

Planting a seed – the Australian “Science and Engineering Challenge”

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Abstract

Over the past 25-30 years, Australia has experienced a significant decline in the percentage of senior secondary school students electing to study the enabling sciences and higher level mathematics that are the career pre-requisites for Engineering and Science. Without arresting this decline and increasing the size of this ‘pool’ of students, there can be no significant improvement in the present situation.

The Australian “Science and Engineering Challenge” has grown from small beginnings in New South Wales in 2000 as a secondary school outreach program for the Faculties of Engineering and Science at the University of Newcastle. Supported by the Australian Federal Government and industry with 27 partner universities, numerous Rotary Clubs and an army of thousands of volunteers (including retired professional scientists and engineers) it reaches 18,000+ year 9 and 10 secondary students each year in 40 venues across the nation. It is the largest national outreach program for secondary students and is managed by the University of Newcastle.

Whilst the underlying goal is to increase the national pool of science and mathematics ‘enabled’ year 12 students, the immediate goal of the program each day is to implant a seed in the minds of the students who compete in fun-filled activities based on sound science and mathematics principles. The ‘seed’ is that, scientists and engineers actually do interesting and challenging things and to instill a positive mental image that “I too could become a scientist or an engineer!”

The range of activities available in a typical Challenge event are demonstrated as is the operational structure that sees regional competitions leading annually to a national competitive event for outstanding secondary schools. The real impact on the decisions students make in their final year 12 subject selections in the enabling sciences are also demonstrated.

Keywords: enrolment decline, enabling mathematics and sciences, school outreach program, increase pool of STEM qualified students

1. INTRODUCTION

In the summary report “Audit of science, engineering & technology skills” undertaken by the Australian Government – Department of Education, Science and Training, July 2006 [1] the purpose of the audit was to include (amongst other key issues) an examination of “skills shortages in many engineering and some science disciplines; a static or declining proportion of participation in the enabling sciences and advanced mathematics in schools and in post-school settings; concerns about the quality of science education”. The audit came after a period of at least 5 years during which the Australian Government had committed A\$3 billion to the support of Australian science and innovation and at a time when a further expenditure of A\$5.3 billion to 2010-11 was foreshadowed.

The audit confirmed the belief of many education professionals that the proportion of domestic students in SET study programs at all education levels had been essentially static or in decline over the preceding decade, and that in some SET fields at University undergraduate and postgraduate level it was the enrolment of overseas

students that provided viability for programs. Evidence of a lack of sufficient suitably qualified secondary school science teachers and a lack of properly informed SET careers advisors was seen in the poor perceptions held by students about the value of a career in SET.

Whilst an assessment of data between 1998 and 2003 showed a net inflow of SET skilled persons into Australia, the growth of expenditure on SET research and development in the OECD country group (often at a rate exceeding that in Australia) could result in a future net outflow of SET skilled professionals in the near future.

Future downwards influences on SET workforce participation rates were expected based on the ageing of the present SET workforce, a post 2010 expected decline in the number of school leavers, the low profile of SET careers and limited community awareness of the value of an investment in SET skills.

1.1 Demand for SET occupations

In 2006, Australia had a SET skills base where approximately 13.5% of employed persons had SET qualifications. Recorded and projected growth in Engineering as a field of education from 1996-7 to 2004-5 and for 2004-5 to 2012-13 is summarized in Table 1. In Table 3 recorded and projected levels of annual replacement demand and new employment growth for the occupations of Engineering and Science are shown.

Table 1 shows strong expected growth in all areas of Engineering with an increased overall growth rate to 13.5% from the previous 7.1%. Table 3 suggests that replacement generated demand has been and would continue to be greater than growth generated demand to the end of the study period of 2011-12 in both Engineering and Science.

1.2 Higher education graduations - 2003

As a percentage of total University graduates, Australia has comparatively fewer Science and Engineering graduates than other OECD countries and comparatively more social science/business/law graduates (as is indicated in Table 3). Using OECD 2003 data [5] comparisons can be made as shown in figures 1 and 2. Then (as now), the situation is considered to be unacceptable.

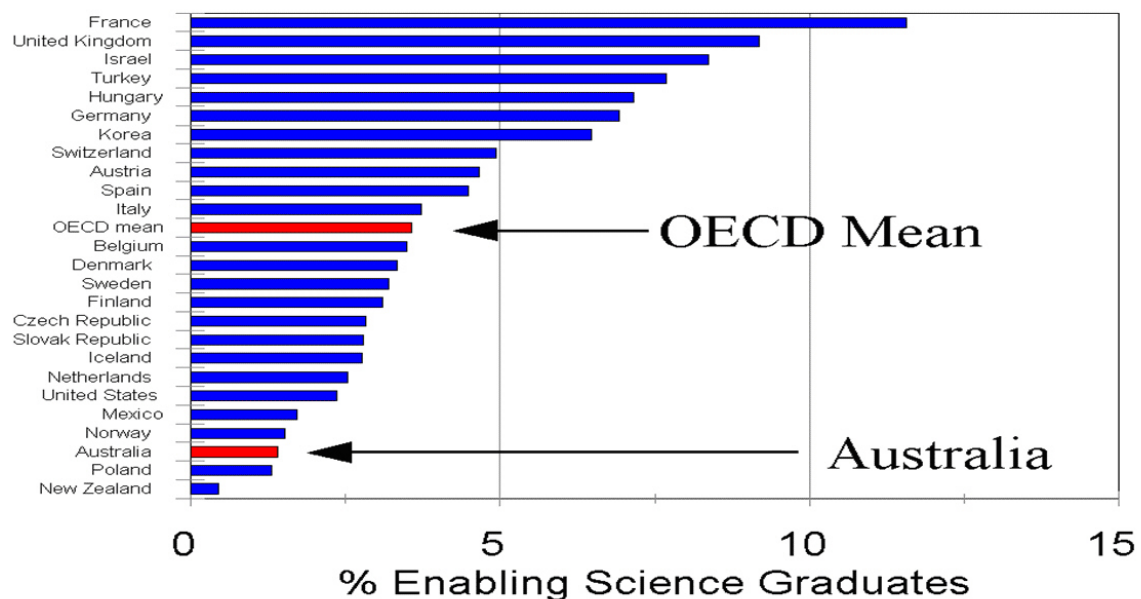


Figure 1

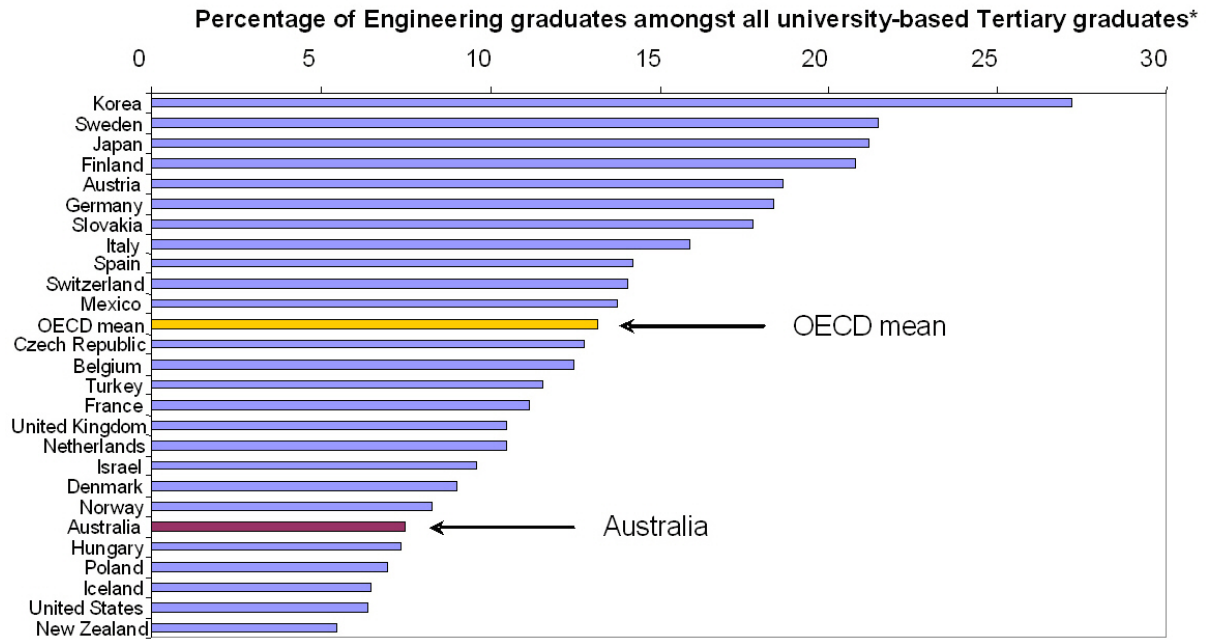
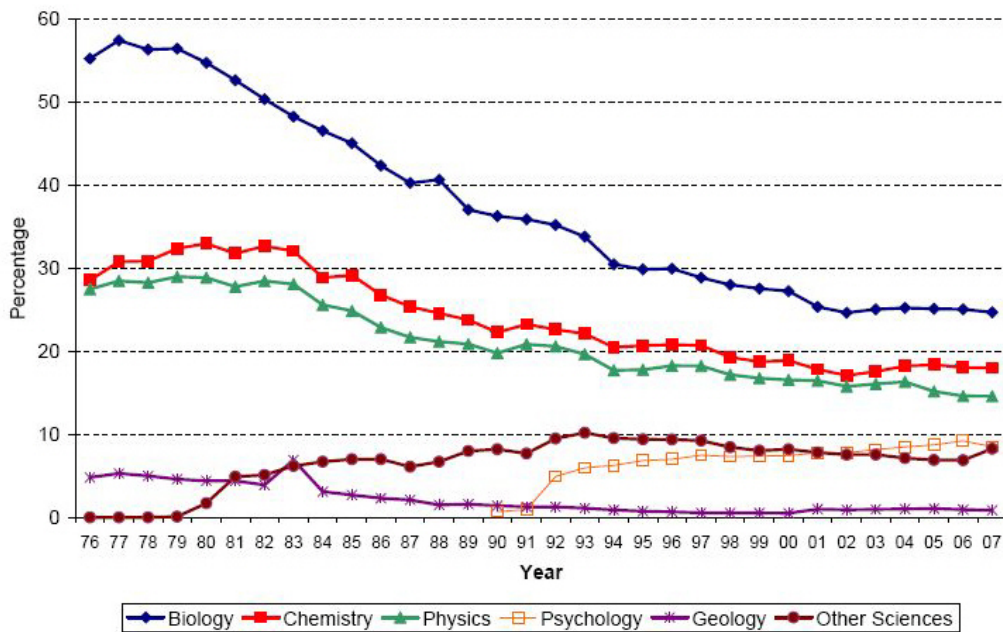


Figure 2

1.3 Participation in science, mathematics and technology education

The 2008 study by Ainley, Kos and Nicholas [2], charts the national enrolment levels in Year 12 science subjects from 1976 to 2007. These are reproduced in tables 5 and 6. In addition, Figure 3 displays the levels as a percentage of Year 12 enrolments over the same period. Table 7 presents the national enrolment levels, as a percentage of total Year 12 students, participating in advanced mathematics from 1991 to 2007. Relative to other subjects on offer in Year 12, the national decline in the study of physics, chemistry and advanced mathematics can clearly be seen. (Note: Primary and secondary education in Australia operates in a similar fashion to the “K-12” model of the USA.)



Year 12 science participation as a percentage of the Year 12 cohort in Australian schools: 1976 to 2007

Figure 3 (Extracted from Figure 3.2 [2])

1.4 Choosing physical science courses

In 2003 Lyons [3] examined the reasons why high achieving students chose or declined to choose physical science courses in Year 11 and 12 and concluded that their decisions were most likely to come from the intersection of their ‘worlds’ of school, science and family. Students themselves described science as “focused on facts, which were transmitted from experts sources – teachers and texts – to relatively passive recipients”. In addition it was often “presented in a decontextualised manner, leading many of the students to consider school science irrelevant and boring”. Physics and Chemistry were however also seen as “having a primarily strategic value, in that they would enhance the students’ university and career options”.

That junior and middle school students were generally uninspired by their experiences in/with science, as they found it, should sound a clear warning to education professionals.

1.5 Gender differences in school science and mathematics enrolment

In 2006 a Victorian State Government review included a report on enrolment level trends in school science and mathematics [4]. In Figure 4 below, gender comparisons over five years show the significant differences in preferences by males for the traditional sciences such as Physics cf. the preference by females for ‘newer’ science offerings such as Psychology and in the preference by males for the high level mathematics “Mathematical Methods” and “Specialist Mathematics”.

The inquiry found that use of an “investigative approach” in both science and mathematics education was almost universally preferred by students and teachers and other inquiry participants as a way of successfully ‘engaging’ students with their studies.

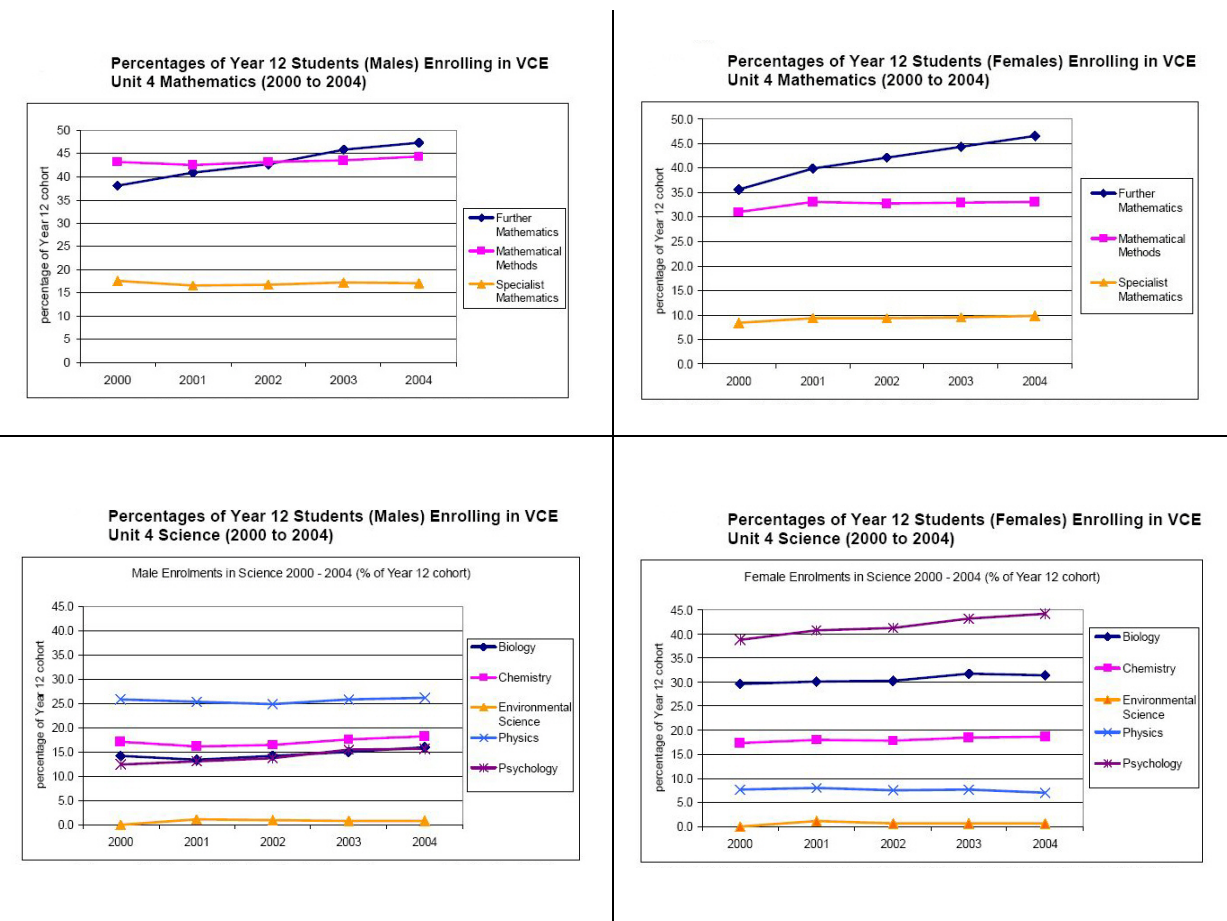


Figure 4 (Extracted from Figures 4.2,4.3,4.8 &4.9 - [4])

2. ORIGIN OF THE SCIENCE AND ENGINEERING CHALLENGE

In the period 1991-1997 the University of Newcastle, New South Wales, ran a Science and Technology Summer School which brought to Newcastle each year 120 of the surrounding regions best year 9 students for a week of hands-on activities and inspiring presentations aimed at convincing them to continue on in Physics, Chemistry and Mathematics with the view of entering into a science or engineering career. An evaluation of the program identified some key problems:

- 1) In the main, only students already committed to science or engineering elected to attend
- 2) Only 120 students participated

It was expensive on time and resources for little real return. It involved finding accommodation and coordinating transport for students coming, at times, from large distances

An experiment in an alternative approach was developed in the year 2000 in which some of the hands-on activities of the Summer School and a few new activities were brought together to develop a problem solving activity in Science Week. This was such a success that the new format was expanded and enhanced. The key elements of success with this new format included:

- 1) the Challenge went to the students rather than them coming to the event
- 2) it engaged many more students
- 3) it was able to involve students who were not only not committed to science or engineering but in some cases are initially disinterested in such endeavours.
- 4) Rotary International are an integral part of the process
- 5) The activities are centred on student engagement and enjoyment of the activities. There is no attempt to 'market' the university or the careers.
- 6) It was a more 'cost effective' method of engaging students.

This format was very popular and its growth by word of mouth alone ensured that demand grew faster than available resources.

2.1 Design of the Challenge

To combat the misconceptions that students have developed from their exposure to science through the media and other sources, the Science and Engineering Challenge was designed to directly address these misconceptions. Activities were designed to demonstrate to participants that science and engineering required creativity, innovation, problem solving and teamwork. This is a combination of attributes that students often look for in a career but may not have associated previously with these particular careers.

To provide maximum impact, there are two significant features (of many) worth noting. The first is the introduction of the concept in a less direct manner than other outreach programs; the Challenge was designed to 'mimic' sporting competitions with which the students already had considerable familiarity. So each school provides typically 8 teams of students who undertake activities in direct competition with other schools performing on the day. The performance of the different teams is compared with score updates.

The second major feature is the management of the excitement level. This starts well before the day of the Challenge by sending out information sheets to students with background information set within interesting scenarios. On the day, the excitement level is built through the day to the finale event at which all schools are present. Most observers are overwhelmed by the open show of excitement and engagement of the finale which has more in common with the excitement of a sporting even than a science and engineering outreach activity. Teachers routinely report back to the organizers that students are still talking in a highly positive manner about the Challenge weeks after their involvement in it.

Excitement on the day is only a small part of what is needed to ensure success of the Challenge in meeting its goals. The real test is that there is a long-term impact on students' perceptions and decisions. The evaluation of the program is a two stage process and so far we can only report on stage one.

The stage one evaluation has been running since 2005 and involves asking students about the Challenge and its impact 12 months after their participation in the event. The first question asked is whether they found their involvement rewarding and consistently 90% of the students respond in the affirmative with a slightly higher percentage for female students than for males. The second question is whether they found the Challenge informative about careers in science and engineering to which 80% respond affirmatively. This is a very reassuring outcome as the emphasis on careers during the Challenge is always an understated theme and we focus on the students learning how scientists and engineers work by doing.

Students who were studying Mathematics, Chemistry and Physics in year 11 who participated in the Challenge were then asked if their participation influenced their decision to choose these subjects to study. For those studying Mathematics, 25% indicated that the Challenge influenced them to choose that subject, while it was 35% for Chemistry and 45% for Physics. These impacts indicate the outstanding success the Challenge has on meeting its primary goal of convincing students to continue studying the core subjects for an engineering or science career – mathematics, physics and chemistry.

There are two additional features in the evaluations which are important to note. The first is that in the subject specific responses it is predominantly the case that the Challenge has a bigger impact on female students than on male. The second noteworthy aspect is that there is a very strong impact on chemistry even though there are no chemistry related activities for a variety of reasons related to occupational health and safety and because it is difficult to find a chemistry activity which fits in with the protocols of the Challenge. This is important as it demonstrates that the students take away much more about the underlying nature of the career than the actual activity they are involved in. Although it is not tested explicitly, it is believed that similar impacts occur for biology as well.

The stage two evaluation is a longer-term process, which looks at student enrolment impact at university level. While some broad data if available, it is not possible to clearly identify the impact of the Challenge amongst a plethora of other impacts that the students experience between year 10 and university entrance. To overcome this, a targeted survey has been developed which is being administered at the start of the academic year 2009 so respondents are participating as this paper is being written. The analysis is complex to ensure that competing influences are accounted for but we seek to be in a position to provide a rigorous response later in 2009.

2.2 Activities in the Challenge

The activities that students undertake in a Challenge are prepared following a rigorous protocol. The number of activities has grown over the life of the Challenge now to number 20. Typically 2 new activities are developed each year and now that we have made 20 there is an agreement that with the advent of two new activities each year, two will be retired. This will ensure that the Challenge continues to be refreshed on a regular basis.

All activities are designed to be multidimensional so that a team performs better than an individual. So the outcome is never the fastest, the strongest, etc. There are one or more additional complications to ensure that there is no one best solution. So it may be the strongest but also bonus for being the lightest, or the fastest but under low and high load, etc. Challenge events are constructed with a mix of full and half day activities, from the list below. Typical activities are shown via photographs taken at the Victoria University 2008 Challenge event, in Figure 5. The following list is the inventory of activities for 2009.

Full Day Activities

- *Engineering Game*:- Design and build a doll's chair to support a 3Kg doll statically and dynamically.
- *Catapult*:- Construct a catapult from given materials and launch a squash ball. Scores are based on distance and accuracy.
- *The Great Tea Race*:- Activity involves making hulls out of thin plastic and electrical tape, covered with plastic wrap to ensure watertight. Hulls are drawn through the water by a simple pulley and the time taken for the hulls to travel a set distance is recorded.
- *Escape from the Lost World*:- Make an airframe onto which helium filled balloons are attached. The motive power is supplied by pre wired motors and propellers, one to provide lift and two to provide horizontal motion. Once built the craft is flown and timed around a course.
- *Gold Fever*:- This is a bridge building activity that uses a test rig to deliver a dynamic load. The lightest bridge to support a load wins.
- *World Sailing Spectacular*:- Students make a suit of sails for a boat and sail it up the towing tank. A wind generator supplies lateral air movement.
- *Mission to Mars*:- Students construct a vehicle and suspension system. They pull the vehicle over an undulating surface and are assessed on how steady their vehicle is.
- *Hover Frenzy*:- Students receive a 'lift' fan and two motorised propulsion units together with styrofoam, balsawood, rubber strips and tape to construct a small hovercraft. Scoring is based on several criteria: maneuverability, time through a course, and ability to negotiate obstacles.

Half-Day Activities

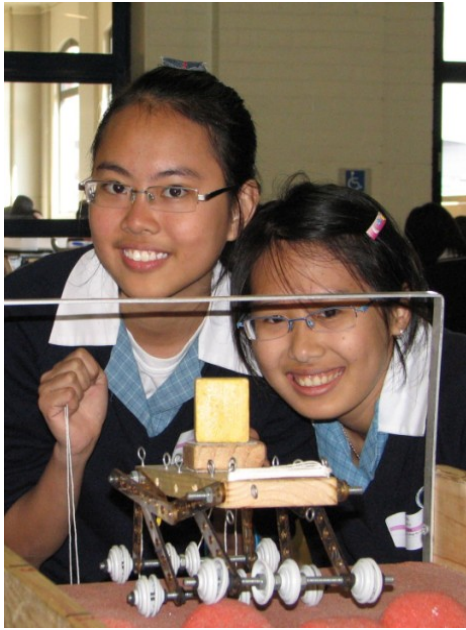
- *Who gets the Water:-* Australia is a dry continent. In the middle of the worst drought on record teams are charged with developing a new, 'cutting edge' way of reticulating water around the nation. Student teams design the connection of calibrated containers, hoses, valves, tee-joiners and manifolds so as to deliver water at a pre-determined rate from upper reservoirs to lower target reservoirs.
- *Future Power:-* In this activity students must assume responsibility for the management of power supply and distribution across a city. Using a combination of coal-fired, nuclear, gas, hydro, solar and wind power the teams must meet the demands of a variety of users, both domestic and industrial. With each of the stations having differing 'sweet spots' in terms of power supply, students must mix and match supplies to find the best solution.
- *Job Juggle:-* Job Juggle is all about project management. Students are cast as high-flying record executives who must ensure the successful production of five new albums. To do this, they must schedule time for recording the singer and band, CD cover art design, a marketing campaign and production of the CD. None of the required jobs for each album can overlap, so students must minimise their slack time to ensure they produce the most profitable albums.
- *Babe: Home Sheep Home! :-* Home Sheep Home pits students, their sheepdogs and their sheep-herding pig against foxes, thorns and other obstacles to get their sheep home safely as quickly as possible. To achieve the highest possible score, students will have to work together as a team, deciding on where to direct their sheep dogs, where to use the powerful sheep pig and whether or not to save all the sheep.
- *Virtual Maze:-* Two groups are combined for this activity. Students face a checker pattern floor 8 by 8 and the supervisor has a random secret maze that the team has to solve.
- *Leprechaun Cannon:-* This is a fascinating use of a smoke ring generator. Essentially a column of air is compressed and released through an orifice. This air then strikes a target.
- *Crypto Cracking Cronies:-* This activity involves students experimenting with codes used in protecting data that is transferred electronically.
- *On a Wing and Prayer:-* Students use sheet styrene foam, paper and balsa to make a glider that is launched by hand.
- *Confounding Communications:-* Students are provided with some basic optical fibre communication devices and must develop a means of accurately transmitting two types of messages. Students will be assessed on the accuracy and speed of their communication.
- *Heli Rescue:-* Students will be required to build a fixed arm helicopter given some standard materials and equipment. They will need to consider damping the travel of the heli arm both vertically and horizontally and determining the sensitivity of the pivot, which makes the heli arm able to travel forwards and backwards. Students will then be required to complete a number of rescue related tasks.
- *ElectraCITY:-* Students will be given a board with which they can simulate power distribution. Students will be provided with different quality cables and are required to make all loads operate. Students are assessed on the cost of their network, and how many loads are shed due to the failure of a power source.
- *Back to the Future:-* Students are provided with a vehicle on which they attach a propeller or fan to drive the vehicle along rails. The students develop their own fan and can experiment with diameter and pitch. The vehicles are timed over a set distance and bonus points are available for accuracy and control.

2.3 Assessment of the impact of the Challenge

The first comprehensive survey of Year 11 students who participated in the Challenge in the previous year was conducted in 2005. This survey was modified in 2006 and repeated in 2007. The questionnaire is distributed to students who participated in the Challenge in the previous year and who are currently studying Mathematics, Physics and Chemistry.

There is currently a detailed evaluation being conducted of the Challenge and other similar outreach programs as part of an ARC Linkage project. To avoid asking participants to complete two questionnaires, this evaluation survey was only sent to those students who were not part of the research project. Thus the total number of responses in 2007 was down a little on previous years however they are still statistically significant. Some responses came in late for 2007 so the final numbers are different to that reported in the end of year report 2007 having now accounted for all responses.

In 2008 a changed protocol for the surveys was used, which significantly increased the response rate. This is shown in Table 2.



Mission to Mars



Who gets the water?



Gold fever



Escape from the lost world

Figure 5 – Typical Challenge Activities

3. CONCLUSION

Today, the Science and Engineering Challenge is supported by the Australian Federal Government and industry. It is nationally managed by the University of Newcastle, with 27 partner universities, numerous Rotary Clubs across the nation and an army of thousands of volunteers including retired professional engineers and scientists.

It annually reaches 18,000+ year 9 and 10 secondary students in 40 venues and has become the largest national outreach program for secondary students in Australia.

A key difference introduced by the Science and Engineering Challenge is to depart from the primary goal of most outreach programs – which is to “interest” students in Science or Engineering in the expectation that they will then pursue that as a career. In life most people have “interests” which are unrelated to their career and certainly secondary school students separate their “interests” from their career choices.

The success of the Challenge has been to change the students’ perceptions about what a career in Science and Engineering entails. In doing so it has demonstrated to them that it is a career which encompasses many of the skills and qualities they are seeking in a career. This opens a valuable new pathway to viewing the effectiveness of outreach programs which will bring a more productive approach.

This raises a second essential issue and that is valid evaluation. Too often evaluation, if it occurs, only attempts to see if the student enjoyed the activities on the day. What is really needed is to evaluate whether the activity had a longer term impact on participants. This is much more difficult as in real life a student will encounter many influences, however if this aspect is ignored, then the outcome is that short term impact quick “fun” activities are supported in lieu of more effective long term solutions.

Attend a Challenge event and ask any one of the thousands of volunteers who supervise activities each year whether it is a worthwhile exercise for the future benefit of the nation, and the answer will invariably be an unequivocal (and resounding) “Yes!”

Nomenclature

STEM - Science, Technology, Engineering, Mathematics
SET - Science, Engineering, Technology
ASCED - Australian Standard Classification (of) Education Description
ASCO - Australian Standard Classification (of) Occupation
FOE - Field Of Education
ARC - Australian Research Council

References

- [1] Australian Federal Government, Department of Education, Science and Training, “Audit of science, engineering & technology skills – Summary Report”, July 2006
- [2] J. Ainley, J. Kos, & M. Nicholas, “Participation in Science, Mathematics and Technology in Australian Education”, ACER Research Monograph No 63, August 2008
- [3] T. Lyons, “Choosing physical science courses: the importance of cultural and social capital in the enrolment decisions of high achieving students”, International Organisation for Science and Technology Education, IOSTE XI Symposium, Lublin, Poland, 25-30 July 2004
- [4] Education and Training Committee of the Parliament of Victoria, Australia – Inquiry into the promotion of mathematics and science education, pp81-97 “Chapter 4, Trends in Enrolments of Mathematics and Sciences”, March 2006
- [5] <http://webnet.oecd.org/wbos/index.aspx>

Figures

- Figure 1. Percentage of University enabling science graduates 2003 – Australia cf. OECD country list
- Figure 2. Percentage of University engineering graduates 2003 – Australia cf. OECD country list
- Figure 3. Year 12 science participation as a percentage of the Year 12 cohort in Australian schools 1996 to 2007 (from Figure 3.2 -[2])
- Figure 4. Percentages of Year 12 students in Victoria (males and females) enrolling in VCE Unit 4 Mathematics and Sciences – 2000 to 2004 (from Figures 4.2,4.3,4.8 &4.9 - [4])
- Figure 5. Photographs of typical Science and Engineering Challenge activities.

Tables

ASCED Field Category	Employment Growth	Projected
	1996-97 to 2004-05 (%)	Employment Growth 2004-05 to 2112-13 (%)
Total Agricultural Sciences	56.8	36.2
Physics and Astronomy	33	49.6
Biological Sciences	70.3	33.8
Other Natural Sciences	36.7	33.8
Mathematical Sciences	52.1	32.5
Chemical Sciences	5.4	28.6
Earth Sciences	-11.9	26.2
Total Natural and Physical Sciences	36.7	33.3
Aerospace Engineering	6.1	39.5
Process and Resources Engineering	32.9	38.7
Geomatic Engineering	25.2	36.0
Maritime Engineering	2.5	32.7
Civil Engineering	14.9	24.3
Mechanical and Industrial Engineering	8.1	12.1
Automotive Engineering	1.9	8.0
Electrical and Electronic Engineering	7.8	6.5
Manufacturing Engineering	-12.3	5.2
Other Engineering	34.2	34.4
Total Engineering	7.1	13.5

Employment growth for Engineering between 1996-97 and 2004-05 and projected growth between 2005-05 and 2012-13, expressed as a % of total growth.

Table 1 (Extracted from Table 2.3 [1])

Question	2005	2006			2007			2008		
	Total	Total	Male	Female	Total	Male	Female	Total	Male	Female
Was the Challenge rewarding?	92%	91%	89%	94%	91%	89%	94%	93%	93%	92%
Was the Challenge informative about potential careers in science and engineering	81%	79%	80%	78%	80%	81%	79%	84%	85%	83%
Did it influence your choice to study Mathematics		27%	23%	32%	26%	24%	29%	32%	32%	32%
Did it influence your choice to study Chemistry		31%	27%	38%	30%	27%	34%	37%	35%	39%
Did it influence your choice to study Physics		43%	41%	50%	45%	43%	49%	52%	51%	53%

Table 2 – Challenge participant survey results

ASCO Occupation	Persons Employed	Annual Employment Demand		Persons Employed	Annual Employment Demand	
	1995-96	1995/6 to 2003/4		2003-04	2003/4 to 2011/12	
	(000's)	Repl(%)	Growth(%)	(000's)	Repl(%)	Growth(%)
Chemists	7.7	4.5	-1.3	7.0	4.1	-0.4
Geologists & Geophysicists	5.7	4.1	4.9	8.3	5.1	1.6
Life Scientists	6.7	3.9	1.5	7.5	3.4	1.5
Environmental/Agricultural Scientists	12.5	1.5	7.0	21.6	2.0	3.9
Medical Scientists	12.4	1.6	3.2	16.0	4.3	2.8
Other Natural and Physical Scientists	5.5	4.5	-6.0	3.3	4.5	-2.3
Mathematicians, Statisticians & Actuaries	3.7	5.3	-0.5	3.6	5.9	-0.8
Business Analysts	26.9	1.2	5.2	40.3	2.0	3.2
Pharmacists	13.2	2.7	1.8	122.7	3.8	1.2
Total Science Professionals	94.3	3.3	1.8	122.7	3.8	1.2
Civil Engineers	24.7	2.9	1.5	27.9	3.8	0.4
Electrical & Electronic Engineers	21.4	2.2	1.7	24.5	3.7	0.9
Mechanical, Production & Plant Engineers	24.0	2.5	-3.0	18.8	4.8	-1.9
Mining & Materials Engineers	4.7	4.2	-1.4	4.2	5.7	-3.6
Engineering Technologists	0.5	7.5	-9.4	0.2	8.4	-4.9
Other Building & Engineering Professionals	9.2	4.1	5.5	14.1	3.3	2.8
Total Engineering Professionals	84.5	3.9	-0.9	89.7	5.0	-1.1

Levels of annual replacement demand and new employment growth between 1995-96 and 2003-04 and projected levels of replacement demand and new employment growth between 2003-04 and between 2011-12 for Engineering and Science as occupations.

Table 3 (Extracted from Table 2.4 [1])

Field of Study	Australia %		OECD % (country mean)	
	Type A	Type B	Type A	Type B
Education	11.8	1.5	13.6	18.5
Humanities and Arts	11.0	9.2	11.5	8.9
Social Sciences , Business and Law	37.7	45.3	32.2	28.4
Services	2.7	6.4	2.8	10.8
Engineering, Manufacturing and Construction	7.3	10.8	13.1	17.2
Agriculture	1.0	2.5	2.0	2.1
Health and Welfare	13.8	13.7	13.2	19.2
Life Sciences	3.0	1.0	2.9	1.1
Physical Sciences	2.1	0.3	2.5	0.8
Mathematics and Statistics	0.4	n	1.0	1.1
Computing	9.2	9.3	3.9	8.0
Unspecified/not known	n	0.1	3.4	3.5

Type A programs are a 3 years (min) of tertiary study leading to the professions and research careers, whilst type B programs are 2 years focusing on technical/occupational skills for the labour market.

Table 4 (Extracted from Table 6.1 [1])

Year 12 science participation in Australian schools: 1991 to 2007																	
Science subject title	YEAR																
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Numbers of students enrolled																	
Biology	65852	67833	63230	54872	51498	51032	49932	49677	50339	50675	47744	47770	48532	48774	48807	49245	48964
Chemistry	42645	43594	41372	36894	35711	35466	35821	34225	34259	35130	33554	33105	34074	35230	35734	35490	35697
Physics	38260	39690	36749	31890	30673	31128	31532	30490	30622	30805	31016	30552	31141	31588	29506	28730	28931
Psychology	1731	9462	11147	11257	11794	11922	12941	13001	13446	13828	14670	15037	15824	16386	16982	18124	16858
Geology/Earth Science	2350	2460	2078	1607	1257	1134	975	960	982	924	1888	1809	1865	1936	2070	1883	1684
Other Sciences	14088	18292	19060	17176	16217	15976	15965	14973	14694	15240	14713	14650	14617	13823	13421	13532	16386
Percentage of Year 12 students																	
Biology	35.9	35.2	33.8	30.5	29.9	30.0	28.9	28.0	27.6	27.3	25.4	24.7	25.1	25.2	25.1	25.1	24.7
Chemistry	23.3	22.6	22.1	20.5	20.7	20.8	20.7	19.3	18.8	18.9	17.8	17.1	17.6	18.2	18.4	18.1	18.0
Physics	20.9	20.6	19.7	17.7	17.8	18.3	18.2	17.2	16.8	16.6	16.5	15.8	16.1	16.3	15.2	14.6	14.6
Psychology	0.9	4.9	6.0	6.3	6.8	7.0	7.5	7.3	7.4	7.4	7.8	7.8	8.2	8.5	8.7	9.2	8.5
Geology/Earth Science	1.3	1.3	1.1	0.9	0.7	0.7	0.6	0.5	0.5	0.5	1.0	0.9	1.0	1.0	1.1	1.0	0.8
Other Sciences	7.7	9.5	10.2	9.5	9.4	9.4	9.2	8.4	8.1	8.2	7.8	7.6	7.5	7.2	6.9	6.9	8.3

Table 5 (Extracted from Table 3.1 [2])

Year 12 science participation in Australian schools: 1976 to 1990																	
Science subject title	YEAR																
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990		
Numbers of students enrolled																	
Biology	47733	49722	51258	51034	48865	46537	45214	47687	51450	52408	54367	57318	65647	62197	61481		
Chemistry	24739	26675	28111	29274	29395	28103	29297	31707	31941	33930	34297	36124	39756	40029	37729		
Physics	23779	24693	25703	26249	25695	24519	25550	27722	28318	29018	29379	30884	34203	35142	33537		
Geology/Earth Science	4124	4561	4508	4212	3953	3856	3526	6804	3461	3128	2960	2939	2487	2652	2403		
Other Sciences	-	-	-	114	1481	4310	4545	6101	7359	8177	9038	9828	10768	13484	13920		
Percentage of Year 12 students																	
Biology	55.3	57.5	56.4	56.5	54.8	52.7	50.4	48.3	46.6	45.1	42.4	40.3	40.7	37.1	36.3		
Chemistry	28.6	30.8	30.9	32.4	33.0	31.8	32.7	32.1	28.9	29.2	26.8	25.4	24.6	23.8	22.3		
Physics	27.5	28.5	28.3	29.0	28.9	27.8	28.5	28.1	25.6	24.9	22.9	21.7	21.2	20.9	19.8		
Geology/Earth Science	4.8	5.3	5.0	4.6	4.4	4.4	3.9	6.9	3.1	2.7	2.3	2.1	1.5	1.6	1.4		
Other Sciences	0.0	0.0	0.0	0.1	1.7	4.9	5.1	6.2	6.7	7.0	7.0	6.1	6.7	8.0	8.2		

Table 6 (Extracted from Table 3.2 [2])

Percentage of Year 12 students participating in selected advanced mathematics subjects 1991 to 2007																	
	YEAR																
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
New South Wales																	
3 Unit Mathematics	28.2	25.1	23.3	22.5	20.6	19.6	18.5	17.6	17.0	16.7							
4 Unit Mathematics	8.3	7.6	7.1	6.1	4.6	4.2	4.1	3.8	4.0	3.9							
Extension Mathematics											20.7	20.6	21.2	22.5	21.2	20.2	19.1
Victoria																	
Change & Approximations	20.7	20.2	na														
Extensions																	
Specialist Mathematics				10.5	11.2	12.8	14.0	13.7	13.2	12.7	12.4	12.4	12.6	12.5	11.4	10.5	9.8
Queensland																	
Mathematics C	15.8	12.8	13.7	10.9	12.6	10.6	10.2	8.4	8.4	8.1	8.2	7.6	7.8	8.4	8.1	7.8	7.8
South Australia																	
Specialist Mathematics	13.5	13.8	13.2	12.3	11.8	12.0	13.4	11.5	11.3	11.2	10.2	9.7	8.6	9.0	8.2	7.9	8.0
Western Australia																	
Calculus		13.9	13.6	12.7	12.5	11.4	10.9	10.5	10.9	10.2	9.2	8.4	9.3	8.2	8.2	7.3	7.7
Tasmania																	
Mathematical Methods				13.0	9.4	9.5	9.6	8.4	6.1	6.7	7.8	6.6	5.9	5.5	5.7	6.8	6.9
Specialised Mathematics				5.6	5.1	5.3	5.2	4.7	4.0	3.6	5.1	4.8	5.8	5.8	5.5	5.0	5.8
Northern Territory																	
Specialist Mathematics	7.6	9.5	9.3	7.7	6.2	6.5	6.1	6.9	6.6	5.6	6.4	6.2	4.6	5.5	5.0	5.6	2.8
Aust. Capital Territory																	
Advanced Maths (Extend)						10.8	11.1	11.8	11.5	10.7	10.8	10.7	10.8	11.8			
Specialist Mathematics															10.4	9.6	9.4

Table 7 (Extracted from Table 3.5 [2])