
BLACK and WHITE SCIENCE

**Encouraging Indigenous Australian Students
into University Science and Technology**

**Claire McLisky and Diana Day
Koori Centre**

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Authors

Claire McLisky
Research Assistant
Koori Centre
University of Sydney 2006

Associate Professor Diana Day
Research Development
Koori Centre
Old Teachers College A22
University of Sydney 2006
diana@koori.usyd.edu.au
www.koori.usyd.edu.au

Thanks to all the anonymous interviewees who gave important substance to this study. It would not have been possible without your input.

EXECUTIVE SUMMARY

In this scoping study the University of Sydney addresses the complex and very contemporary challenge of increasing the participation of Indigenous students in university Science and Technology. The study was undertaken with the support of the College of Sciences and Technology and the Koori Centre of the University of Sydney. It makes a preliminary assessment of what causes low Indigenous Science and Technology enrolments and graduations at the University of Sydney, and how to increase educational success and career path opportunities for Indigenous scientists.

Educational disadvantage and lack of participation of Indigenous students in undergraduate science and technology is well known but there is little research to inform effective policy or management intervention from pre-school to tertiary or at postgraduate level. Results are low graduations, the academic neglect of the importance of traditional Indigenous knowledge, and the persistence of social and economic disadvantage which accompanies educational under-representation.

'If there are no [Indigenous] science students now, and no Indigenous teachers, how will we ever get more?'

- Indigenous B.Sc. student

The issue of relevance-practical, intellectual and financial has emerged as one of the biggest challenges to encouraging Indigenous students into science and technology, and it applies equally at primary, secondary and tertiary level, and across institutions, in the public and private sectors

This study found complex cultural, social, economic and institutional issues influencing under-representation especially the prime importance of Indigenous knowledge to communities and the apparent lack of relevance of Science and Technology to Indigenous people. This is especially the case where Indigenous students are exposed to Western Science and Technology curricula from primary to tertiary level, yet see no connection or relevance to their own lives. Students report no mentors, no role models, no idea of future careers, nor perceived positive outcomes for them or their communities in the study of Science and Technology. The need for increased targeted marketing of Indigenous access and support at the University was also observed.

This report suggests that further policy and research interventions and investments are needed in Indigenous education from the primary through to the tertiary sector and beyond, to teacher and academic research training and support for Indigenous staff. In addition, wider institutions and groups which contribute to Indigenous educational access – pre-schools, day care centres, peers and parents, community and the media – need to be targeted to ensure awareness and a continuity of attitude, understanding and action.

Awareness of what is available at university and the options for entry is a big factor in the motivation and success of Indigenous students at high school

This study recommends a suite of policy and administrative options for the University of Sydney to enhance the participation of Indigenous students, especially in Science and Technology. Our

goals are equity of access, equity of participation, equity of educational outcomes (completions and graduations), and equity of employment and career paths – and the quality, relevance and variety of career options, including post-graduate study as required. Recommendations include:

- Enhanced in-faculty support for Indigenous university students
- In-service training of non-Indigenous university staff and school teachers
- Update of the University's and Faculties' websites to include prominent information links to information for Indigenous students and staff
- Creation of targeted promotional material – for the University, its Colleges and their Faculties – in the form of pamphlets, posters, kits, books and advertisements for prospective Indigenous university students
- More scholarships and bursaries for Indigenous students, with private sector support
- Further organised events –such as Indigenous science camps, workshops, and open days at university – for prospective Indigenous students
- Collaborative inter-faculty projects to address Indigenous educational inequity in and outside the University
- Internal review of current University, College and Faculty policy on Indigenous representation and curriculum enhancement with Indigenous perspectives
- Improved links with schools, industry partners and other universities who are working on attracting more Indigenous students into Science and Technology
- A higher University profile (and priority – financially especially) for Indigenous student attraction and retention
- More proactive practices to increase Indigenous representation where it is falling and lower than the national average in Science, Engineering, Veterinary Science and Architecture
- Specific encouragement for currently under-represented Indigenous males to study at university – the statistics suggest that when they do come to university, they are likely to choose Science and Technology
- Specific Encouragement for Indigenous females to choose Science and Technology courses
- Provision of information on University of Sydney courses, entry requirements and career outcomes for Indigenous students early in their school career– perhaps even when students are in Year 7. Continue to target primary and secondary school students at key points in their development – Year 9 (subject choices) and Years 11 and 12 (HSC)
- Target indifference to Science and Technology in the Indigenous community, and communicate the relevance and positive benefits of science and technology study and science to Indigenous communities
- Research and teaching engagement with Indigenous criticisms of Western Science and its lack of relevance to Indigenous communities, and the experience of 'failure' with mathematics
- Publicity of success stories of Indigenous science students and scientists to bring forward the positive role models, and the counter-narratives of Indigenous contributions to science
- Further research in the field of Indigenous students and science

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INTRODUCTION

Approximately 2.2% of Australians are Aboriginal or Torres Strait Islander (ABS, 2001), and yet they make up only 0.97% of the Australian university population (DEST, 2003). Despite ambitious strategic plans and reports – the University of Sydney’s 2002-2004 Triennium Report, for example (University of Sydney, 2002) – which claim increasing Indigenous participation, numbers of Indigenous students nationally have fallen for the last four years consecutively (AVCC, 2003, Table C.12 – see Statistics section below). Indigenous representation in Australian undergraduate university students is erratic across subject areas: Indigenous people account for 1.93% of tertiary students in Education, 1.56% in Society and Culture and 1.18% in the Creative Arts. Participation in university Science and Technology (0.36%) and Economics (0.32%) however, is notably low, and nowhere in the national figures does Indigenous participation reach a representative level (2.2%).

At the University of Sydney the picture is even bleaker. The Cadigal Special Admissions Policy, developed in 1992, states a target percentage for the admission of Indigenous Australian students of 5% (Cadigal Program, Academic Board, 1992). Yet Indigenous representation at Sydney is lower than the national average: Indigenous students make up only 0.73% of the total student population. Representation at postgraduate and staff level is even lower.¹ Mirroring the national statistics, Indigenous participation at the University is strikingly low in the College of Sciences and Technology (0.21%) and the Faculty of Economics and Business (0.08%). It is widely agreed that these figures, whether in the context of government, University, or College policy, are a cause for concern.

It is widely noted that the profound educational disadvantage of Indigenous Australians stems from a wider societal and economic disadvantage. Indeed, an appreciation of the influence of legal, welfare and health status is critical in understanding Indigenous under-representation in education (Day and Davison, 2004, 7). Enhancing academic literacy in Indigenous adults returning to study has been a positive educational outcome for the University (Rose et al., 2003). However a high rate of incarceration (20% of the prison population is Indigenous), juvenile detention, a life expectancy 30 years less than the general population, and health issues such as diabetes, cancer, and accidents are factors which affect Indigenous participation in education on a day to day basis.

Another factor perpetuating disadvantage is the lack of knowledge about how to improve conditions for Indigenous students. In attempting to explain why educational outcomes for Indigenous students remain well behind those of non-Indigenous students, Mellor and Corrigan (2004) cite the lack of research evidence as a crucial limiting factor in policy making. They argue for the urgent initiation of a national research program to examine ways of improving outcomes. This project undertakes to begin to meet this need for research by examining how the University of Sydney can increase student representation in Science and Technology.

¹ The University of Sydney’s 2002-2004 Triennium Indigenous Education Strategy states that ‘the University aims to increase the numbers of postgraduate Indigenous coursework and research students from the current level of 25 to 30 by 2002 and to 40 by 2004. Currently there are only 30 Indigenous postgraduates at the university; 2 of these in the College of Sciences and Technology, and 14 in the College of Health Sciences.

At the University of Sydney the Koori Centre (centre for Indigenous education) and the College of Sciences and Technology are committed to increasing the participation and contribution of Indigenous students in Science and Technology. In order to identify the key factors in educational disadvantage for Indigenous students in Science and Technology, and some practical solutions to them, this preliminary scoping study was funded jointly by the Koori Centre and the College of Sciences and Technology. The report focuses substantially on initiatives at the University of Sydney, (especially within the College of Sciences and Technology, the Faculty of Education and Social Work and at the Koori Centre). However many of its recommendations apply more widely.

The broad theme of Indigenous disadvantage in education (which is at the root of under-representation) is present in every aspect of Australian society: historical, societal, cultural, institutional and personal. While these issues transcend the academy, they interact with the university, both as an institution and in equity terms, on a day-to-day basis. For this reason, our qualitative research has been open-ended. We asked stakeholder interviewees for their concerns and recommendations outside as well as within the university context. This integrated approach, involving the primary, secondary and tertiary education sectors and the wider community, is vital if the University is to ameliorate the under-representation of Indigenous students in Science and Technology.

METHODOLOGY

This study, while small in scope and sample, aims to get behind the statistics of Indigenous disadvantage in Science and Technology by consulting with individuals directly involved in their teaching, facilitating and learning of Science and Technology. Included in this brief was to review current initiatives at the University of Sydney to find out ‘what works’, and finally to draft a set of recommendations which directly address the factors in Indigenous under-representation in Science and Technology.

To develop an understanding of the specific nature of Indigenous under-representation in Science and Technology at Australian universities, and in particular at the University of Sydney, we conducted a comprehensive survey of current national, state and University statistics. We also looked at current Vocational Education and Training and High School statistics on Indigenous representation to put the above university statistics in context.

The qualitative aspect of our research was conducted in consultation with Indigenous students and their Indigenous and non-Indigenous teachers, advisors and support staff. As Sherwood and McConville commented in 1994,

Aboriginal people... are the greatest source of knowledge of their own needs, their learning process and the ways in which learning takes place and the most effective ways and environments in which... [they] learn (Sherwood and McConville, 1994, 40).²

With this in mind, we conducted our research primarily with students and academic and general staff at the Koori Centre, which acts as a hub for Indigenous students and staff at the University of Sydney. Despite the limited applicability of our findings, we hope that we have gathered some signature environmental and life perceptions as to issues and barriers active in stopping Indigenous students from choosing Science and Technology at university.

Informal discussion interviews were conducted with Indigenous Sydney University students (Science and non-Science), their tutors and lecturers, administration and outreach staff at the Koori Centre, teachers and students at local schools, a TAFE representative and a co-ordinator of the National Indigenous Cadetship Program. Interviews were approximately 30 minutes long, and used 7 standard questions as prompts for discussion (see Appendix A). To preserve the informal discussion atmosphere, interviews were not tape-recorded, but responses were noted and transcribed later with details of age, sex, student/staff status and Aboriginality, but with no reference to their name or specific position. In total, 27 interviews were conducted. A focus group was held with 5 Indigenous undergraduate students in which the interview questions were discussed in a group situation. A survey containing the same questions was also circulated to Block students studying at the Koori Centre during the research period, of which 8 were completed and returned. The total number of interviewees / discussion group members / surveyees was thus 40.

All interviews conducted as part of this study were confidential. For this reason, we developed a system of referencing which preserves the anonymity of interviewees. Any quote followed by a

² Our thanks to Sally Farrington, Susan Page and Kristie Daniel DiGregorio from Yooroang Garang, whose article ‘The Things that Matter’ (Farrington et al., 2001) referred us to this reference.

number in brackets thus refers to an interview or survey conducted by the authors. Any quote followed by S and then a number refers to a survey completed by an Indigenous student anonymously at the Koori Centre. The group discussion is numbered collectively as 8, and each participant assigned a letter, a-e.

Responses were analysed by grouping into themes under each question heading. The frequency of various responses was noted, but the complexity of personal testimony was also preserved and coded accordingly. The issues identified in interviews follow in the Discussion section below, along with personal testimony from Indigenous staff and students. Interviewees' recommendations were noted, along with their opinions of current initiatives inside and outside the university. Overarching themes uncovered in interviews were combined with qualitative data of 'meaningful comments' and 'personal testimony' to inform a background of factors and processes precluding the participation of Indigenous students in university Science and Technology. Finally, the authors of this report in consultation with senior staff members at the Koori Centre and the College of Sciences and Technology, developed policy, administrative and research recommendations for consideration within the University of Sydney context.

THE STATISTICS: INDIGENOUS REPRESENTATION IN SCIENCE TECHNOLOGY

Indigenous representation Australian Universities

Table 1.1 tells two stories: the first is of declining representation. As evident in the bottom row, by our calculations (which include two percentile decimal points), the proportion of Aboriginal and Torres Strait Islander students at Australian universities has decreased each year since 1999, from 1.39% to 1.20%. The second is of misrepresentation: the table below appears in the Australian Vice Chancellors' Committee (AVCC) 2003 Access report, but without the bottom row. The AVCC recorded Indigenous representation in the years 1999-2001 without decimal points; in their table, it appeared that in the year 2002 representation had increased by 0.2%. (In reality, it fell by 0.03%.) Note also that the AVCC used the total for 'Non-overseas Students' for the purposes of comparison. Elsewhere in the report we use 'Total Enrolments' for calculating Indigenous representation.

	1998	%	1999	%	2000	%	2001	%	2002	%	2003	%
Aboriginal or Torres Strait Islander	7,789	1	8,367	1	7,682	1	7,682	1	7,912	1.2	8084	
Total All non-overseas Students	599,670		603,156		599,878		614,076		649,663		671,492	
Our calculations of Indigenous %		1.30		1.39		1.28		1.25		1.22		1.20

Table 1.1: Indigenous and All Non-overseas Enrolments at Australian universities, 1998-2003 (appended table from AVCC, 2003, Table C.12)

Taking into consideration that Indigenous Australians make up 2.2% of the Australian population, Indigenous Australians are under-represented in all faculties. This under-representation is most severe, however, in the broad subject areas of Science, Management and Commerce, and Food, Hospitality and Personal Services. On a positive note, the Sciences had the highest growth rate of any broad field of study of award courses between 2002 and 2003, as seen in Table 1.2 below.

	Science	Education	Management and Commerce	Society and Culture	Creative Arts	Food, Hospitality and Personal Services	Mixed Field	Non-award courses	Non-Science TOTAL	TOTAL
Indigenous Enrolments 2002	1,991	1,780	786	3,133	683	0	728	48	7,158	8,871
Indigenous Enrolments 2003	2,109	1,740	811	3,170	681	0	691	54	7,147	8,988
% Change on 2002	5.9%	-2.2%	3.2%	1.2%	-0.3%	0.0%	-5.1%	12.5%	-1.5%	1.3%
All students 2003	349,747	90,312	255,756	202,738	57,896	109	2,048	24,901	633,760	929,952
Indigenous representation	0.60%	1.93%	0.32%	1.56%	1.18%	0.00%	33.74%	0.22%	1.13%	0.97%

Table 1.2: Indigenous Science and other faculties Enrolments compared with all students enrolled at Australian universities (DEST, 2003, Tables 21 and 45)

As seen in Table 1.3, there is much variation within the category of 'sciences'. Most noticeably enrolments in Agriculture and Health are much higher than in other subject areas. Representation is lowest in the Natural and Physical Sciences, Engineering and Related Technologies,

Information Technology, and Architecture and Building. While the first two seem to be experiencing growth, the latter two appear fairly stagnant.

	Natural and Physical Sciences	Engineering and Related Technologies	Information Technology	Architecture and Building	Agriculture, Environmental and Related Studies	Science (excluding Health)	Health	Total Sciences
Indigenous Enrolments 2002	257	129	177	50	223	836	1,155	1,991
Indigenous Enrolments 2003	282	153	184	51	224	894	1,215	2,109
% Change on 2002	9.73%	18.60%	3.95%	2.00%	0.45%	6.94%	5.20%	5.90%
All students 2003	70,556	64,670	77,004	18,676	18,493	249,399	100,348	349,747
Indigenous representation 2003	0.40%	0.24%	0.24%	0.27%	1.21%	0.36%	1.21%	0.60%

Table 1.3: Breakdown of Indigenous Science enrolments at Australian universities (DEST, 2003, Tables 21 and 45)

Table 1.4 shows Indigenous representation at Bachelor's Pass, Masters and Doctoral level, and reveals that under-representation in science at undergraduate level is compounded at postgraduate level, especially doctoral. This is a field where direct intervention and support is needed urgently. Indigenous postgraduates are a key element in developing a stream of undergraduate and further postgraduate Indigenous students. This would likely contribute to changing the science itself enriching national intellectual scientific capital and fostering further creative interdisciplinary collaborations as traditional Indigenous knowledges take their rightful place in scientific research.

	Indigenous Science students	All science students	Indigenous representation in Science	All Indigenous Students	All students	Indigenous representation across all faculties
Bachelor's Pass	1,421	256,992	0.55%	5,265	609,524	0.86%
Masters	113	38,039	0.30%	501	139,288	0.36%
Doctorate	47	18,864	0.25%	182	37,511	0.49%

Table 1.4: Indigenous Science Students by Level of Study at Australian Universities (DEST, 2003, Table 45)

For youth from remote regional and very remote areas, universities are not an accessible option (see Appendix B). When we take into account that a much higher proportion of Indigenous Australians live in these areas, it is obvious that the disadvantage of rural or remote living compounds the social, economic and historical disadvantage suffered by Indigenous people.

Indigenous representation in the NSW education system

As seen in Table 2.1, Indigenous students' representation in NSW schools drops from Year 9 to 10, 10 to 11 and 11 to 12, then again at first year university and again in later years (recent figures were not available for schools across Australia). Indigenous representation in Vocational Education and Training (VET) courses is, however, much higher than at university and Year 11 and 12. As seen in the table, overall Indigenous representation in VET is 3.0%, much higher than Indigenous representation in Years 11 and 12. And Indigenous representation in VET in the 15-19 age-group (not shown in the table) is 3.9% (Saunders et al., 2003), suggesting that for many Indigenous teenagers, VET courses act as an alternative to school. The table suggests a range of critical points where students are lost to the education system. Our study addresses these critical stages.

	2003 Statistics						2003 Statistics		2001 statistics
Level	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	First Year Uni	Continuing Uni	VET
Indigenous students	4.8%	4.7%	4.4%	3.6%	2.4%	1.6%	1.3%	1.1%	3.3%

Table 2.1: Indigenous students as a percentage of state-wide enrolments for NSW (table assembled from data taken from DET (2004), DEST (2003), and Saunders et al. (2003).

Indigenous representation at the University of Sydney

Table 3.1 shows that participation of Indigenous Australians at the University of Sydney is lower than the national average in every category except Science and Technology. As will be seen in Table 3.2, this is due to the disproportionately high number of Indigenous students studying health sciences at The University of Sydney. Furthermore and of concern to the University is that Indigenous representation is dropping in all fields except Arts and Law, despite increasing numbers of non-Indigenous students.

	Sciences and Health Sciences	Education and Social work	Economics and Business	Arts and Law	Sydney College of the Arts and Sydney Conservatorium of Music	TOTAL
2003 Indigenous enrolments	212	36	5	33	6	339
2003 All enrolments	22,034	2,743	6,370	7,011	1,282	46,194
2003 Indigenous representation at Sydney University	0.96%	1.31%	0.08%	0.39%	0.47%	0.73%
2004 Indigenous	164	35	5	38	5	247
2004 All enrolments	22,665	2,769	7,212	8,811	1,319	42,776
2004 Indigenous representation at Sydney University	0.72%	1.26%	0.07%	0.43%	0.38%	0.58%
% change from 2003	-0.24%	-0.05%	-0.01%	0.04%	-0.09%	-0.15%

Table 3.1: 2003 and 2004 Sydney University Indigenous enrolments by Faculty (data from Sydney University Plansup Report, <http://www.plansup.usyd.edu.au/pubs/stats2003.PDF>, and from the Sydney University Statistics Office, unpublished data, 2004)

As seen in Table 3.2, while Indigenous Health Sciences enrolments at the University of Sydney are higher than the national average, enrolments in Science, Engineering, Agriculture and Veterinary Science and Architecture are significantly lower than the national average.

	Science and Technology	Engineering	Architecture	Agriculture, Food & Natural Resources and Rural Management and Veterinary Science	College of Sciences and Technology	College of Health Sciences	Total science
Indigenous enrolments 2003	10	6	2	8	26	186	212
All enrolments 2003	5,385	3,055	1,257	2,442	12,589	9,895	22,034
Indigenous representation at Sydney University 2003	0.19%	0.20%	0.16%	0.33%	0.21%	1.88%	0.96%
Indigenous representation at Australian universities 2003	0.31%	0.24%	0.27%	1.21%	0.36%	1.21%	0.60%

Table 3.2: 2003 Sydney University Indigenous enrolments in Science and Technology (data from Sydney University Plansup Report, <http://www.plansup.usyd.edu.au/pubs/stats2003.PDF>)

Low proportion of Indigenous university students on Abstudy

A surprisingly low proportion of Indigenous university students receive Abstudy (which might have mitigated against low representation). In the Northern Territory the percentage is lower than other students (youth allowance and pensioners) who receive Centrelink benefits (see Appendix C, AVCC, 2003).

Gender imbalance in Indigenous representation at Australian universities

In order to compare participation rates of Indigenous males with those of Indigenous females, Table 4.1 shows Indigenous male representation (as a percentage of total males) and Indigenous female representation (as a percentage of total females). Allowing for higher female participation in the general population in this way, Indigenous males are still more disadvantaged than Indigenous females Australia-wide.

	NSW	Vic	Qld	WA	SA	Tas	NT	ACT	Multi-State	Total
Indigenous male enrolments	929	373	742	463	191	105	337	90	64	3294
All male enrolments	138,176	109,856	80,369	40,773	27,647	8,237	2,146	13,198	3,726	424,128
Indigenous males as % of all males	0.67%	0.34%	0.92%	1.14%	0.69%	1.27%	15.70%	0.68%	1.72%	0.78%
Indigenous female enrolments	1533	568	1224	894	349	173	653	105	195	5694
All female enrolments	162,058	126,966	95,378	51,807	35,388	8,278	4,130	13,534	8,285	505,824
Indigenous females as % of all females	0.95%	0.45%	1.28%	1.73%	0.99%	2.09%	15.81%	0.78%	2.35%	1.13%

Table 4.1: Gender of Indigenous and All University Students by State

Table 4.2 compares Indigenous male representation with non-Indigenous male representation. In all states except the Northern Territory, Indigenous males are under-represented in comparison to non-Indigenous males.

	NSW	Vic	Qld	WA	SA	Tas	NT	ACT	Multi-State	Total
All males as percentage of all students	46.02%	46.39%	45.73%	44.04%	43.86%	49.88%	34.19%	49.37%	31.02%	45.61%
Indigenous	41.55%	43.15%	41.84%	39.69%	41.19%	37.89%	49.83%	46.78%	42.19%	40.84%

Table 4.2: Gender imbalance in Indigenous and All University Students by State

As seen in Table 4.3, Indigenous male disadvantage overall is compounded at the level of course completions. In Science and Technology, however, this disadvantage is diminished, and if we exclude Health – by far the most popular science course with Indigenous students – males are better represented than females. While Indigenous males are severely under-represented at university, they are better represented in Science (excluding the Health Sciences) than in any other broad field of study. Thus perhaps one of the most important reasons they don't choose Science and Technology is that they don't choose university at all; if more Indigenous males in particular could be encouraged to attend university, representation in all fields, but especially Science and Technology, should improve.

	Natural and Physical Sciences	Information Technology	Engineering and Related Technologies	Architecture and Building	Agriculture, Environmental and Related Studies	Health	Total Science and Technology	Total other faculties	Total completions
All males	6,323	13,531	9,011	2,533	2,092	6,047	39,537	49,777	89,314
Indigenous Males	18	14	21	5	19	48	125	261	386
All females	7,647	4,956	1,825	1,635	1,806	17,888	35,757	75,677	111,434
Indigenous Females	14	7	7	5	7	146	186	556	742
Indigenous Male representation	56.25%	66.67%	75.00%	50.00%	73.08%	24.74%	40.19%	31.95%	34.22%
All Males' representation	45.26%	73.19%	83.16%	60.77%	53.67%	25.26%	52.51%	39.68%	44.49%

Table 4.3: Course Completions for Indigenous and All Students at Australian Universities

Indigenous Students in Secondary Schools

The following tables 5.1-5.3 elucidate the low educational participation of Indigenous students within New South Wales secondary educational institutions. Table 5.1 below shows that the proportion of Indigenous students studying Science and Technology is lower than non-Indigenous students both at Year 10 and Year 12 level. In Year 10, 90% of Indigenous students study Science and Technology as opposed to 97% of non-Indigenous. In terms of representation, Indigenous students make up 1.69% of total Science and Technology enrolments, but 1.82% of total enrolments. Thus, even before the subject choices of Year 11, Indigenous students are under-represented in Science and Technology.

At HSC level, Indigenous representation decreases across the board, but especially in Science and Technology. While total Indigenous representation in the HSC is at 1.02%, representation in HSC Science and Technology subjects is a mere 0.59%. Put differently, while 59% of non-Indigenous students study Science and Technology in the HSC, only 33% of Indigenous students do. Also of note is that Indigenous representation in HSC Science and Technology is highest in the subjects of Earth and Environmental science (1.49) and Senior Science (1.20), where Indigenous students are over-represented in comparison to the rate of enrolment (1.02).

	Year 10			Year 12								
	Science and Technology enrolments	Enrolments in all subjects	Percentage of students in Science and Technology	Biology	Chemistry	Earth and Environmental Science	Physics	Senior Science	Total Year 12 Science and Technology	Enrolments in all subjects	Percentage of students in Science and Technology	
Indigenous students	1382	1528	90%	98	35	17	33	49	228	685	33%	
All students	81463	84086	97%	13226	10389	1140	10361	4081	39197	66904	59%	
Indigenous representation	1.69%	1.82%	-	0.74%	0.34%	1.49%	0.32%	1.20%	0.59%	1.02%	-	

Table 5.1: Indigenous and All NSW student entries in Year 10 and Year 12 Science and Technology Courses, August 2004

Gender representation at HSC level

Table 5.2 documents Indigenous under-representation in Science and Technology by showing Indigenous enrolments across Science and Technology subject areas as a percentage of all enrolments. In comparison to the general population, Indigenous males are most under-represented in Chemistry and Physics (it should be noted that in these subjects males in the general population tend to be over-represented). Similarly, while Indigenous females appear to be under-represented in biology, this only means that they are less likely to choose the subject than females in the general population who are generally over-represented. In terms of raw numbers there are more Indigenous females studying biology than Indigenous males (see Table 5.3). On a positive note, Indigenous females are well represented in Senior Science, and both Indigenous males and females are well represented in Earth and Environmental sciences.

	Biology	Chemistry	Earth and Environmental sciences	Physics	Senior Science	Total Science and Technology	All subjects
Male	0.90%	0.29%	1.46%	0.29%	0.98%	0.54%	0.98%
Female	0.65%	0.39%	1.53%	0.40%	1.50%	0.65%	1.07%
Total	0.74%	0.34%	1.49%	0.32%	1.20%	0.59%	1.02%

Table 5.2: NSW enrolments of Indigenous Australian students in HSC Science and Technology, August 2004, as a percentage of all NSW students

As seen in Table 5.3, both in the general population and in the Indigenous population there are significantly more females than males studying for the HSC. By contrast in HSC Science and Technology, females in the general population are under-represented; Indigenous females, however, are not. Some areas of note in which Indigenous females are more equitably represented than in the general population are Chemistry, Earth and Environmental Science and Senior Science. Even in Physics, traditionally a predominantly male discipline in the general population, Indigenous female are better represented than their non-Indigenous female peers.

		Biology	Chemistry	Earth and Environmental Science	Physics	Senior Science	All subjects	All enrolments
Indigenous Students	Male	43	16	9	22	23	113	314
	Female	55	19	8	11	26	119	371
	Total	98	35	17	33	49	232	685
All Students	Male	4776	5537	617	7641	2343	20914	32205
	Female	8450	4852	523	2720	1738	18283	34699
	Total	13226	10389	1140	10361	4081	39197	66914

Table 5.3: Indigenous and All enrolments in Science and Technology Courses and across subject areas by gender, NSW August 2004

Table 5.4 shows Indigenous under-representation in Science and Technology in terms of completions as a percentage of all enrolments across Science and Technology subject areas. Unlike the relatively high percentages for Indigenous enrolments seen in Table 5.2, representation in course completions is much lower, and Science and Technology completions surpass average Indigenous subject completions in only one science course, Senior Science. In other courses, Chemistry and Physics in particular, representation at the level of completions is dismally low. Indigenous representation in course completions of Earth and Environmental sciences is also much lower than the enrolment rate; this could be because it is a relatively new subject, but still suggests low retention rates for Indigenous Science and Technology candidates.

	Biology	Chemistry	Earth and Environmental Science	Physics	Senior Science	Total Science and Technology	All subjects
Male	0.45%	0.34%	0.47%	0.21%	0.82%	0.38%	0.67%
Female	0.58%	0.09%	0.71%	0.12%	0.98%	0.43%	0.83%
Total	0.54%	0.22%	0.58%	0.19%	0.89%	0.41%	0.75%

Table 5.4: Proportion of all course completions who are Indigenous in NSW, 2003

As seen in Table 5.5 the gender balance in terms of raw numbers at the level of course completions is quite different to the balance at the level of course enrolments. Whereas a similar number of Indigenous males and females are enrolling in HSC courses, significantly more Indigenous females are completing their HSC courses. Although we do not have enrolment and completion data for the same year, we can infer from this that Indigenous retention rates are higher for female Indigenous students. In Science and Technology the picture is somewhat different. Indigenous female completions are significantly higher than male completions in biology, although interestingly not in the other science courses. From this we can infer that Indigenous males who choose Science and Technology subjects have a better chance of HSC completion than those who choose other subjects.

		Biology	Chemistry	Earth and Environmental Science	Physics	Senior Science	Total Science and Technology	All subjects
Indigenous Students	Male	19	17	3	15	20	74	208
	Female	47	4	4	3	17	75	281
	Total	66	21	7	18	37	149	489
All Students	Male	4212	4960	645	7030	2451	19298	31106
	Female	8047	4388	567	2516	1727	17245	33675
	Total	12259	9348	1212	9546	4178	36543	64781

Table 5.5: NSW Indigenous and All student HSC completions in Science and Technology courses and All subjects, 2003

In summary, Indigenous students are under-represented at all levels of the Australian education system except Vocational Education and Training. Representation is particularly low at university level, and the University of Sydney surpasses the national average for representation in only one subject area, the Health Sciences. Representation at the University of Sydney is particularly low in the areas of Science and Technology and Economics and Business. Indigenous disadvantage is also evident along gender lines: while there are more Indigenous females than males in the education system as a whole, Indigenous females are under-represented with respect to males in university Science and Technology. Indigenous males, on the other hand, are likely to study Science and Technology if they enrol in university at all. Low numbers of Indigenous males in the HSC, and their relatively low representation even in science courses at HSC level (in comparison to non-Indigenous males) suggest that a subtly different approach is perhaps needed along gender lines. This said, Indigenous students of both sexes clearly deserve encouragement, assistance and support to continue on to university for the further study in Science and Technology.

The statistics tell of poor Indigenous representation, but not why...

The above suite of best and most recently available statistics on Indigenous student representation in secondary and tertiary education across Australia and at the University of Sydney shows that Indigenous students are not gaining appropriate representational access or participation to higher education, especially in Science and Technology. This is a negative finding as western educational achievement correlates with better employment, health and overall life outcomes in a complex society of change.

While the causes of under-representation are complex, ranging from racism to relevance to access, it is clear that there is a great deal of room for improvement in the Australian education system. Indigenous students are missing out on a rightful education, and this is reflected in poor employment prospects, promotional prospects and overall life outcomes. Thus, without further intervention such statistics showing absence and often decline of representation will be ongoing. What is not so clear are the changes necessary for more positive outcomes for Indigenous communities and students. Our following survey examines current policy, teaching and administrative support at the University of Sydney and elsewhere, and further considers the voices of the students and educators themselves to show possible paths for change.

SURVEY OF CURRENT INITIATIVES

This brief survey considers current initiatives to encourage Indigenous students to study Science and Technology at the University of Sydney. These initiatives are broken into three categories:

1. Student Support
2. Access
3. Scholarships and Bursaries
4. Community Liaison
5. Electronic Resources
6. Industry / Government links
7. Teacher training
8. Policy and practice reviews

1. Student Support

The Koori Centre, which is independent from the University of Sydney's three colleges and reports to the Pro Vice-Chancellor for Teaching and Learning, provides educational research and support facilities for Aboriginal and Torres Strait Islander students at the university. It was originally set up to provide support for Indigenous Education students and to run courses on Indigenous Education and Indigenous Studies. The Centre, while undertaking a range of postgraduate research projects and consultancies, currently teaches the B.Ed. (Secondary: Aboriginal Studies) and the Dip.Ed.(Aboriginal) and Indigenous study units within other faculties of the University. It also operates the Cadigal Program, an access and support program for Indigenous Australian students in all courses at the University.

The Cumberland Campus School of Indigenous Health Studies, Yooroang Garang, provides a full range of academic courses as well as support programs for Aboriginal and Torres Strait Islander students. The School has been very successful, as is evident in the University's Indigenous representation in the Health Sciences (1.88%), which is well above the national average (1.21%). The key difference between Yooroang Garang and the Koori Centre is that, while the former caters only to Indigenous students on one campus, the Koori Centre is responsible for the recruitment and support of Indigenous students across the university in addition to its teaching role. Yooroang Garang's success can be attributed to its specialization. In the absence of other such centres, university colleges and faculties need to recognize the crucial role fulfilled by the Koori Centre.

In a recent report commissioned by the National Centre for Vocational Education Research (NCVER) on Australian Indigenous completion rates in TAFE, authors Balatti et al. described a phenomenon in the TAFE system which parallels the above situation at the University of Sydney. The report found that 'the legacy of relegating Indigenous 'business' to the Indigenous education units has had the consequence of making the 'mainstream' organization unprepared for the increasing number of Indigenous students in mainstream programs' (Balatti et al., 2004, 6). They cited the lack of quality data about Indigenous participation in mainstream courses collected and/or made accessible to personnel, a concern which has also been mentioned by a academic in

the College of Sciences and Technology at the University of Sydney: ‘It is very difficult for us to support Indigenous students in our faculties because we don’t know who they are, or how to ask about their identity in a culturally sensitive way’ (23). The administrator also outlined the need for more data on current Indigenous at the University of Sydney, such as whether they live on or off campus, what sort of support they are currently receiving and where the areas of need lie.

The NCVER report identified ‘insufficient systemic links between the Indigenous education unit and ‘mainstream’ to assist support officers in servicing mainstream Indigenous students’, ‘insufficient relevant professional development for all staff, especially in cultural awareness and cross-cultural communication’ in Australian TAFEs. They also found a lack of managerial experience in ascertaining the needs of some indigenous students (Balatti et al., 2004, 6). Interestingly these concerns were also identified by University of Sydney students and staff in interviews, and will be dealt with in the following sections.

2. Access

The Cadigal program has run since 1993, and has successfully increased numbers of Indigenous students at the university. However, according to a recent internal audit of the program, student numbers ‘seem to have fallen’ over the last five years (Cleverley, May 2004, 4). Several Cadigal students interviewed for this project reported that they did not always find a member of staff to answer their queries, and were often confronted with closed doors. One Cadigal science student commented that, while in her first year of university (2001) she had felt supported in the program, help since then had been patchy and several students had dropped out because they had no ongoing support and it was hard to get the right tutors. The Koori Centre’s historic and academic base in Education means that specialized academic and administrative assistance for Indigenous students from other faculties is sometimes limited, however tutorial support for Indigenous students is sought across all disciplines across the University. While the Centre aims to meet the needs of all its students (except for students on Cumberland campus who are served by Yooroang Garang), this is difficult without collaboration and support from other faculties. As one B.Sc. student observed, ‘it might have been helpful to have someone explaining the course requirements, credit points, and how to organize classes during my first few years’(9). The Koori Centre is committed to addressing this issue, and in response to the May 2004 review of the Cadigal program is developing further administrative and academic initiatives.

The Koori Centre also publicises Centrelink’s ‘Abstudy conversion’ option for Indigenous university students who wish to live in residential colleges at the University of Sydney. Under this scheme, Centrelink tops up the Abstudy payments of eligible students so that they cover residential college fees, and also provides a small expenses allowance for students every week. This means that, above and beyond dedicated Indigenous scholarships to residential colleges, a theoretically unlimited number of Indigenous students should be able to access the support and opportunities offered by the colleges. One potential flaw in this scheme is the perhaps surprising fact that few Indigenous university students actually receive Abstudy (see Appendix C): apart from the demographic of Indigenous students who do not qualify for Abstudy on the basis of their financial situations, a lack of targeted information and support for Indigenous students can prevent

students who are eligible from applying. Without knowledge of their rights, many students find it embarrassing to have to prove 'Aboriginality', or have trouble filling out the forms without assistance. The Koori Centre is currently working with the residential colleges, particularly Women's and Wesley, to publicize the Accommodation conversion option, and provide advice and support to Indigenous students undertaking the application process.

3. Scholarships and Bursaries

The College of Sciences and Technology at The University of Sydney offers bursaries for Indigenous Science and Technology students. There are up to 12 bursaries of \$5,000 available to students enrolled in any degree or unit of study offered by the Faculties of Agriculture, Architecture, Food and Natural Resources, Engineering, Rural Management, Science and Veterinary Science. These are awarded on a merit and needs basis. No application is necessary and all Indigenous students enrolled in the College of Sciences and Technology are considered for an award. These bursaries are advertised on the Koori Centre website, and through the Scholarships Unit website. The scholarships are not advertised on the College's website which is limited in terms of demonstrating resources for Indigenous students or future students. Various other scholarships and bursaries are available for Indigenous students, although none specifically for Science and Technology.

4. Community Liaison

The Koori Centre and Yooroang Garang are the main points of Indigenous community liaison at the University of Sydney. As mentioned above, while Yooroang Garang liaises only with prospective Health Science students, the Koori Centre is responsible for the recruitment of all Indigenous students at the university, with little or no support from the colleges for which it recruits.

The Koori Centre runs an Indigenous HSC Enrichment Camp annually during the first week of the July school holidays for Year 12 students completing their HSC. The Centre is committed to assistance and support for Aboriginal and Torres Strait Island year 12 students who are completing their HSC and who wish to obtain a UAI for university entrance. The Centre seeks to inspire and encourage other Indigenous students to accomplish a high level of achievement and ultimately the possibility of a university degree and more employment opportunities. Students attending the Camp are provided with intensive tuition in chosen subjects, the opportunity to study past exam papers, workshoping on the skills needed to understand the language and process questions and the opportunity to link with other Indigenous students to share knowledge and experience. The Camp also allows HSC students to visit the Koori Centre and familiarises them with facilities and staff. During the week the Centre distributes information on its Aboriginal & Torres Strait Islander Courses, as well as the Cadigal (special entry) Program. The Camp has been running since 2002, and is an unqualified success. As one current Indigenous B.Sc. student commented:

The Koori Centre Camp made me feel more comfortable with campus – It's so large and has so many buildings. We went to lectures from different areas of science: science engineering, the health sciences and education. They could do something like this at other universities. The experience was very encouraging – towards the end of the HSC you're a bit sick of school. It's good to get encouragement to go on (9).

Koori Centre incentives such as the camp have proven highly effective at attracting Indigenous students to the University, and it is the opinion of the authors of this report that a higher degree of collaboration between the colleges and the Koori Centre on these initiatives would prove productive. If the Colleges were to aid the Centre with funding and information to assist with recruitment material and practices, it would ease the burden of recruitment which currently rests on the Centre. Alternatively, the appointment of an Indigenous recruitment officer in the College of Sciences and Technology could fulfil this role much as Yooroang Garang do for the Health Sciences.

The College of Sciences and Technology currently liaises with Indigenous schools through two avenues: resources for high school students on the World Wide Web, and informal contact through workshops held in University laboratory facilities for school Science and Technology classes.

UniServe Science is an incentive of the College of Science and Technology, and provides support for teachers in secondary and tertiary education. As part of the suite of teaching resources available on the UniServe website, there are two sections on Indigenous Science in the Stage 4 & 5 Curriculum Resources, 'Traditional technologies of different indigenous peoples' and 'Aboriginal Use of Native Plants'.⁴ For the main part these resources are to be commended, although it must be noted that the two schools visited in the course of this project (both with high Indigenous populations) had not heard of them. Additionally, one article included in the resources (Fallon and Enig, 1999) refers explicitly to Indigenous Australians as 'primitive peoples' and contains outmoded, even racist, content and language. The authors of this report deem this article inappropriate in the context of 'science resource' in which it was presented.⁵ However, this is not to denigrate the significant and useful resource provided by the website. With adequate promotion it will fill a gap in the high school curriculum, which has been found to be lacking in resources on Indigenous Science and Technology.

The second point of contact between schools and the College of Sciences and Technology occurs when local metropolitan high schools attend workshops in University laboratory facilities to complete their practical assessment for the HSC. Matraville Sports High School (MSHS), for example, lacks the facilities to do core high school Science and Technology experiments in its school grounds, and have attended physics and chemistry workshops in College laboratories at the University of Sydney, run by academic staff. MSHS's science department offered positive feedback on the quality of the laboratories and the presentations, but observed that the \$20 per student fee was unaffordable for most students. (MSHS is classed as a Disadvantaged School by the Department of Education and Training, and has a high Indigenous population.) Because of the cost of such workshops, many Indigenous students at MSHS (and around Sydney) miss out on excursions to the university, and the practical experiments which form an integral part of the science curriculum, or extend students' knowledge and interest in the field.

⁴ These resources can be found at http://science.uniserve.edu.au/school/curric/stage4_5/aborigines&plants.html and <http://science.uniserve.edu.au/school/quests/nativeplants.html> respectively

⁵ The two Indigenous students to whom this article was shown (one B.Sc. and one B.A. undergraduate) objected strongly to the language and opinions of this article. They suggested that if it were to be studied by high school students, it should be contextualised as an example of an outdated, colonial view of Indigenous Australians, and not simply an unproblematic 'scientific' text.

The Indigenous Australian Engineering Summer School (IAESS), organized by the Institute of Engineers Australia and currently held at the University of New South Wales, was held at The University of Sydney in 1996 with great success, resulting in increased enrolments in the Faculty of Engineering. For the past few years the summer school has been held at UNSW, despite the organizers professing their preference for the University of Sydney. Engineering enrolments during this period have decreased to pre-summer school levels. If the College of Sciences and Technology at The University of Sydney made a commitment to hosting the school again, the summer school could again be an asset to the university in attracting Indigenous students into Science and Technology.

5. Electronic Resources

As the first point of contact for many prospective university students, electronic resources are a crucial interface between the university and its target demographic. Unfortunately, the University of Sydney's resources are currently lacking in information for prospective Indigenous students.

Unlike some other universities' home pages which contain links to articles or pages on Indigenous education (The University of New South Wales currently has a link to a national forum, 'Indigenous health and the treaty debate'), The University of Sydney's home page does not have a link for Indigenous students, prospective Indigenous students or Indigenous studies.

There is no mention of Indigenous entry requirements, bursaries, or scholarships on the College of Sciences and Technology website itself. The 'Future Students' icon links back to the general university page for 'Future Students, which contains a link for 'Indigenous Support'. This page offers information on the Cadigal Program (special admissions for Indigenous student) and directs students to the Koori Centre. The College of Sciences and Technology's Strategic Plan, furthermore, does not address Indigenous representation or the support of Indigenous students, although it does undertake to 'provide an environment of welcome and support to international students' (CST, 2004, www.cst.usyd.edu.au/strategic.html).

The home pages of the six faculties within the College - The Faculty of Agriculture, Food and Natural Resources, The Faculty of Architecture, The Faculty of Engineering, The Faculty of Rural Management, The Faculty of Science and The Faculty of Veterinary Science – are also lacking in links for Indigenous students. The first four of these faculties make no mention of entry requirements or support for Indigenous students on their websites. The Faculty of Science has a link on its Future Students page to the 'About/Apply' page, which includes a small section on Special Admissions, and directs Indigenous Students to the Koori Centre by phone number but not web address. The Faculty of Veterinary Science has a similar section which is accessed through its 'Study Veterinary Science – Undergraduate Courses' link on the home page by clicking the Apply link. It invites students to contact the Koori Centre by telephone or mail, but does not provide the Koori Centre's web address. On balance, the College of Sciences and Technology and its faculties' websites are bereft of Indigenous acknowledgements, information and links.

In contrast, the College of Health Sciences' website provides an example of better practice by acknowledging the Indigenous peoples of Australia and providing information and links for Indigenous students. The CHS Strategic Plan as published on its website has a strong focus on the

recruitment and support of Indigenous students and staff.⁶ The website also discusses its commitment to Indigenous students in some depth in the 'Future Students' page under 'Teaching and Learning', which cites the courses offered by Yooroang Garang and the Faculty of Nursing's as examples of this commitment. Unfortunately, however, the link for 'Indigenous' on the 'Future Students' page opened a page titled 'A warm welcome to Indigenous Students' which had no content. While the provision of space for Indigenous pages on College websites is to be commended, without informative and meaningful content these pages are practically useless and can even be off-putting for prospective Indigenous students seeking information about the University.

Within the College of Health Sciences, the Faculty of Nursing website provides an example of 'best practice' in Indigenous-friendly website design. On the Faculty's home page there are three direct links for Indigenous students, including an 'Indigenous Education Vision Statement', which is described as "an important and integral part of the Faculty's commitment in addressing the variety of Indigenous social justice, socio-economic disadvantage and health issues, which affect the health of Indigenous Australians adversely".⁷ The Faculty website also contains a page on Indigenous Student Support with a description of the facilities available to Indigenous students within the Faculty, and links to the Koori Centre and Yooroang Garang websites. The Faculty of Nursing Website was observed to be user-friendly not just in the context of Aboriginal education, but for all students generally, containing a section answering the Frequently Asked Questions of Prospective Students. It should be noted that the future of the Faculty of Nursing is currently under question. The effects that the potential closure of the Nursing Faculty will have on Indigenous representation at the University of Sydney are not discussed on the website. Plans to close the Orange campus, which provides access to courses such as Rural Management and Sustainable Management, which are particularly popular with Indigenous students, can only impact negatively on Indigenous representation at the university.

6. The National Indigenous Cadetship Program

One Indigenous science student at the University of Sydney is currently enrolled by the National Indigenous Cadetship Program. The program matches diploma, advanced diploma and undergraduate degree level students with employers who can give them work skills and professional employment opportunities. Indigenous cadets undertake full-time study (40 weeks) and an employer paid work placement of 12 weeks, generally undertaken during the long vacation break between academic years. Financial assistance is provided to employers to offset part of the costs of employing a cadet. The employers then pay the cadet a student allowance of \$300 per week, a book allowance of \$500 per semester, travel expenses for study and travel and accommodation expenses for work placements, although they do not reimburse HECS. There are currently 108 cadets studying Science and Technology in Australian universities; with adequate promotion of the program by the College of Sciences and Technology, more Indigenous students would be able to consider the study of Science and Technology at The University of Sydney.

One positive initiative fostering Indigenous students into university study more generally is the National Indigenous Cadetship program as indicated in Table 6.1 below. Interestingly many Indigenous students had not heard of the program or its success in terms of funding university

⁶ <http://www.chs.usyd.edu.au/about/plan.shtml>

⁷ Faculty of Nursing, 2004, www.usyd.edu.au/nursing

study, mentoring and ongoing employment support throughout undergraduate studies and even honours degrees.

	Agriculture	Architecture	Computing	Engineering	Environmental Studies	Medicine	Medical Science	Psychology	Science	Veterinary Science	Total cadets
Male	1	0	14	18	5	1	1	3	26	1	70
Female	0	2	2	2	4	3	0	11	13	1	38
Total	1	2	16	20	9	4	1	14	39	2	108

Table 6.1 Current Indigenous Cadets at Australian universities in the National Indigenous Cadetship Program

7. Teacher Training

In 2001 a review of Gregor Ramsey's *Quality Matters* report, senior Koori Centre staff Michelle Blanchard and Arthur Smith called for 'pre-service and in-service education of Aboriginal and Torres Strait Islander teachers and, inter-connectedly, the more effective preparation of non-Indigenous teachers who will teach Indigenous studies' (Blanchard and Smith, 2001). The Koori Centre, in association with schools, Government, and the Faculty of Education and Social Work at The University of Sydney, runs a successful pre-service teacher education program for Indigenous students at both Diploma and Bachelor levels. Additionally, the Faculty of Education and Social Work requires that all Primary Teacher Education students study a core Aboriginal Education unit, although this unit is not currently required for Secondary Teacher Education students. Nonetheless, close links between the Koori Centre and the Faculty of Education and Social Work mean that there is a good base of understanding of Indigenous Education issues in the Faculty, and academics within the Science Teaching sector are eager to increase the emphasis on Indigenous knowledge and pedagogy in the Masters of Teaching and the Diploma of Teaching courses.

Two Faculty of Education and Social Work staff members observed that teachers are too often told what they should be doing, but given no examples of how to do it or recognition of the advances which have been made in teaching practice (10, 22). One of these interviewees observed that for a shift in teaching practices to take place at ground level – i.e. schools – science teachers need to be presented with examples of best practice in teaching science to Indigenous students:

We need to engage, debate, analyse and criticism examples of good practise. Where are the successful programs? Let's showcase them, blueprint them. It's very difficult for teachers with limited time and resources to invent things themselves. But if we model good practice, they can then make their own modifications (22).

The academic staff member suggested that the collation of a database of best practice approaches and resources would require a full time position, perhaps funded jointly by the University and the NSW Board of Studies, or even the national Department of Education, Science and Training. This observation is supported by Blanchard and Smith, who argued in 1991:

There are many successful Indigenous Teacher Education programs around the country. It would be an interesting and potentially useful exercise to initiate a review of best practice, and not only in Indigenous Education, to draw together the best of the best in order to establish a more pervasive view of what quality, relevant education and training looks like in Australia. What are the characteristics of a quality teacher as perceived by Indigenous students and their parents? (Blanchard and Smith, 2001, 2)

They go on to suggest collaboration between teachers as one possible solution to this situation:

Unfortunately, the benefits of high quality local, regional and even state-wide education initiatives are not always known about or shared between colleagues. Activities of a progressive professional body

amongst teachers may help to address this issue of inadvertent parochialism, at a state level at least. (Ip sid.).

In personal communication with Arthur Smith, he observed that since sending their review of the Department of Education and Training (DET)'s *Quality Matters* report to the DET, they had received no feedback from the department. The suggestions in their review have yet to be taken up by the DET, and for this reason are re-iterated in the Recommendations section of this report.

8. Reviews of Policy and Practice

The University of Sydney has set up an Indigenous and Equity Taskforce to address major Indigenous education issues. It has yet to report on its findings.

In June 2004 the Koori Centre initiated an *Audit of Aboriginal Studies / Perspectives and Related Issues in the Professional Activities of the Faculty of Education and Social Work in Association with the Koori Centre* which was undertaken in collaboration with the Faculty of Education and Social Work. The audit provides an excellent model for the review of current professional practice which this report recommends to other Faculties and Colleges. The Faculty of Education and Social Work is now considering the implementation of its recommendations.

Yooroang Garang has also undertaken a research project into the factors affecting participation and retention of Indigenous students in the Cadigal Program in the College of Health Sciences. In their 1998 article 'The Things That Matter', Farrington et al. reported on the factors affecting Indigenous students' decision to study at university, those that facilitate Indigenous students' success and retention once at university and the factors which challenge success and retention. Their findings concerning lack of retention of Indigenous students have helped prompt the following discussion.

Interviews and Discussion

The following comments were collected anonymously in the interview process described in the Methodology section above. Interviewees were encouraged to ‘brainstorm’ around the discussion questions in an attempt to delve as deeply and broadly into the issues as possible. The ideas, opinions and suggestions outlined below represent a broad and inclusive sample of the input we received. It should go without saying that they are not necessarily the opinions of the authors or their funders, the Koori Centre and the College of Sciences and Technology but are reproduced in the spirit of multiplicity and multi-pronged approach, to stimulate debate and to act as signposts towards future areas of research.

Why don't Indigenous students choose Science and Technology at university?

When asked why Indigenous students don't study Science and Technology at university, interviewees in the study cited a wide range of causes, ranging from social and cultural factors to specific aspects of Science and Technology teaching and curriculum.

Irrelevance

According to over half our interviewees, Indigenous people perceive Science and Technology as irrelevant, in many senses of the word. It is irrelevant because it is not seen to be useful, not visible and not interesting, because it does not seem to explain or address the problems facing the Aboriginal community, and because it is perceived to be something white people do, inside white institutions, sometimes even with black people as their subjects. For all these reasons many Indigenous Australians, even university students and graduates, see Science and Technology as meaningless. As one general staff member commented, aspiring Indigenous students ‘can't see the relevance of science to them, or its place in their everyday lives’ (5).

University in general and Science and Technology in particular, are often seen as elitist and unrelated to Indigenous communities. One Indigenous staff member said they had ‘thought university was for rich kids, and I never thought I'd be rich enough to go’ (11). Conversely, another observed that ‘if a student knows that this place is open to anyone, that's a huge thing. It's a big wall to get over if you think university's not the place to be’ (7). Our research confirmed this observation: students who see how studying Science and Technology can be applied in their own communities are more likely to pursue it.

“Perhaps the difference between me and other Indigenous students who don't study science is that I can see the connection between what I'm studying and its application to the community. If you can see a need and try to work on it, it's a big factor.”

- Indigenous B.Psych. student

Whether or not students will consider Science and Technology relevant to their lives is influenced by a number of factors, perhaps most notably the way science has been presented to them in the classroom from an early age. In our survey of current Indigenous university students we found that B.Sc. undergraduates were more likely to have had ‘inspirational’ teachers.

"I come from a rural background, and was discouraged by teachers to do science, instead they thought I should focus on English. I did biology for the HSC, but didn't feel like I could do it very well. The English teachers at my school were supportive, whereas the science teachers weren't."

- Indigenous B.A. student (8c)

A first year B.Sc. student observed that his biology teacher was 'particularly good' (8d), a B.Psych. student commented that 'Science appealed, it clicked easiest. I understood it, and my teachers were enthusiastic'(9), and an Advanced Science undergraduate said he had always 'thoroughly enjoyed most science subjects... the high school course served to further this interest' (S7). Undergraduates enrolled in other degree courses or diplomas had consistently felt excluded, bored, or even belittled by their high school Science and Technology teachers. In the words of one:

"I really liked science at Primary School, but was discouraged out of it. I remember when it happened, it was in science class one day when we'd been learning about astronomy, and I started to think about whether it was really possible that astronauts could have landed on the moon. I asked the teacher, not because I thought I was right, but just to check if my understanding of what we had been learning, which seemed to contradict the moon landing, was correct. The teacher reacted really negatively – she got really defensive and raised her voice and put me down for asking the question. After that I realized – you don't ask questions in science. I wanted to be a good student, wanted to be the teacher's pet, so I didn't ask questions any more. But after that I was put off, and never really got interested in science again."

- Indigenous B.A. student (8a)

In his 2001 report to the Department of Education, Science and Training, Jerry Schwab observed:

Making science relevant is one of the key practices that can be of enormous value to education and policy makers across the country who are struggling to engage or re-engage young Indigenous people with education and training in their own communities (Schwab, 2001, x).

The issue of relevance – practical, intellectual and financial has emerged as one of the biggest challenges in encouraging Indigenous students into university Science and Technology, and it applies equally at primary, secondary and tertiary level, and across institutions, in the public and private sectors. Amongst the students interviewed for this report, it proved to be a crucial factor in whether or not students chose to pursue the further study of science. As Noel Pearson observed recently in *The Australian*, 'education needs to be exciting and culturally engaging to encourage parental and community interest' (Pearson, 2004).

Despite the consistency of such comments in the testimony given by Indigenous interviewees, others identified these experiences as part of a wider societal estrangement from Science and Technology. One comment, by an academic staff member, raises some important concerns about the relevance of Science and Technology for Australian school students in general:

Western Science is a way of thinking which is not natural for many people – Indigenous or non-Indigenous. Because there is usually a 'right' and a 'wrong' answer, many students are afraid of science because the sense the prospect of failure, or it conflicts with their intuitive or believed worldview. Perhaps this phenomenon is more marked in the Indigenous community because Aboriginal Australians don't have the tradition of a mechanistic philosophy of knowledge. But this

general problem with science – that it seems impersonal and inflexible – is certainly not limited to Indigenous students (22).

Negative associations with Science and Technology can be usefully compared to those faced by other disadvantaged groups for whom concerns such as the relevance of Science and Technology and access to jobs are equally pertinent. The factors of socio-economic disadvantage and remoteness are strongly correlated against participation in Science and Technology (Eamon, 2002). The history of interactions between Western Science and Indigenous Australia, however, suggest that the reasons for Indigenous under-representation warrant separate consideration.

Historical associations with Science and Technology

Western Science and Technology as it has been taught in Australian schools draws on a tradition which conflicts, not just ideologically but historically, with Indigenous Australia. As Linda Tuhiwai Smith observes, there are many reasons why Indigenous people across the world have an ‘abhorrence and distrust of research’ (Smith, 1999, 107). This distrust is in part a response to hundreds of years of being studied, classified and objectified by Western science and scientists. It is exacerbated by the failure of Western Science and Technology to acknowledge the achievements of Indigenous Science and Technology. As one academic staff member commented:

The growth of science, as it appears now in the curriculum, draws on Ancient Sumeria, Egypt, Greece, Rome and Renaissance Europe. It is not relevant to Indigenous Australian peoples, their technologies, such as firesticks and land management, are not recognized (10).

In the twenty-fourth of her ‘Twenty Five Indigenous Projects’ Smith articulates the need for ‘discovering Western Science and Technology and making science work for Indigenous development’:

There are very few Indigenous scientists who remain closely connected to their own Indigenous communities. Indigenous students across many contexts have struggled with Western science as it has been taught to them in schools. Science has been traditionally hostile to Indigenous ways of knowing. Science teaching in schools has also been fraught with hostile attitudes towards Indigenous cultures, and the way Indigenous students learn (Smith, 1999, 160).

These ‘hostile attitudes’ have contributed strongly to perceptions in the Indigenous Australian community that western Science and Technology is opposed to traditional ways of knowledge, disrespectful of Indigenous rights and sovereignty, and thus ‘irrelevant’ and even damaging in the education of their children.

At the root of this problem is often inadequate teacher training. As Blanchard and Smith commented in 2001, for many Indigenous students, formal schooling is still like ‘doing time’:

It lacks relevance, and often the teacher lacks interest and expertise. Even some teachers who begin in an enthusiastic and well-meaning, positive way find the going too tough because they are just not prepared thoroughly enough for this highly complex challenge in Indigenous Education (Blanchard and Smith, 2001, 3).

While the onus is obviously on universities and teacher training colleges to prepare cohort groups of non-Indigenous graduating classes to teach more knowledgeably, sensitively and competently about Indigenous Australian contemporary issues, achievements and history, according to Blanchard and Smith (2001), not a great deal has yet been done.

Teachers with little knowledge of Indigenous community dynamics, or the communication skills and protocols necessary for consultation and partnership with Indigenous peoples, are ill-equipped

to teach Indigenous students. As Blanchard and Smith observe, ‘the better preparation of non-Indigenous teachers... both at pre-service and in-service levels, needs to be moved much higher up the priority list’ (Blanchard and Smith, 2001, 24).

Identity

In this historical/cultural context ‘self-concept’, or how Indigenous students imagine themselves and the possibilities open to them, plays a powerful role in the course of study they choose. According to a report commissioned by the Department of Education and Training Youth Affairs (DETYA), the influence of self-concept on life choices, particularly educational choices, is active in the choices all school-leavers make. They argue that ‘perceptions of self and attainability are strong influences in the choice of a field of study and of a particular course within that field’ (James et al., 1999). Yet the question of identity is particularly problematic for Indigenous students. Elizabeth McKinley has written of the ‘impossible fiction’ of the term ‘Maori woman scientist’ which, she argues, stems from the fragmented nature of the identity, ‘Maori’, ‘woman’, and ‘scientist’, which has limited Maori women’s participation and access in Science and Technology, both imaginatively and practically (McKinley, 2002, 109). She further says that deeper issues are involved embodying race, ownership of knowledge and perception. These deep issues ‘are not easily solved by some pragmatic approach to get Indigenous students into science and mathematics and will always undermine attempts to encourage more participation and achievement’ (McKinley, 2004 pers.com.).

The significance of fragmented identity on the career paths young Indigenous students choose was evident in our research. A quarter of the respondents commented that Science and Technology ‘seems like something someone else would do’; another quarter cited lack of role models as a reason for their decision not to study Science and Technology, while half commented that they did not perceive that Science and Technology was relevant to their lives, or that studying Science and Technology could be of benefit to their communities. Both Indigenous and non-Indigenous Australians interviewed for this project commented that, in choosing a course of study, Aboriginal and Torres Strait Islander students are more likely to consider the larger significance of the courses on offer than their non-Indigenous peers. Finding coherent answers to questions such as ‘what can it do for me and my community’ is a crucial part of the selection process.

Science and Technology is not considered to be beneficial to the Indigenous community

This concern was cited by 53% of interviewees as a factor in under-representation. According to interviewees, many Indigenous school-leavers have the impression that they are obliged to study a course which will feed directly back into their community. In the words of an 18 year old education student:

I personally don’t know what science subjects are being offered. But maybe from my point of view Aboriginal people like to help other Indigenous peoples so therefore [they] study subjects that help their communities internally (S4).

Science and Technology, the student implies, do not fall into this category of ‘helping’ other Indigenous people. The issue is complicated by the emphasis that the university and government place on ideals of community service. Three academic staff observed that the wording and presentation of scholarship application forms and surrounding information leads applicants to believe that they have to study something which will directly benefit their community.

“There’s a strong idea that you need to do something for your community. This limits students to thinking you need to be a teacher, or a lawyer, to help your community. The questions on the scholarship application form imply that it’s a privilege to go to university, so you’ve got to be of service, to give back to your community. This emphasis exaggerates the onus on students to feed back into their communities. Until you actually study science you don’t know what the benefits are – it’s too intangible. So for this reason, science and business miss out on Indigenous students, because they don’t have that obvious altruistic element.”

- Indigenous staff member (12)

The perception among Indigenous students who have reached university through special entry programs that they don’t really deserve to be there (or the fear that others perceive this), was also found to be strong, and reinforces the tendency to choose subjects which are seen as unproblematically ‘altruistic’.

This said, most Indigenous interviewees agreed that the study of Science and Technology should now be prioritised as important.

“As young kids we grow up being told that education is the best place to start [making a difference]. The majority of Koori Centre students are enrolled in Education or Arts. Education has been perceived to be the area of most need. However, the need has changed now – education policy these days is much improved, we’ve got Aboriginal Teaching Assistants out there, and things are changing. We need to start breaking down the barriers in other areas, like science and business, where Indigenous representation is still low.”

- Indigenous staff member (7)

Lack of role models

It has been observed that strong Indigenous representation in a faculty creates a ‘ripple effect’ as students tell their families and communities about their positive experiences of inclusion and support. Under-representation in Science and Technology, conversely, acts to effectively exclude science from the range of choices considered by school-leavers. 32% of interviewees cited a lack of role models as a key factor in under-representation. Referring to the importance of word-of-mouth and collective experience in the Indigenous community, an 18 year old Bachelor of Science student asked: “If there are no science students now, and no Indigenous teachers, how will we ever get more?” (8d). This points to the need for positive intervention.

Continuing up the academic ladder, the negative influence of under-representation becomes more severe. Indigenous disadvantage at the undergraduate level is compounded by a lack of role models and mentors in the academic community. Not only are Indigenous Australians under-represented in Australian university staff, the status of Indigenous staff is less secure. Greg McConville links this inequality to that fact that Indigenous Australian people do not have a legislated right to participate in the management and oversight of any Australian university: “the presence of Indigenous Australians within universities as students, teachers, researchers and advisors is dependent on the goodwill of those institutions, and of the governments which fund them” (McConville, 2002, p.4). Without a consistent presence at university, the cycle of under-representation is reinforced. In the case of Science and Technology, generational memory of

exploitation and negative experiences in the classroom combined with a lack of role models make the possibility of Indigenous students choosing to study at university very slim indeed.

Perception of difficulty

Just as inequality and prejudice on the part of non-Indigenous legislators and institutions has led to a mistrust of university, negative experiences with science and maths in the classroom have engendered some degree of fear and hatred of these subjects in the Indigenous community. Part of this fear is the perception that it is too difficult. In our discussions, 39% of interviewees/surveyees cited discouragement on the basis of perceived difficulty as a key factor in under-representation. Some interviewees felt that the field of science itself perpetuates this view of science being ‘difficult’, and only for the highly ‘intelligent’:

Many are made to feel that they are not “smart” enough to study it in any case, even though they may be highly capable (S7).

One student’s story highlights the enormous potential – positive or negative – which school teachers, careers advisors and family members have in influencing students’ choices. Without consistent, collaborative support from these key groups, students are often actively discouraged from the study of Science and Technology, or streamed into other subjects deemed more suitable. 32% of interviewees said that study in Science and Technology was not encouraged by the parents of Indigenous students, or discussed at home. This issue is discussed further in the section on high school Science and Technology.

“I came from Bourke, in a school with a high Indigenous population where we had good funding and a really great principal. He often used to teach our science class because we had discipline problems, and he was really respected by everyone. In Bourke we did heaps of pracs, and used drawings, diagrams and models to understand the processes we were learning about. The principal knew what would be best for our class. Often we’d learn about something in the text book, and then he’d draw a diagram of it on the board, and for homework we’d make models at home out of paper mache and all sorts of stuff. He used to use different coloured chalk on the board as well when he was drawing diagrams – I remember that really helped. I think he actually trialed a lot of techniques on our class, because we were so difficult, and then if they worked with us he’d use them with the younger kids. He’d also come around the playground at lunch time and get feedback from Koori kids about the classes, if we enjoyed them etc. He was a really great teacher. Then when I went to boarding school in year 11, I wanted to do Chemistry for the HSC, but the careers advisor talked me out of it. She said it was really hard, and that I wouldn’t be able to cope with it. So I did general science instead. Then I found out that other Koori girls who’d gone to school with me in Bourke had come to Sydney and studied Chemistry and Biology in the HSC, I was pretty disappointed. When I came to university I wanted to do maths, but my mum discouraged me.”

- Indigenous B.A. / L.L.B. student (8b)

Perception of limited job outcomes

Another aspect of this prejudice is the perception that job outcomes for Science and Technology graduates are limited: 24% thought that Indigenous school students lacked awareness of the courses and jobs Science and Technology could lead to, or perceived there were no jobs at the end of a science degree. As one interviewee observed,

There is also the parental perception that young adults in disadvantaged groups need to get out to work – a goal that university in general, and pure science in particular, is not seen to fulfil (1).

An Indigenous science graduate confirmed that this perception was a powerful influence on the courses students choose:

Students tend to think of what subjects are likely to get them employment at the end of their studies. To that end, subjects with a more practical focus, say engineering, will be perceived more likely to end up in good employment prospects over subjects with a more theoretical basis, for example chemistry. Attending university is a matter of prestige within most Aboriginal families, but not being able to find well-paying jobs demeans the investment of time, money and opportunities made by the students and their families (25).

According to 16% of interviewees, jobs in Science and Technology were perceived as badly paid and boring, which in combination with their perceived irrelevance made them an unattractive prospect. One Indigenous staff member lamented the mis-information which had dissuaded her from pursuing her love of Science and Technology. Despite such testimony there is still the perception that jobs for Indigenous graduates in Science and Technology are scarce. One academic staff member voiced the concern that with the demise of Aboriginal employment strategies, universities are creating over-educated Indigenous people (14). This interviewee reported how an Indigenous male PhD from another Australian university couldn't get a job, even though he had received first class honours in his undergraduate degree. He ended up going to France, and is employed there now. The onus is on Science and Technology to prove that there are jobs out there for Indigenous graduates.

"I always liked science and maths at school, and I had good experiences in general with my science teachers, but they weren't overly encouraging. For girls to go into science... I felt it was more office work you had to do. I didn't have any role models in the family who had got a degree at that stage. Also I thought university was for rich kids, and I never thought I'd be rich enough to go. Now when I see the block students, I think 'I could do that'. I'd like for my son to go to university, to become a marine biologist or something. I tell him about the possibilities that are open to him. My uncle, for example, he was on campus one day seven years ago, just staring at a poster on astronomy or something, and a lecturer came past and started chatting to him. The lecturer got him into the course, and he did a degree in Environmental Science. Now he works for the government in the NT as an environmental scientist, he's got three people under him, and it's a really interesting job. He has the authority to close down any mines if they threaten Indigenous sites, so it goes to show that Science really can be a way of achieving social justice. If I had known that I could get a job, and a different sort of job like that, I might have chosen science."

- Indigenous staff member (11)

One Indigenous Academic staff member also commented that, among aspiring school leavers, Science and Technology has an image problem.

"I always liked science at school – human biology, maths and history were my best marks in year 12. I did consider doing science at university. The subjects I really wanted to do in first year were psychology, anthropology and archaeology, and all of them could have fallen into Arts or Science. If I'd done science I would have had to take maths, which I liked anyway, so that wasn't the problem. The attraction of Arts was its culture, the idea of sitting in cafes drinking coffee and discussing philosophy – it was easy to imagine through films and literature. It has an atmosphere that you can anticipate and romanticize. Science, on the other hand, was an unknown, and combined with the long contact hours and a complicated structure with lectures, tutes, pracs and labs, it just didn't seem like such an appealing option. I had also heard that first year Chemistry was compulsory in a science degree – I don't know if that was true or not – but I didn't like Chemistry so I guess that was a factor."

- Indigenous academic staff member (12)

The unromantic image of Science and Technology – both in terms of the activities involved in undergraduate study and the perceived ‘boringness’ or irrelevance of Science and Technology jobs for the Indigenous community – is a problem which is perhaps more influential than initially obvious, and can only be solved by raising the profile of Science and Technology with Indigenous school students.

Lack of targeted information

In New South Wales school students have to select their HSC subjects in Year 9 or 10, depending on the school. As science is one of the few degree courses which has stringent pre-requisite requirements, students often feel that if they have not studied the correct subjects in Year 9 or 10, and/or for the HSC, they will not be able to study science at university. For this reason we argue that as early as Year 7 and 8, Indigenous students should be provided with information on the range of degrees offered at university, career outcomes for these degrees and how the jobs they lead to – in this case Science and Technology jobs – can benefit the Indigenous and wider communities. Without this information Indigenous students cannot make informed decisions about what to study for the HSC and at university, or whether to go at all. As one Indigenous staff member commented, generalized pamphlets and posters are not a particularly good means of communicating with the Indigenous community, or indeed, with school leavers in general. A 1999 study at The University of Melbourne, *Which University?*, comments that:

Many applicants could be considered to be under-informed on key matters, basing their decisions extensively on word-of-mouth information. This is apparent in the main impressions they have formed of their preferred universities, many of which are vaguely reputational, idealistic, or limited to impressions of the campus buildings and surrounds (James et al., 1999).

This trend of school-leavers relying on word-of-mouth for their information is amplified for Indigenous students by the strong influence that community and family members exert in Indigenous society. Yet little effort is made by universities, and Science and Technology faculties in particular, to utilize these family and community networks to promote courses and their relevance to Indigenous communities. Instead, Science and Technology is promoted in concepts and language which exclude these communities. One staff member commented:

Architecture is an unknown concept; many kids wouldn’t realize that pharmacy means studying to become a chemist; few kids have access to computers, and physics is an alien concept, with its own language and jargon. It’s difficult for kids to see the practical relevance of these subjects (5).

Universities are not the only culprits here; students reported that unnecessary jargon and over-complication of scientific concepts in the classroom was also a disincentive to continue with the subject after school. As one academic staff member commented, ‘students in schools pick up enthusiasm, but also negativity. Some teachers mystify science; for Indigenous kids, the perceived exclusivity of science is off-putting. Some careers advisors also have very low expectations for Indigenous kids. And if there is an expectation that a kid won’t complete a course, they will pick up on that and often drop out (10).

“The main problem with science is that the teachers are really critical of language, they expect you to speak like them and use jargon. My brother, for example, was really into science, but he kept getting criticized by his teacher for using slang and not being able to name the concepts correctly, so he quit science.”

- Indigenous B.Sc. student (8d)

"I come from a rural background, and was discouraged by teachers to do science, instead they thought I should focus on English. I did biology for the HSC, but didn't feel like I could do it very well. The English teachers at my school were supportive, whereas the science teachers weren't."

- Indigenous B.A. student (8c)

13% directly blamed teachers and careers advisors for estranging Indigenous students from the sciences, and suggested that students were often 'streamed' into the humanities and away from Science and Technology.

Do eager employers exacerbate the problem?

5% of interviewees claimed that some Indigenous school leavers are prevented from continuing on to tertiary education by Government organizations which 'snap people up' into employment, offering students deals which are financially 'too good to refuse' in an effort to fill affirmative action quotas:

Government organizations play a big part in trying to snap up school leavers, and this keeps them out of tertiary education. Offers of salary are a very attractive option (13).

This practice was seen as quite significant and condemned by the staff members interviewed. They observed that while in the short term these appointments were beneficial to young Indigenous people, in the long term they are being denied promotion because of a lack of tertiary qualifications. These staff members suggested that instead of outright 'poaching', employers (in the public or private sectors) should sponsor these students through university to enable them to achieve the best long-term career outcomes. It was also suggested that universities are guilty of a similar practice, offering tutoring and teaching positions to undergraduate Indigenous students who find the salaries and benefits very attractive. While in the short term, again, this seems like a win-win situation, the fact that so few Indigenous teaching staff have finished their PhDs suggests that this practice is distracting Indigenous students from their university studies and ultimately leaves them under-qualified, under-supported and overworked, as they attempt to juggle teaching and research with their family and community responsibilities. Again, staff members agreed it would be preferable if undergraduate and PhD students were adequately supported financially through their degrees without the necessity of undertaking full-time employment. If Indigenous students were given this opportunity, they would be, finally, on a level playing field with other university employees when they were employed, and better able to provide the role models that young Indigenous students need.

This practice is doubly problematic when Indigenous employees are appointed to 'allowed' institutional positions without sensitivity for complexity of their skills or experience. Writing of Maori women scientists in New Zealand, Elizabeth McKinley contends that individuals in this position are 'constituted as subjects in multiple and contradictory ways' (McKinley, 2002, 110). They become subjects of their employers through the process of labelling which identifies them as token 'Indigenous scientist', and are expected to perform in this role (involving duties such as welcome to country, liaising with Indigenous communities) despite the fact that they may not be comfortable in it. As a rare and much sought commodity, Indigenous scientists and Science and Technology students are burdened with a cultural currency which, ironically, may be off-putting. It is possible that these expectations put students off choosing Science and Technology subjects,

because of the fear that they will be isolated, and perhaps exploited because of their unique position in the field.

Interestingly, Blanchard and Smith made the same observation in 2001 in the context of Education graduates who ‘never actually enter the profession’:

Some have been attracted by more pressing employment and/or community obligation demands elsewhere, or they have been offered jobs by government and other agencies that have been too good (financially) to turn down. Some of these Indigenous teachers might be attracted back to the profession if appropriate incentives were provided. Perhaps such an outcome could be encouraged, at least in part, through re-entry courses provided by the proposed Australian Graduate School of Teaching. There appears to be a growing number of Indigenous people who express keen interest in studying and obtaining further qualifications at the postgraduate level’ (Blanchard and Smith, 2001, 2).

Their observation gives weight to the anecdotal accounts of Indigenous graduates across subject fields being ‘snapped up’ by the public and private sectors, an issue which is addressed in the Recommendations section.

Why don’t Indigenous males study Science and Technology at university?

As discussed above, the statistics suggest that Indigenous males are more likely to choose Science and Technology at university than Indigenous females; it is the fact that they are so unlikely to choose university at all which is a factor in under-representation. Thus in this section we will discuss the reasons that Indigenous males are under-represented at university in general, as well as in Science and Technology courses specifically.

Lack of role models

As we have seen, the importance of role models for Indigenous students cannot be underestimated. This is particularly the case for Indigenous males, who have few if any men to look up to in the tertiary sector. This issue was the most common explanation (21% of interviewees) that interviewees gave for the severe under-representation of Indigenous males at university, and in university Science and Technology. As one Indigenous staff member commented, ‘Males need male role models, a man to look up to and respect’ (11).

Interviewees agreed that the dearth of Indigenous males in teaching and support staff at universities made the necessity to publicise those men who are prominent Aboriginal Australian scientists so that young males can imagine themselves in those roles. Figures such as David Unaipon and Professor Eric Willmat, both famous Indigenous inventors, were suggested as men that Indigenous males could ‘look up to’.

“It comes back to the early years at school - because my older brother went to university, I knew I could. If kids don’t have male role models at university they tend towards labour. Young boys growing up don’t think of themselves as going on to university.”

- Indigenous male staff member (7)

Difference in youth cultures

Some interviewees identified a difference in youth culture between Indigenous girls and boys, and suggested that this might be a factor which stopped males from coming to university. While girls are seen as supportive of each other (one student reported that in her experience, women often come to university in pairs, and support each other through the degree) the pressure to be ‘cool’ is

stronger for males. 16% of interviewees identified peer pressure as a factor which discourages males from study. Science especially, with its emphasis on book-learning and abstract thought, is seen as ‘nerdy’ (6). According to one staff member ‘to be bookish, to want to learn is seen as a sign of weakness in a macho society’. In this way, Science and Technology runs against sport and the positive associations of males doing physical, overtly constructive activity. Because there is not such a focus on reading or education in the dominant male culture, young Indigenous men are less likely to come to university, or to stay once they get there.

Pressure to leave school for work

According to six interviewees, Indigenous males face more pressure to leave school for work (16%), and are more likely to feel the need to be financially independent at an earlier age. One academic staff member suggested that this might be partly due to Indigenous couples having children earlier than the national average; as a result, males in the role of provider don’t have the option of further education (13). Once males have been employed for a number of years, they are also less likely to leave work to go back to study as they may be the family’s sole breadwinner, or fear the loss of face that a loss of income might incur. For all these reasons – early fatherhood, money problems, lack of family support or absent fathers – Indigenous men may not see university education as a viable financial option.

Streaming by teachers

At school, males are streamed by teachers and careers advisors away from academic subjects and into more ‘practical’ fields (11%).

I think the pressures on Indigenous male students are different to those on female students as they go through primary and secondary schooling. Whereas female students are seen as more compliant, male students are often stereotyped as poor learners and uncooperative, less likely to engage in school work and so penalised before entering the classroom. They often see more value and acceptance by teachers and other students through playing sport than through academic pursuits (21).

Sport and trades are seen (both by teachers, students themselves and their communities) as the conventional, tried and tested way to achieve (16%). One interviewee also observed that in his experience teachers don’t put as much time in with Indigenous male students, because they are seen as ‘hopeless cases’.

Cultural factors

In traditional Aboriginal society women were the ‘caretakers’ of young children. This meant that education was seen as ‘women’s business’, closely related to childcare. 11% of interviewees suggested that this perception stopped Indigenous males from studying, not just education, but any subject at university.

Historical and societal factors

Two academic staff members stressed the historical and societal disadvantage of Indigenous Australian men as a factor in under-representation

Males were more damaged psychologically by invasion – perhaps this was not a matter of degree, but of difference. Males were socialized as protectors, warriors and defenders of culture. Women had similar responsibilities, but for some reason males were more damaged by the invasion of a superior technology. They are still standing on the fringes; many still feel that to participate in white Australian society would be submitting to white invasion. Refusing to participate is a form of continued resistance. Women, since the time of initial conflict have been more willing to take on aspects of the invading culture. Indeed, Aboriginal women are often criticized by men for embracing some aspects

of white culture. To participate in the education process is seen to be becoming complicit with the invaders (10).

Another Academic staff member suggested that the difference in male and female Indigenous cultures might be related to the trans-generational impact of the stolen generations, when more women were removed from their families than men. While many of the girls stolen were institutionalised and thus not exposed to any educational advantage, the psychological effect on those 'left behind' should not be underestimated.

Racism and conflict

Indigenous males are also, according to 5% of interviewees, more likely to experience conflict and even violence as a result of racism. Perhaps because of this, 11% of interviewees saw Indigenous males as having lower self-esteem than Indigenous females. With few role models, and living in a society where they are branded by schools, teachers, careers advisors and peers as 'dangerous', 'lost causes' or 'drop-outs', it is easy to see why Indigenous males do not perceive university study as an attractive, viable, or even useful option.

There are much more derogatory stereotypes and fears about Aboriginal men than women. To keep on at school despite these you've got to be really tough and determined. I'm the first to go to university in my family, and since then it's only been girls who've managed to stick it out. Boys have a much harder time – they can get into physical conflict. Racism is amplified for boys, and from the early years they end up on a different path. There is a strong image in Aboriginal culture of the woman holding things together. Indigenous females have a culture of strength which is missing in the male culture.

- Indigenous female academic staff member (12)

Why do Indigenous kids drop out of science and maths at high school?

Indigenous Australians are not unique among First Nations peoples in under-representation in Science and Technology. In Indigenous populations around the world

'the majority of students either avoid science and mathematics completely in school or perform poorly in these subjects when they enrol. A good number of students also drop out from these courses but still do well in other subjects and eventually complete their schooling' (Ezeife, 2003, 180).

One model which has been developed to explain the difficulties Indigenous students have negotiating Western science conceptualises the Indigenous World view as existing in a different physical space to Western Science and Technology. Learning Science and Technology in the classroom thus becomes 'cultural border crossing.' Anthony Ezeife (2003) draws on the work of Costa (1995) and Jegede & Aikenhead (1999) to identify four types of border crossings corresponding to the levels of difficulty students experience while making transitions from the life-world culture into the culture of school Science and Technology.

Smooth border crossing. Students whose life-world culture (home, peer, communal, societal) and school science culture are congruent easily move from one culture to the other. Such students experience smooth transitions and are referred to as Potential Scientists.

Manageable border crossing. When the life-world culture of the students is not too different (somewhat different) from the culture of Science and Technology, then such students would undergo manageable transitions and are classified as Other Smart Kids.

Hazardous border crossing. This occurs when the two cultures “are diverse”. Hazardous transitions would produce I-Don’t-Know students

Impossible border crossing. When the two cultures are “highly discordant,” students find it impossible to cross from one culture to the other. Thus the transitions are impossible, and the overall effect is the complete alienation of students from Science and Technology. Such students are referred to as Outsiders.

A survey of low attendance and retention rates for Indigenous high school students made with 25 Koori students completing a Tertiary Preparation Course (Peat et al., 2001) highlighted the fact that cultural understanding between schools and Indigenous students and their communities is very poor, suggesting hazardous or impossible border crossing. Many of the factors our interviewees identified as causing Indigenous students to drop out of HSC Science and Technology suggest that ‘border crossings’ for Indigenous Australians often fall into the category of ‘Hazardous’ or ‘Impossible’.

Inter-generational fear of Science and Technology

32% of interviewees observed that Indigenous students often drop out of Science and Technology because there is no support for education at home. One student commented that “When you come home and tell your parents what you’ve learnt [in science] they might say it’s stupid” (8a).

Indeed, as the National Academy of Sciences observed in 1989:

Math is seen not as something that people actually use, but as a best-forgotten (and often painful) requirement of school. For most members of the public, their lasting memories of school math are unpleasant – since so often the last math course they took convinced them to take no more (NAS, 1989, p.10).

The effect of inter-generational negative experiences with Science and Technology compounds this perception, which becomes, in effect, a culture of antipathy towards Science and Technology. Border crossing in this context is ‘impossible’, not just because of discordance between Western Science and the traditional Indigenous worldview, but more importantly because of negative associations of Science and Technology with exclusion, prejudice and colonization.

While the estrangement of Indigenous students from Science and Technology emerged as a key factor, the estrangement of high school Science and Technology from the day-to-day lives of its recipients was also emphasized by interviewees. 32% of interviewees believed that high school science is presented as too abstract and philosophical, and that it is this which puts students off.

Peer pressure

While peer pressure, as discussed above, may be more serious for males than for females, 31% of interviewees identified it as a factor which caused Indigenous high school students of both sexes to drop out of Science and Technology. Indeed, one female Indigenous academic staff member recalled the racism and pressure she was subjected to in a high school physics class, which caused her to drop out.

“One school I went to was really racist, and in science group work that meant I had to engage with people who were prejudiced. If you fit into the social environment it’s fine, but if not it adds a lot to the trauma. It can sometimes be an intimidating experience. It’s definitely also a gendered thing: boys are more boisterous and overt than girls. I remember in year 11 I chose physics, and I was the only girl in the group. It was really intimidating. I always got asked questions, and I dropped out.”

- Indigenous female academic staff member (12)

As seen in the Tables above and reflected in the above comment, many Indigenous students who complete the HSC do so as part of a minority group in a much larger school. Because Science and Technology is such an unpopular choice with Indigenous students (for the reasons mentioned above) the few Indigenous students who do study Science and Technology at high school are often isolated, even when they attend a school with a high rate of Indigenous retention. As one Indigenous staff member commented, “I don’t know any students who achieved in Science and Technology at high school”(11). Combined with the lack of role models and often a lack of encouragement, the isolation of being sometimes the only student in an HSC Science and Technology class takes an exceptional individual to continue with that subject.

Home environment

16% of interviewees thought that Indigenous students’ difficulties with maths and science stemmed from or were heightened by problems at home. Absenteeism due to family problems or lack of motivation was observed to be a big factor in students’ performance. 10% of interviewees linked absenteeism particularly to problems with maths and science, observing that the cumulative nature of science learning (each new concept is built on the basis of what has been taught before) disadvantages students who have incomplete or interrupted candidature:

The concepts are taught gradually, and if a student misses periods – because their parents are seasonal workers, or because of problems at home – in which foundation concepts are taught, they have no chance of understanding what comes next (10).

Because Indigenous students are more likely to be absent from school and move schools frequently, they are less likely to do well in Science and Technology than in other subjects. As one Indigenous academic staff member commented, ‘if you miss a bit, you miss the year’ (12).

Literacy and numeracy skills

Literacy and numeracy skills, the basic building blocks of further Science and Technology study, are lower than the national average in the Indigenous population. 18% of interviewees thought that educational disadvantage from early school years was a key factor stopping Indigenous students from studying Science and Technology. The attitude of science teachers were also thought to be crucial to the success of students; 21% of interviewees attributed high Indigenous drop-out rates to the lack of help or encouragement at school.

The need to change teaching practices to raise Indigenous literacy and numeracy levels has long been recognized, and there is a wealth of literature on the subject. 13% of our interviewees agreed that negative early experiences with maths and science contributed to a culture of fear and disinterest towards Science and Technology in the adult Indigenous population. Mathematics emerged in our study as a particular source of anxiety for Indigenous students. One Indigenous staff member remembered:

“One subject I always hated was maths. I don’t know anyone who didn’t hate it. Being asked to stand up in front of the class and say your multiplication tables was a ritual of public humiliation. Adults in the Tertiary Preparation Courses still fear the maths component. There’s a negativity around it. If you hate something early on, you will continue to hate it.”

- Indigenous staff member (7)

This observation is supported by research conducted in Australia and overseas. The tendency for schools to use mathematics as a ‘gate-keeper’, allowing only successful high school students through to the tertiary study of maths and science, has been condemned by the American National Academy of Sciences:

“Mathematics is the worst curricular villain in driving students to failure in school. When math acts as a filter, it not only filters students out of careers, but frequently out of school itself” (National Academy of Sciences, 1989, p.7).

Interviewees were aware of this tendency, identifying difficulty as the crucial factor that causes students to drop out of Science and Technology in high-school. When maths and science ‘get harder’, 45% of interviewees contended, students (especially from disadvantaged groups) lose interest, drop out of the subject or sometimes drop out of school completely.

Why do some students achieve anyhow?

Yet against the odds some Indigenous students do achieve in Science and Technology. As part of our research we interviewed 5 such students, 3 who are now at university, one who is employed in a graduate position, and another who is currently completing the HSC. All five of these individuals were male. Their comments and personal testimony are discussed in the second part of this section. Firstly, we consider the observations of staff and students in general on what distinguishes the ‘exceptional’ students who make it into university Science and Technology, from their peers.

Overwhelmingly, interviewees identified background, schooling and personality as crucial factors. 45% said that a love of maths (which they identified as a combination of aptitude and interest) was the most important element in success in Science and Technology. 37% identified a supportive home environment as crucial. It was observed homes where there is more access, information about and experience of education will value Science and Technology more, and that students who come from these homes are more likely again to do well. Four interviewees identified positive role models as a significant factor in success, and the same number thought that students from a middle class home were more likely to succeed in science. 25% of interviewees thought good teachers were indispensable in encouraging students’ interest in Science and Technology, and 11% thought a history of positive associations with Science and Technology were important. Two interviewees thought that Indigenous success in Science and Technology was the product of ‘good schools’, and one teacher observed that Indigenous students who do well often get extra help and encouragement from teachers. 18% thought that students who do well at Science and Technology are brainier, and not afraid to take hard subjects, and 5% thought the distinction came down to motivation and determination.

The B.Sc. students we interviewed agreed unequivocally that they had had no problems crossing in to the ‘world’ of Science and Technology at school, and their descriptions of their ‘life-world culture’ supported this. Perhaps the most evident congruence in their experience was having supportive, interested parents. All five science students agreed that they had been encouraged by at least one member of their family, and one student commented “My dad was interested in science, and he would talk to me about it” (8d). They had also been more aware of the opportunities available to them than other Indigenous school students. One interviewee said that

he had “never considered *not* studying science at university! I was lucky enough to see early what university was like and decided that it was for me” (S7).

A large part of this awareness and confidence stemmed from their exposure to good teachers at school. Science and Technology students reported they had received positive feedback, and felt supported and inspired by their high school Science and Technology teachers, who in some cases acted as role models for them (even though none of the students interviewed had had Indigenous science teachers). They also had histories of positive associations with Science and Technology, and many recalled “an interest in science from primary school” (9, 8d, 17). Indigenous B.Sc. students had also attended schools with a culture of attendance- all identified their schools as ‘good’ and ‘supportive’. Indigenous Students in a University of Sydney [CST]Science and Technology scholarship winners’ discussion lunch, agreed that awareness of what was available at university as a big factor in their motivation and success at high school. One student described how being sent promotional material from a university in Year 7 had spurred her on to achieve in the HSC and reach her goals. She also commented that it was only through the commitment of her Careers Advisor that she had found out about the University of Sydney’s Cadigal program, which finally convinced her that she would be able to get into university. The value of getting such information out to schools in the early high school years should not be underestimated.

Familiarity with the university and campus life was also identified as an important factor by those B.Sc. students interviewed. One student linked his motivation in the second semester of Year 12 directly to his experiences at the Koori Centre HSC camp. For this student, what could have been a ‘hazardous’ border crossing from community to university life, was softened through an on-campus intermediary, the Koori Centre. In discussion with B.Sc. students it emerged that it is sometimes this ‘crossing’ – from school to university – which is more daunting than Science and Technology itself.

The University of Sydney Indigenous B.Sc. undergraduates also identified other factors which fell outside Ezeife’s categories: primarily these characteristics fell into the category of ‘personality’ and ‘intelligence’. Others had not been mentioned by the general group. One B.Sc. student observed that he took up Science and Technology because he ‘loved a challenge’. The qualities of commitment, and a refusal to be intimidated by the numerous cultural, societal and economic barriers which often prevent Indigenous students from choosing Science and Technology are, it seems, necessary to survive in science.

“If I say to someone I’m doing science, they think it’s got this halo around it. I did science because it was so hard, but many don’t do science for this reason. There’s a stigma about doing well at science. Students choose something different because they want to do well, for their families.”

- Indigenous B.Sc. student (8d)

Finally, B.Sc. students agreed that in order to get to University Science, a natural aptitude was necessary. In contrast to the B.A. and B.Ed. students interviewed, B.Sc. students reported a life-long interest in Science and Technology. As one student observed: “I always enjoyed science at school. It seemed to have the answers, unlike English”(9). These students (along with other interviewees) believed that science is a ‘style of thinking’ which some individuals – Indigenous or non-Indigenous – are naturally more attracted to than others. One student maintained that while he

does not appear Indigenous and was not recognized as such by his peers or teachers at high school, “being Indigenous was not an issue” (9).

What can we do about low representation?

In the words of Maori researcher Linda Tuhiwai Smith, ‘the clash between science and Indigenous knowledge remains structured around the interests of science’ (Smith, 1999, 104). Acknowledging that this is most pertinent, this report structures recommendations around not only the needs of Science and Technology, but the needs of Indigenous peoples. ‘Making science relevant’ is not just about presenting Western Science in a way that appears useful to Indigenous peoples, it is about working with Indigenous peoples and incorporating their knowledges and concerns into the Science and Technology that is taught and practiced. The question arises: do we want to inform and ‘educate’ Indigenous peoples so that they can succeed better in Western Science and Technology, or change Western Science so that it better reflects the concerns and experience of Indigenous peoples?

Gloria Snively (2004, pers.com.) is currently addressing the latter question for British Columbia, Canada. Her ‘Aboriginal Knowledge and Science Education Research Project’ in collaboration with the Ministry of Education, is addressing under-representation of Aboriginal students in science classes at secondary school and the resultant under-representation in science related careers. The topic, as mentioned above, is complex and multi-faceted, and certainly warrants more in-depth research and investigation than has been possible in this scoping report.

With this in mind, a summary of all the suggestions canvassed in interviews follows. While some are very broad, and perhaps outside the scope of this report, we hope that their presence will be a stimulus to thinking outside existing structures and policies, and that in conjunction with our recommendations they deal with the issues surrounding Indigenous disadvantage in university Science and Technology at all levels.

How could the University of Sydney increase numbers of Indigenous students in Science and Technology?

AT UNIVERSITY

PUBLICITY - aimed at schools, maybe TAFE and community centres	TOTALS (out of 40)
Highlight career opportunities	19
Demonstrate relevance, usefulness, link between everyday lives and Science and Technology	18
Show students the ways that Science and Technology can benefit Indigenous communities	18
Publicise Koori Centre and the support it can offer to school students	11
Create a secondary schools newsletter for Science and Technology	9
Develop marketing strategies which touch youth	8
Publicise Abstudy conversion to residential costs option	4
Dispel the myth that Science and Technology is only for geniuses	2
Publicise preparation classes	2
Make Science and Technology 'sexier'	2
Publicise scholarships	2
Ads on Koori Radio	2
Compete with other institutions for HSC graduates	1
Pamphlets in plain English which explain science outcomes, targeting specific Indigenous age groups	1

Pictures of Indigenous people around the world	1
Produce interesting promotional material - visual, with music	1
Word of mouth	1
PUBLICITY AIMED AT CURRENT UNIVERSITY STUDENTS	
Publicise the Koori Centre at uni, so current university students will find out about it	14
Publicise Abstudy conversion to residential costs option	4
Take students from other faculties into Science and Technology	2
Publicise scholarships	2
Encourage nursing students and Aboriginal Teaching Assistants to consider studying Science and Technology	1
Tertiary Preparation Courses should feed Indigenous students into Science and Technology	1
INITIATIVES AT UNIVERSITY	
• Changes to College of Sciences and Technology course content, structure	
Offer Science and Technology degrees in block mode	10
Have a component in the science degree that relates to Indigenous world and interests	10
Appoint more Indigenous lecturers / tutors in the science faculty	9
Make Science and Technology Indigenous specific, culturally appropriate	6
Collaboration between Koori Centre and Science faculty on coursework and marketing	3
Monitor quality of teaching	3
Create a chair of Indigenous studies in the College of Sciences and Technology	3
Have a strand of the education course for teaching Science and Technology to Indigenous kids	3
Publicise high profile aboriginal leaders as role models	3
Faculty strategic plans should have targets for Indigenous students in specific colleges	2
Run a prep course (TPC) with a Science and Technology arm	1
Appoint an assoc professor dedicated to Indigenous Science and Technology education	1
Attract good educators from institutions which have had success in the past	1
Create degrees that span faculties - for example a B.Sc. (Archaeology)	1
Make courses more flexible	1
Satellite campuses of Sydney University College of Sciences and Technology to offer courses to rural and remote Indigenous Australians	1
• Support for Indigenous Students	
Create a support centre for Indigenous Science and Technology students	5
Provide more low or no cost accommodation options	5
More scholarships	5
Koori Centre needs to become more integrated with the rest of the uni	4
More scholarships for school leavers	4
Set up Science and Technology support centres for koori kids	4
Create an Indigenous residential college, or at least create clusters of students in residential colleges	3
Support for people working on new initiatives	3
Special entry levels and flexible progression policy	3
Sponsor an event for Indigenous students	2
Indigenous centres must provide ongoing support	1
Provide funding for travel, etc	1
College of Sciences and Technology could stop being so rigid about entry and marks	1
INITIATIVES IN THE WIDER COMMUNITY	
Financial support for high school students	4
Get community members in the classroom	2
CREATE LINKS BETWEEN SCHOOLS AND UNIVERSITY	
Science and Technology ambassadors - give kids role models, success stories	20
Target schools and help them connect with the university	15
Encourage Indigenous students at high school and improve outcomes, especially through careers advisors	15
Universities should help schools to improve Science and Technology programs - develop science kits	13
Mentorships / buddy programs	8
University representatives on syllabus committees should raise the issue of inappropriate Science and Technology curricula with the Board of Studies	5
Offer lectures at university for high school science students (like the camp, but not a camp)	5
Use university as a place for kids to go for special activities including sport	5
Open days for Science and Technology at the university	5
Provide College of Sciences and Technology laboratory facilities free for disadvantaged schools	4

Science and Technology camps - week or weekend	2
Focus on Science and Technology in the Koori Centre camp	2
College of Sciences and Technology start up a school tutoring program for local schools	1
Use the Service Learning Component in Master of Teaching as a way of creating links between Sydney university students and school students through mentoring, tutoring	1
Hold an engineering camp such as the one suggested by the Australian Association of Engineers and currently held at UNSW	1
Set up mentoring as part of the Masters of Teaching Service Learning Component	1
CREATE LINKS BETWEEN UNIVERSITY AND OTHER GROUPS	
The College of Sciences and Technology should make input into the Indigenous taskforce.	2
Make social connection between science faculty and aboriginal advisors to secondary schools	2
Incentives for high school teachers to encourage Indigenous students into university Science and Technology	2
Develop industry-focused education plans	1
Partnership with industry - cadetships etc	1
College of Sciences and Technology to work more closely with YG	1
enlist science teachers	1

AT PRIMARY SCHOOL

	TOTALS
Afternoon science / maths activities at schools, show where Science and Technology are used to deal with Indigenous cultural issues	21
Camps or special classes that deal with career paths and science/technology to make opportunities for science study clear,	14
More practical fact-finding activities, with explanations	14
encourage children with a predisposition for science and maths	9
Provide role models, and dispel the myth that you have to be a genius	8
Ensure basic literacy and numeracy skills	7
De-emphasise content of Science and Technology; focus on context	6
Change curriculum - it is too difficult, expects children to mature too quickly	6
More outside work	6
Monitor quality of teaching	5
Make them feel equal	4
Support and educate parents, get them involved in the classroom	4
Careers afternoons once every term	3
Special attention, tutoring	2
Teacher in-service training	1
Reference to database of best practice in Indigenous teaching	1

AT SECONDARY SCHOOL

	TOTALS
Make opportunities for Science and Technology study clear, through camps or special classes that deal with career paths and science/technology	19
Mentorships or buddy programs between uni and school	16
Present Science and Technology in a way that is do-able; dispel the myths	14
Visits to the university	14
Afternoon science / maths activities at schools, show where Science and Technology are used to deal with Indigenous cultural issues	13
More fact-finding activities, with explanations	13
Universities should help schools with Indigenous science students to improve programs - develop science kits	12
Include Indigenous science and world-view in curriculum	8
Make Indigenous students feel equal	8
Outreach programs, like a travelling show	7
Monitor quality of teaching	6
Link 'soft' sciences like archaeology to pure science	6
Create packages for careers advisors	6
Encourage children with a predisposition for science and maths	5
Tutorial scheme like the Aboriginal and Torres Strait Islander Assistance Scheme, but for high school students	4
Integrate Science and Technology across key learning areas: ethics, history etc.	4

Change maths curriculum - it is too difficult, expects children to mature too quickly	3
Teacher education / re-training	2
Teacher in-service training	1
Reference to database of best practice in Indigenous teaching	1
Industry bursaries for yr 11 and 12	1
Virtual resources on the www for high school kids	1

While our recommendations are specifically targeted at the University of Sydney, many apply to other Australian universities and educational institutions. As one of the most prestigious and internationally recognized universities in Australia, the University of Sydney can lead the way in innovations to encourage more Indigenous students and staff into the field of Science and Technology. Senior university administrators and academics need to embrace further comprehensive steps to increase Australian Indigenous representation at all educational and teaching levels, and hence ameliorate the systemic educational disadvantage reported above. Our recommendations are made in the spirit of enhancing Indigenous representation, and thus addressing the key imperatives arising from the Discussion and Interview section of this report.

RECOMMENDATIONS

- A. Policy, management and administration
- B. Research

A. Policy, management and administration

1. University of Sydney

Short Term Goals

Indigenous research, teaching and policy development

1. Create three Indigenous Chairs at the University of Sydney, one for each College. These Chairs will show leadership in research and raise the profile of Indigenous contexts in teaching and learning at the University. They will provide long-term academic support and mentoring for Indigenous staff and postgraduate and undergraduate students and place the University at the forefront of Australian Indigenous studies in academia.

Indigenous Student Support

2. Each Faculty to provide an mentor (preferably, though not necessarily Indigenous) for Indigenous students from each academic stream

Scholarships

3. Encourage University of Sydney residential colleges to continue to introduce more scholarships and bursaries for Indigenous students as part of the University of Sydney Indigenous Education Strategy 2002-2004 and beyond

Marketing

4. University of Sydney Website to have a prominent Indigenous student link on its Home Page which leads to details of the range of pathways for admission for Indigenous students and the scholarships and bursaries available. It should also outline the programs offered to Indigenous students at the University of Sydney and importantly the support provided. This page would feature prominent links to the Koori Centre, Yooroang Garang and the College of Sciences and Technology Indigenous Information Page as well as other faculty pages such as Nursing.
5. Each Department provide information to Indigenous students concerning careers available to students once they have graduated. Encourage the public and private sectors who seek Indigenous employees to support Indigenous students in higher education before graduation through to the completion of their degrees. Encourage and develop the Indigenous cadetship program at the University of Sydney.

Internal Reviews

6. University of Sydney Academic Board to report on implementation of the Indigenous Education Strategy for the 2002-2004 Triennium and
7. Develop a new Indigenous Education Strategy based on contemporary issues, goals, targets, performance measures and time horizons and for the next Triennium. Each College to develop specific strategies, goals and targets for Indigenous students.

Longer Term Goals

Indigenous College

8. Consider the utility of forming an Indigenous College of Excellence in attainment of the University of Sydney for students from all faculties

2. College of Sciences and Technology

Short Term Goals

Indigenous student support

1. Appoint a dedicated Indigenous Student Officer (preferably though not necessarily Indigenous) with responsibility to develop an Indigenous student support and development program within the College of Sciences and Technology. The officer would ideally be familiar with the College, either currently employed there, or a graduate. Depending on funding, the officer could split a full time position between the College of Sciences and Technology (based in Carslaw) and the Koori Centre (based in Old Teachers' College). The Officer would be available to students 9-5, and would make it a priority to inform students of the general facilities and support available at the Koori Centre, as well as giving more specialised help with courses and administration in the College of Sciences and Technology.
2. Encourage current Indigenous students and graduates of the science faculty to regularly meet with university staff and the Indigenous student officer. Regularly update an e-mail list of Indigenous students to which updates of new scholarships, bursaries, or College of Sciences and Technology initiatives could be regularly sent.
3. The Indigenous student officer to be available to Indigenous science students on a regular basis, by email, telephone and in person.
4. The Indigenous student officer to develop a program of further College of Sciences and Technology-school linkages targeting Indigenous students and to liaise with the NSW Aboriginal Education Consultative Group
5. Provide an (preferably Indigenous) mentor for each undergraduate Indigenous science student in their first year.
6. Develop a dedicated administrative information communication link with the Koori Centre, so that any difficulties faced by Indigenous students in the College of Sciences and Technology are dealt with quickly and effectively.
7. Review College of Sciences and Technology Indigenous entry and progression requirements for Indigenous undergraduates- there is some current perception of inflexibility. The Koori Centre could liaise to increase administrative flexibility without compromising rigour of assessment.

Scholarships

8. That the Messel International Science School (ISS), hosted every two years by the Science Foundation for Physics within the School of Physics, allocate two scholarship places to Australian Indigenous Aboriginal students. Such an important initiative would promote the highest level of achievement and motivation for Indigenous Science and Technology students. Two scholarships are needed to create a more safe and secure environment for the Indigenous Australian students
9. Offer several dedicated Indigenous postgraduate degree scholarships. Could be named after an Indigenous leader or scientist with the possibility of one of the scholarships being dedicated to research on traditional Australian Indigenous Science and Technology.
10. Work with University of Sydney residential colleges to encourage the introduction of more funded places for Indigenous students where a cohort of students can nurture each other within the college system. Women's College is already running a program – The Women's College Indigenous Scholarship - closing 1 December in 2004

11. College of Sciences and Technology to increase the number and diversity of scholarships for Indigenous undergraduate Science and Technology students. Such scholarships, separate from any federal awards, need to support full on-campus accommodation for students as well as fees, text book and laboratory fees. Collaboration with industry and government partners could allow for cadetship programs.

Marketing

12. Update the College of Sciences and Technology website to include a prominent link on the Home Page to Indigenous education at the University of Sydney including special entry provisions, admission requirements, scholarships, and further support provided including links to the two Indigenous centres – the Koori Centre and Yooroang Garang.
13. Seek funding from DEST to create a quarterly secondary schools newsletter for Indigenous Science and Technology, to be sent out to all the schools around Australia with an Indigenous population. The newsletter to be used to raise awareness of Indigenous participation in Science and Technology, and include competitions, articles on Indigenous kids in Science and Technology at The University of Sydney. All information to be provided in plain language
14. Develop marketing material [brochures, kits, videos, posters etc] specifically targeted at Indigenous students which showcases Indigenous scientist role models, the jobs and careers available to Science and Technology graduates and the range of opportunities such as in agriculture, ecology, the environment, astronomy etc. Include success stories and pictures of Indigenous scientists. This material needs to show why Science and Technology is relevant to Indigenous communities and should have wide distribution across the University of Sydney catchment.
15. Host a one-day conference/workshop on Indigenous careers in Science and Technology for tertiary and secondary careers advisors/science teachers for exchange of career material, identification of gaps and recommendation of new research and career material development, and funding strategies. Collaborate with the Koori Centre outreach program of university careers information visits for the delivery of information on Science and Technology education to NSW schools.
16. Develop Science and Technology career kits specifically designed for Indigenous students targeting high school careers advisors and in particular science teachers. Creation of such kits requires review, research and collaboration between College of Sciences and Technology, Faculty of Education and Social Work, Koori Centre, and federal and state educational training and Science and Technology bodies. Kits would contain marketing material and academic support including the alternative pathways that Indigenous students can explore to attend the University of Sydney such as the Tertiary Preparation Courses, the Cadigal program, scholarships, the Abstudy accommodation conversion scheme and the National Indigenous Cadetships Scheme. Possibility of researching careers material.
17. College of Sciences and Technology to liaise and collaborate with the Koori Centre on the development and implementation of Indigenous Science and Technology marketing and outreach programs. Review how the College of Sciences and Technology can demonstrate its relevance to Indigenous communities both locally and regionally through development of meaningful consultative processes and partnerships in collaboration with the Koori Centre. With a solid base of experience in the issues facing Indigenous university students, the Centre should be recognised and consulted in any new initiatives regarding Indigenous students.

Internal Reviews

18. Suggest to UniServe Science that the 'Indigenous' materials be reviewed for ease of use and appropriateness in the wake of criticism of some of the articles currently posted. Encourage UniServe to promote their services, especially to teachers at schools with high Indigenous populations or schools that are classified 'Disadvantaged'. Ideally, UniServe should develop a policy on the presentation of Indigenous Science on the UniServe website.

Links with schools

19. Initiate a program of Science and Technology Ambassadors. These could be undergraduate or postgraduate Indigenous science students, Indigenous science teachers or prominent Indigenous scientists within or outside the University of Sydney. Invite applications for employment of ambassadors for visits to primary and high schools with high Indigenous student numbers in NSW and to participate in Science and Technology open days and conferences.
20. The College of Sciences and Technology could fund on a rotational basis, selected city schools classified as disadvantaged with high Indigenous student numbers – to use some University laboratory facilities free of charge.
21. Develop with the NSW Dept of School Education a mentors program for Indigenous high school science and mathematics students.
22. Target schools when Koori students are in Year 9 making subject choices for Years 11 and 12 for entry into science-based university courses.

Links with Science and Technology providers

23. Network with other Australian travelling Science and Technology shows to remote areas and across regional NSW to access Indigenous students.

Links with industry

24. Review development of new external partnerships with business, government, Indigenous organisations, equity organisations and technology groups for scholarship/cadetship/ work experience and other support for Science and Technology students.

25. Links with other universities

26. Further develop links and programs [through the Indigenous Science Officer] with other Universities working to enhance Indigenous representation in Science and Technology, such as the University of Queensland program of the Indigenous Support Centre where industry links and further support increased the numbers of Indigenous students into Science and Technology

Collaborative Inter-Faculty Projects

27. Oversight of content of High School Science and Technology Resource Packs to be designed by Faculty of Education and Social Work students. Kits will be distributed to schools with Indigenous students, and will include worksheets, activities and experiments.
28. Develop teacher and student resources specifically for the new secondary Stage 4 & 5 syllabus to be implemented next year. Again, this could be done in collaboration with the Education Faculty's Science Teaching Department.

Longer Term Goals

Marketing

29. Seek collaborative funding for the development of an Indigenous careers in Science and Technology manual with interviews and testimonials of successful Indigenous students. Material for the manual to be drawn from across Australia- to be developed by the Indigenous student officer in collaboration with the Koori Centre, the Faculty of Education and Social Work and the Careers Centre. The manual would include positive case studies and contacts from current and past students of the College.

Teaching

30. Each faculty in the College of Sciences and Technology should be required to hire at least one Academic staff member with specialisation or interest in Indigenous Science in the next two years. NB. This does not necessarily entail the creation of a new academic position, rather that when new staff members for existing positions are being considered, their experience of and sensitivity to Indigenous perspectives in content and pedagogy be prioritised.
31. Develop a unit of study (possibly in the History and Philosophy of Science department) on Indigenous Science Perspectives. The unit would be available to students in all degree courses, and would include a strong emphasis on the interactions between Indigenous and Western Sciences since 1788.
32. Consider developing of a new B.Sci. (Traditional Indigenous Science and Technology) degree, which would focus on subject areas such as Traditional Ecological Knowledge, the ownership and copyright issues regarding traditional Indigenous intellectual property, the ethical problems inherent in researching Indigenous peoples as 'subjects', the relevance of Indigenous perspectives to contemporary scientific theory, and the innovation in Western Science which has been achieved, and continues to be achieved by Indigenous scientists who combine Western and traditional world-views to create radical new theories and inventions. The course could be taught across Colleges, with interdisciplinary components and a focus on the practice, theory, and philosophy of Indigenous and Western sciences.
33. Review the possibility of offering a Science and Technology degree in block mode to Indigenous students.
34. Develop a policy on the incorporation of Indigenous knowledges and contributions to Science and Technology at College of Sciences and Technology, including within science curricula

Indigenous summer Science and Technology schools

35. Reinstate the Indigenous Engineering Australian Summer School at the University of Sydney (Currently held at the University of New South Wales).
36. Hold an Indigenous Science and Technology Summer School for years 10/11/12 (or Australia's first national Indigenous Student Science Conference) for 2 days. This would come at a time when students can learn about alternative pathways to university and may be motivated to do Science and Technology. Indigenous scientists could tell their career stories, Indigenous Science specialists could mentor students and administrators could outline undergraduate and postgraduate support available at the University. The Summer School could be linked to industry and government to promote career paths in the Sciences and the National Indigenous Cadetship Program. The Summer School would include a mini-conference, discussions and visits to Science and Technology venues in Sydney e.g. nuclear reactor, hydraulics labs, biotechnology labs, agriculture experiments, pharmacy, veterinary

science clinic, ecology labs, and Sydney science museums, and would focus on showing how Western Science can benefit Indigenous communities.

Pre- Science Program

37. Scope the introduction of a pre-university science program for Indigenous students with reference to the successful Indigenous pre-law program at UNSW. Include briefings of Science and Technology career opportunities, Indigenous Science in research and Indigenous research methodologies. Indicate the application of Science and Technology to Indigenous interest areas such as the environment, natural resources management and biodiversity protection.

3. Koori Centre

Short Term Goals

Indigenous Student Support

1. Provide for greater Cadigal Science and Technology student support for the special entry program for new undergraduate students in the sciences. It is critical for Cadigal students to have daily in-person and email access to support at the Koori Centre.
2. Work with College of Sciences and Technology to distribute Science and Technology career information to state high school and career festivals (e.g. Croc Fest in Moree in September) as part of school and community visits programs. Develop closer links with College of Sciences and Technology and Faculty of Education and Social Work relating to and outreaching to Indigenous school students across NSW.
3. Review design of scholarship application forms and information sheets for Indigenous students with an aim to include further information on examples of previous scholarship holders and their professions, including those who have succeeded in non-traditional fields.
4. Encourage University faculties to provide funds for attendance of Indigenous undergraduate students at national conferences in their field of interest.

Staff Support

5. Review protocol on information dissemination. Include issues of interest to College of Sciences and Technology such as protocols and ethics in seeking students who are Indigenous and the availability or otherwise of Koori Centre and university data on Indigenous students for the purposes of further student support.
6. Review extent of and need for staff training and awareness in cultural awareness and ethics in teaching multi- cultural students including Australian Indigenous Aboriginal students at the undergraduate level.

Marketing

7. Seek funds from the Deputy Vice-Chancellor (Academic) and faculties to prepare a scholarships book/web resource for all University of Sydney and external government and non-government scholarships, bursaries and cadetships available to Indigenous students of the University of Sydney and within the catchment of the University of Sydney.
8. Continue to facilitate distribution of careers information to Indigenous students in NSW secondary schools- to school science teachers and career counsellors early in students academic career for year 9/10/11 students, so there is motivation to apply for University entrance under alternative pathways available for Indigenous students. This means that secondary students may not give up on university entry based solely on their UAI.

Collaborative Inter-Faculty Projects

9. Participate in compiling a resource bank of best practice in Indigenous Science and Technology education with the Faculty of Education and Social Work and College of Sciences and Technology
10. Provide advice on the presentation of careers information kits to be developed by the College of Sciences and Technology (recommendation 2.16 above). Give feedback on appropriateness of marketing and outreach programs.
11. With support from College of Sciences and Technology's new Indigenous Science and Technology Officer, expand outreach programs to state schools and Indigenous communities. Confer with College of Sciences and Technology on the Science and Technology

Ambassadors Program and advise on schools, approach, etc. Perhaps visit with the Ambassadors.

12. Outreach staff to liaise with Faculty of Education and Social Work on the *Masters of Teaching (Science and Technology)* Service Learning Component program suggested in the Faculty of Education and Social Work recommendations (recommendation 4.1 below).

Internal Reviews

13. Develop monitoring and review of Aboriginal and Torres Strait Islander Assistance Scheme (ATAS) student tutoring programs involving Cadigal students in first and subsequent years of university study

Inter-faculty links

14. Link with College of Sciences and Technology Indigenous Science and Technology Officer for invitations to all Koori Centre functions relevant to Indigenous science students

4. Faculty of Education and Social Work

Short Term Goals

Links with schools

1. Collaboratively with the Koori Centre and the College of Sciences and Technology, link up with schools with high Indigenous populations by offering Master of Teaching (Science) students the possibility of tutoring/mentoring Indigenous Science and Technology students in local schools in fulfilment of their Service Learning Component. As part of their assessment, second year Masters of Teaching students are required to complete 12-20hrs community service in a school or community in first semester. This is a good opportunity for the Koori Centre, the College of Sciences and Technology and the Faculty of Education and Social Work to collaborate on meaningful outreach to Indigenous school students. Liaise with College of Sciences and Technology on any further development of the program.
2. Invite science teaching students to design High School Science and Technology Resource Packs on Indigenous Science for school children, perhaps as an assessment project in the Masters of Teaching degree. Work with the Koori Centre and the College of Sciences and Technology to ensure quality, and when approved, offer the packs to schools across the country.

Collaborative Inter-Faculty Projects

3. Develop a resource bank of best practice in teaching Science and Technology to Indigenous school students in collaboration with College of Sciences and Technology. Develop a contacts list with science teachers with success in this area. Resources to be used by Faculty of Education and Social Work students and science teachers across the country during in-service training. Could be made available as a teaching resource on the internet.

Longer Term Goals

4. Conduct in-service re-training days in best practice of teaching science to Indigenous students, and the related issue of teaching Indigenous Science as part of the national school curriculum. This re-training should be publicised to science teachers around the country, especially those who work in schools with Indigenous students. Approach and content of the re-training could be developed in collaboration with the Koori Centre and College of Sciences and Technology and affiliated bodies such as UniServe Science.

5. Challenges for government - finding a way forward?

1. Review of the outcomes of current higher education policy on Indigenous Australians in the education system. This would include policies such as increases to HECS, the allowance of full fee-paying and international students at universities, and the allowed increasing specialisation of universities which means they can cut courses such as Nursing, which have high Indigenous representation and where Indigenous graduates have a significant proven positive impact on the profile of education in Indigenous communities.

2. Make Indigenous representation in education a priority in any future changes to public and education policy. Have new policies researched and reviewed with particular reference to their impact on the educational disadvantage of Indigenous Australians.

B: Further Research Suggestions

1. In-depth research project on the factors contributing to low Indigenous representation in undergraduate university Science and Technology courses in Australia
2. Comparative study of current initiatives to increase Indigenous representation at Australian universities.
3. Institutional change to grow Indigenous Science and Technology researchers
4. The effect of the National Indigenous Cadetship Program on university access, participation, retention and completion, and job outcomes for Indigenous people, especially in Science and Technology.
5. How Indigenous Science and Technology literacy can be improved in the secondary school sector
6. Role of the inspirational teacher in Indigenous student success
7. Career support for Indigenous secondary school students
8. The difference in Indigenous male and female youth cultures and the effect this has on educational interest and outcomes.
9. Research to identify past and present Indigenous Australian technology and scientific culture and management
10. Scope the emerging field of Australian Indigenous knowledge research and how this is being linked to traditional western Science and Technology research and teaching
11. Explore how Indigenous knowledge is portrayed and adopted in university teaching and curricula across colleges. Emerging themes, directions and futures
12. Explore the adoption of Indigenous perspectives in primary and secondary school curriculum, teaching and learning materials and activities
13. The academic, administrative, political and pedagogical issues surrounding the development of university units of study and/or a degree course in Indigenous Science. Survey any similar courses or units of study around the world and the feasibility of a transnational approach to the study of Indigenous Science.
14. Research the role of Western Science and Technology research and its relevance to Australian Indigenous people both in a methodological sense and in practical life experience. Linda Tuhiwai Smith's book *Decolonising Methodologies* is good background reading for this project. Focus in particular on the challenges faced by the Indigenous postgraduate researcher in contemporary Australia.

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APPENDICES

Appendix A: Question prompts for interview discussions

INTERVIEW DISCUSSION FOR INTERNAL REPORT

1. From your experience why do so few Indigenous students study Science and Technology subjects at University?
2. Why do you think Indigenous male representation is lower than female representation at University?
3. How could we increase the numbers of Indigenous students coming into university Science and Technology
 - nationally and
 - at the University of Sydney (given we have a low representation)
4. What causes Indigenous students to drop out of science/math subjects at senior high school? What do you think distinguishes Indigenous students who do achieve in Science and Technology at high school and those who do not or do not take Science and Technology?
5. What do you think should be done at primary, secondary and tertiary level to increase Indigenous students' interest and further study in Science and Technology?
6. How would you research the issue of poor Indigenous representation at University in undergraduate studies and in Science and Technology in particular?
7. What are the best ways to attract prospective Indigenous students?

Appendix B

Selected type of non-school educational institution	Major cities %	Inner Regional %	Outer regional %	Remote %	Very Remote %	Australia %
Males						
University or other higher educational institution	17.5	8.1	4.1	1.4	0.8	14
Technical or further educational institution (including TAFE)	10.7	10.4	8.1	6.1	3	10.3
Females						
University or other higher educational institution	21.9	12.3	7.3	3.6	2.5	18.3
Technical or further educational institution (including TAFE)	7.9	8.1	7.1	6.2	3.2	7.8

Table B.1: Under-representation of all Australians in regional and remote communities: proportion of 15-24 year olds attending a non-school institution by degree of remoteness.

Appendix C

State	Abstudy	All Indigenous students	Percentage of Indigenous students on Abstudy	All other students receiving Centrelink benefits	# non-Indigenous students	Percentage of other students receiving Centrelink benefits
NSW	727	2,462	29.53%	46605	300,234	15.52%
VIC	250	941	26.57%	43227	236,822	18.25%
QLD	551	1,966	28.03%	17864	175,747	10.16%
WA	551	1,357	40.60%	17864	92,580	19.30%
SA	165	540	30.56%	13238	63,035	21.00%
TAS	107	278	38.49%	4807	16,515	29.11%
NT	75	990	7.58%	988	6,276	15.74%
ACT	43	195	22.05%	4585	26,732	17.15%
MULTI	97	259	37.45%	2024	12,011	16.85%
TOTAL	2635	8,988	29.32%	168795	929,952	18.15%

Table C.1: Percentage of Indigenous University students receiving Abstudy compared to all students receiving Centrelink benefits in 2003 (AVCC, 2003)