwyn High School as typical. I think others have made that point. Balwyn High School has been outstanding in the science field. It has huge resources compared with lots of other schools. They have huge numbers of teachers; we have all seen that. They do an excellent job. What I would like to ask is that you look at the community they are serving. Essentially they are people who want their children to go to university. Go up to Mildura and you will get a different type of community altogether. I hope it is still an agricultural high school that is serving the needs of the community and teaching skills that can be applied locally, but after year 10 those who want to specialise in science can go on and do so. We do not all need to specialise in science. We do not all need science majors in order to teach science. We can teach science very effectively up to year 10 without a major subject in science. If anyone wants to challenge me on that I will be happy to challenge you to a duel with whatever weapons you choose!

Thank you for the opportunity to come and listen to what is going on. I am not entirely of touch because I do still develop curriculums for online use. I am a little surprised that so far online services to teachers have not been mentioned — indirectly, yes, I think you mentioned the need and that online courses for professional development courses could be useful. Thank you for the opportunity to come. I wish Balwyn High School all the best and I wish this committee of the best in seeing its recommendations implemented.

The CHAIR — Thanks. You will be pleased to know that we are going to Shepparton and to Bendigo next week, so we will be getting out there to other schools. About online — there was a mention of mathematics 300. I assume that is an online resource.

Mrs BUCKINGHAM — When we commenced this inquiry the Victorian Curriculum Assessment Authority gave us some figures about how the number of students taking science and biology was increasing slightly. Psychology had increased incredibly. Physics had fallen over the last four years, if my memory serves me right, and I think chemistry was static or falling slightly. My question is to the students who have spoken to us today. Bradley put up slides and towards the bottom of about the fourth slide he said something about the perception of science being nerdy, and I think Megan also said something along the lines that science is perceived to be more difficult and that might put people off doing it. I am wondering if any of the students this morning have any ideas about what can be done to change this perception.

Mr POTENZI — I am Bradley Potenzi, one of the students here at Balwyn high. The students who do not study science sort of perceive it as tough, but the students who do study science obviously enjoy it. I think that stems back from primary school and the early years of science. I am one of those people at primary school who did not get any science and not much maths put into it. That only really started coming into fruition at Balwyn in years 7, 8 and 9. I think without science through primary school and in those early years, science gets perceived in a different way.

Ms MUNT — There seem to be two different languages being spoken here: the language of the teachers and the language of the students. I am interested in the language of the students. Every student who gave a presentation a little earlier had three points about why they were doing science. The first was enjoyment, the second was prerequisites and the third was ENTER. That is the language of the students. They had particular reasons why they were doing these courses, because they want to get a result in the end to go on and do what they want to do. I was just wondering with all the things that you have put in place, with all the resources that you have, with the obvious wishes of the students to go through and get an ENTER score, how are the results? We did not hear anything about the VCE results for these subjects.

Mr HOPKINS — I am Colin Hopkins; I used to teach at Balwyn. I can speak on results. I think I can even speak on the numbers and about what used to go on. In 1999 here in physics the size of the school was not dissimilar to what it is now. There were 62 kids doing physics. Last year or the year before, there were about 225 doing VCE physics at this school. Sorry my figures are not right — there were 62 kids doing year 12 physics, and there were about over 105 kids enrolled to do year 12 physics. The results for the physics kids, the results for

science kids over the years, and for the maths kids, have been sensational. The kids are doing it because the results are sensational. So it is a win-win situation. I remember one sensational year for the physics results was 1992, and over 40 per cent of our kids scored over 40. To score over 40 you are in the top 8 per cent of the state.. That success breeds success. It comes from the kids as well. The kids come in wanting to learn, wanting to work and really wanting to achieve, and the teachers just stand there and say, 'Thank you very much'. So it is really the success of the kids, and the results at Balwyn are sensational.

Mr MARK — I would just like to back up what Colin said. In maths we have large numbers of students — for example, we have nearly 100 students in specialist maths; in mathematical methods we have about 180 students; and about 100 in further maths. The results are excellent, not only in the VCE examinations but in any competition that we enter. I mentioned before, for example, the Australian Mathematics Competition in which our students typically achieve prizes, high distinctions and distinctions at three or four times the state average, and we are very proud of what they achieve.

The CHAIR — Before we close I will ask Bruce to say a few words.

Mr ARMSTRONG — Thank you Steve. I want to thank members of the public who have come here today, who have been patiently listening and who have made comments as well. I particularly pay tribute to our students and teachers here today. What a wonderful combined effort to talk about creating a genuine passion for the teaching and learning of mathematics and science. That is why I focused right at the very beginning, upfront and centre, about the effect size of the quality of instruction. You can provide resources, you can provide time, you can provide computers and technology, but unless teachers have a background in the discipline, particularly in secondary schools, and an understanding of how to bring that alive within the classroom and engage students, then it is not going to happen. That is why the resources and the effort needs to be put into helping teachers to be effective.

We want to thank you for coming here today for your forum. The final thing I want to say is that Les raised the issue — and the dean of the life and social sciences faculty at Swinburne University mentioned — that Balwyn High School is not typical of what is found across the state. I want to say that people like Colin Hopkins and other teachers here have given their own time and money to take that outreach service across the state. They fund it themselves because the money has now dried up for that innovation outreach. They provide online resources and they continue to support teachers across the state. Those sorts of staff need to be supported. We understand that we are a privileged community but we also have a passionate commitment to public education, and to the system of education across the state of Victoria. The greater privilege, the greater the responsibility. I want to pay tribute to people like Colin who is now reaching into his own pocket to travel around the state and take those lectures to students. That is the sort of area where we believe we can mentor and support other schools, if the resources are there. So we have a responsibility to our own community, but also to the broader public education system in Victoria. Thank you Steve, and thank you to the committee.

The CHAIR — On behalf of the committee I would like to thank Balwyn High School and its students. The presentations were fantastic, the teachers were very professional and what we observed in the classrooms was excellent. While I acknowledge the point that has been made that Balwyn High School has a very high reputation for the calibre of its science classes, in many ways our job is not just to report on what is happening in maths and science education, it is to make recommendations about what we should aspire to, and that is what we hope to do. We hope to look at a system where what is happening at Balwyn High School, and perhaps even better, is reflected across the state, and to make recommendations on how to achieve that.

Today has been very useful to us. I thank everyone here who has contributed and who has attended, particularly the students, teachers and the school administration for spending valuable time helping us with this inquiry. I know it all adds to your workload. I now declare closed this meeting of the parliamentary Education and Training Committee.

Committee adjourned.