Department of Employment, Education, Training and Youth Affairs

Doers and Thinkers: An Investigation of the Use of Open-learning Strategies to Develop Life-long Learning Competencies in Undergraduate Science Students

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Contents

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Executive Summary

The project ‘Doers and Thinkers: An Investigation of the Use of Open-Learning Strategies to Develop Life-Long Learning Competencies in Undergraduate Science Students’ has examined the range of teaching/learning strategies used by individuals and institutions with a commitment to the principles and practise of opening learning. These strategies have been critique for their effectiveness from both the staff and students perspective and the support, both personal and institutional, required for their effective and continued delivery. The valued characteristics of such programs have been identified to serve as a guide to the effective development of future courses.

Of the original target population of 30 academic staff (20 National Teaching Development Grants recipients and 10 individuals engaged in distance delivery) and 60 students, 36 academic staff and 50 students responded. Distance delivery students from Monash were problematic to access due to institutional concerns over student confidentiality, and although the authors provided all material as requested, no student responses were received from that institution.

As would be expected the greatest diversity of teaching strategies was seen amongst the National Teaching Development Grants recipients. Whilst there was a manifest dominance of technology dependent approaches with 66 per cent of projects using some form of computing, video or multimedia based delivery, more individualistic approaches were evident with problem-based learning, games and peer mentoring being seen in 20 per cent of projects studied. In contrast, academics involved in distance delivery felt more constrained by institutional imperatives and the diverse needs of their student population. One hundred percent of academic respondents in this category used print media as a delivery vehicle, but in association with a range of electronic resources. The unique strategies identified by this cohort encompassed electronic bulletin boards (20 per cent); student-led workshops (10 per cent); fieldwork (20 per cent); and residential schools—some 80 per cent of courses used residential schools and, in the light of its perceived success, had adapted this mode of delivery for on-campus students as well.

Student satisfaction varied. Whilst 78 per cent of students taught by National Teaching Development Grants recipients indicated a high degree of satisfaction with their learning experiences, only 44 per cent of distance students felt the same way about their experiences. Seventy-seven percent of this latter group, however, considered their distance course had unique qualities whilst 67 per cent expressed the belief that delivery could be improved. These responses, from distance students, could be a reflection of their greater maturity and experience in the workplace, although given the numbers of respondents in this category it is hard to draw firm conclusions.

Successful teaching strategies identified by National Teaching Development Grants students were characterised by a student-centred collaborative approach, with lecturers seen as facilitators of the learning process: an element of fun—something different—and a non-threatening environment. For some, it was a chance for autonomy, for others increased support. For distance students, successful teaching was viewed more in terms of skills acquired including development of research skills, organisation of study and increasing understanding through integration of material. One consistent theme emerged from both cohorts of students—the pivotal role played by the academic in the learning process and the notion that students and staff were a team working toward a common objective.

From the staff perspective, support, both from their peers and their institution, at both a physical and psychological level, was seen to be crucial. Both in providing the impetus to start and to continue. On the whole, National Teaching Development Grants respondents did not feel they received such support or recognition for their endeavours. On the other hand, distance deliverers often had peer support through shared burden but felt an ever diminishing level of institutional support. For successful implementation and continuation of effective open-learning strategies, it is imperative that these issues of support be addressed.

Recommendations

Recommendation 1: That institutions establish internal programs directed at the continued support of effective flexible teaching strategies.

In exploring the development and delivery of effective open-learning strategies, personal and institutional enablers and constraints became apparent. Many respondents, especially the NTDG recipients, felt their innovations were not widely accepted by their institutional peers and there was little institutional support for their continuation. In contrast, their students overwhelmingly believed they had benefited from their learning experiences and expressed support for their continuation and further development.

It is suggested that funding programs, similar to those developed to support the research activities of staff, be introduced to offer such support and raise the perceived status of teaching activities viz a viz research.

This recommendation should be considered in conjunction with recommendation 2.

Recommendation 2: That institutions introduce academic staff development programs directed at increasing awareness and understanding of flexible teaching/learning strategies.

Peer support for academic endeavours was important for most of the respondents in this study. Many reasons were given for this lack of such support, but ignorance of the importance of what was being done and perceived lack of recognition at an institutional level were apparent. Staff development programs directed at consciousness raising would thus be of value as would an official acknowledgment of the value of such initiatives by the institution.

Recommendation 3: That institutions establish a forum for discussion of innovative teaching and learning strategies.

This project has highlighted not only a need for effective communication between teaching innovators and their peers but also a need for positive recognition of the value of such contributions and the wealth of ideas which underpin their introduction. In conjunction with strategies outlined in Recommendations 1 and 2, it is also recommended that institutions establish a forum for dissemination and discussion of such ideas and their interpretation. Electronic journals offered by Edith Cowan University—'Showcasing Best Practice at ECU' (http://www.cowan.edu.au/eddev/ showcase/)—and the 'LEAP' site (http://www.etu.adelaide.edu.au/LEAP/) from the University of South Australia, provide examples of sites that enable informal presentation of innovative strategies. Such web sites may also be used for communication amongst staff via informal

chat session and bulletin boards. Communication fora of this type not only reduce the amount of ignorance amongst staff about educational innovations, but also serves to recognise the efforts of individuals at the Institutional level.

Recommendation 4: That institutions introduce more structured programs for both short and long term evaluation of the educational effectiveness of their subjects and courses.

During this study it became apparent that little objective data on the effectiveness of specific teaching strategies or the effectiveness of whole programs of study were available. Whilst many staff had used the readily available Student Feedback Questionnaire, there were reservations about the value of such a tool. Whilst the Questionnaire provides direct feedback on students perceptions it was not perceived to be an objective measure of effectiveness of the teaching program. Moreover, although staff may have the opportunity to add questions specifically related to their subject, they lacked the expertise to construct such questions.

It is therefore recommended that staff be given training in the design and implementation of effective evaluation techniques and their delivery be supported by the institution.

In this study it became apparent that no long term evaluation of the effectiveness of teaching was undertaken, either with the graduates themselves or with their employers.

It is thus recommended that institutionally based programs be developed which facilitate such feedback, closing the educational loop in the effective design and delivery of courses.

Recommendation 5: That the characteristics of effective open-learning be defined.

Both staff and students perceived that the most effective learning strategies were those that involved a collaborative approach, where lecturer and tutor assumed the role of learning facilitators and the learning was focused on student need. The way in which this was achieved varied enormously but there was a significant reliance on computer/technology support either as a readily accessible information resource or a means of communication between staff and students. Overwhelmingly, the appreciation of individuals was apparent, the feeling that the student was respected and valued and that the academic was committed to helping them. This perception of student focus may simply be the result of a shared experience ie a residential school or doing something different to the norm, or it may be the greater ease of access to staff and information afforded by technology. Whatever the underlying reasons, effective open-learning was in this study, in so far as it was restricted by lack of significant, objective evaluation, characterised by the personal touch.

Section 1: Introduction

1

Project Description

Origin and Background of the Investigation

In today's competitive marketplace, there is a clear need to produce science graduates with a strong knowledge base in the discipline area, as well as possessing a range of laboratory competencies. However, as the knowledge base of science is continually expanding—as are the laboratory skills needed to accommodate and advance this knowledge—graduating students need to be equipped with skills to advance their own knowledge base and laboratory skills. This project has explored the efficacy of open learning strategies in delivering these competencies and the individual and institutional support required to support these strategies.

The term open learning means many different things to many different people. In the context of this study, open learning is viewed as a philosophy of approach to the education process which focuses on the needs of individual learners (Carr 1990). Its application is seen in the provision of distance education, which permits flexibility of program delivery and assessment as well as meeting the unique needs of students from diverse educational backgrounds. Most recently this delivery has been increasingly supported by a plethora of multimedia interactive programs. Recent research on open learning has focused on institutional policies and practices needed to foster effective implementation (Johnson 1990; Tierney 1995). It has analysed the changing role of teachers and learners, as well as the need for flexibility in institutional practices of enrolment and assessment. This project has extended the analysis to identify best practice in open learning which can be used to develop life-long learning practices in undergraduate science students. It has sought to identify key techniques, evaluate their effectiveness and provide recommendations for future practice. Moreover, it has examined and evaluated these practises within the context of both institutionally and individually driven desire to adopt a more flexible approach to the subject delivery.

Project Description

This project was approached from two perspectives:

1. open-learning as fostered through institutional directive; and
2. open-learning as initiated through individual drive.

Open-learning as Fostered through Institutional Directive

Two universities were selected for study—Charles Sturt University and Monash University. These were selected on the basis of their involvement in distance education in Australia, and the presumption that distance delivery offered an opportunity to introduce a student centred focus to the learning experience. Charles

Sturt University is a newly established federated university catering to the needs of the rural community of western New South Wales and Monash University, the largest university in Australia, was originally established for on-campus delivery in the city of Melbourne, but which has moved successfully into distance delivery.

Open-learning as Initiated through Individual Drive

University staff who were recipients of National Teaching Development Grants were chosen to be participants in the study as, by definition, they would be at the forefront of teaching innovation in tertiary institutions. It was also believed that such individuals would be interested in contributing to this study.

As students are the recipients of any innovations to the teaching and learning experience, they were considered to be extremely important participants in the study. Students from both distance deliverers were surveyed, as were those who had experienced the teaching changes as a result of implementation of the National Teaching Development Grants funded projects. The empirical research for this project was undertaken in 1996–1997.

The project began with several objectives:

- to identify the diversity of open-learning/teaching strategies being employed at Australian universities;
- to test the effectiveness of such strategies on student learning in both the short and long term;
- to identify and evaluate resources necessary to support the optimal implementation of open learning strategies; and
- to investigate the attitudes of academics to the introduction of open learning strategies into their undergraduate programs.

Research Methodology

The use of open learning strategies was explored from two perspectives:

1. institutionally fostered; and
2. individually initiated.

This involved collection and analysis of the following information.

(A) Individuals and Institutions Involved in the Provision of Distance Education

Two institutions involved in the provision of open learning—Monash University and Charles Sturt University—were requested to provide information regarding:

- level and discipline of courses offered through distance mode;
- their associated entry requirements;

- mode of course delivery;
- assessment techniques;
- staff support required; and
- infrastructure support including learning materials, use of new technology, and novel (non-didactic) approaches.

For each science based course, information was also requested regarding specific student outcomes, including:

- course review and evaluation reports for the past three years;
- entry profiles of students; and
- employment profiles of students pre- and post-course enrolment.

Available data is shown in Appendix 1.

Staff Experience

To achieve the target of ten academic staff respondents, a total of 29 individual academics (23 from Charles Sturt University and 6 from Monash) involved in delivery of these programs were contacted requesting their participation in the project by completing a survey by telephone interview. Of these ten were interviewed (8 from Charles Sturt University and 2 from Monash) and asked to comment on:

- their role in the preparation and delivery of course materials;
- strategies they may have developed to enhance the learning process;
- the support required for effective implementation; and
- finally their perceptions as to the effectiveness of the program as a means of developing learning competencies.

The telephone interviews took between three-quarters of an hour and an hour and a half to complete. The interview schedule is provided in Appendix 2.

Student Experience

Subsequently, selected students from these science based programs were canvassed for their perceptions regarding their learning experience and its influence upon their attitude to their learning future. It was originally intended to select students with designated poor, average and above average grade outcomes but this level of discrimination was not achievable. Originally only Charles Sturt University indicated that it could cooperate in the surveying of students; Monash University advised us that such a survey was impossible as it breached student confidentiality. Towards the end of the study period, however, Monash students were contacted,

although at this time the responses have not been received. One hundred per cent of Charles Sturt University staff who were interviewed consented to their students being interviewed.

Students, who are enrolled in the course(s) of interest, were asked to participate. They were given a consent form and questionnaire to complete (see Appendix 3), and advised that participation was voluntary and their answers would have no bearing on their subject grade. The lecturer did not see the students' completed questionnaires as they were posted out to the students by Charles Sturt University staff of the Dean of Studies and returned to the researchers in sealed envelopes. The original target number of student respondents was 60; of this 9 responses were received from Charles Sturt University students and none from Monash.

(B) Individuals Involved in Developing Novel Teaching Strategies

This portion of the project specifically targeted academics who have or were engaged in developing new approaches to the teaching/learning paradigm. These individuals were accessed through the Committee for Advancement of University Teaching database (1993–1996). It was also originally intended to seek out National Teaching Development Grants applicants who did not receive funding but met the necessary selection criteria (i.e. a demonstrated commitment to develop new ways to support the learning process); however, this information was unavailable.

Staff Experience

To achieve the original target of 20 National Teaching Development Grants respondents, 82 National Teaching Development Grants recipients were originally contacted for interview. Of these 26 were eventually interviewed and asked to provide information regarding the course for which their program was designed including:

- entry requirements;
- the underlying rationale of their approach;
- the details of any program they may have developed, highlighting unique characteristics which foster the learning process;
- support perceived necessary to implement their programs;
- details regarding the effectiveness of their program, specifically competency outcomes and how these have been measured;
- evaluation and substantiation of the effectiveness of their program in developing learning competencies; and
- a copy of their completed Committee for the Advancement of University Teaching report, if available.

National Teaching Development Grants recipients were contacted from the science, engineering/processing technology, health science and agriculture/ renewable resources discipline areas. The selection of potential candidates for

interview was directed at academic staff who were implementing projects characterised by a non-traditional, student centred approach. Projects which were totally technology based were not investigated.

National Teaching Development Grants recipients were initially contacted via email or facsimile requesting their participation in the project by completing a questionnaire (see Appendix 4), by telephone interview, or email according to preference. The response rate was around 32 per cent, approximately the same as that observed with distance education providers. Telephone interviews took between half an hour and an hour to complete. Those recipients who participated were, for the most part, extremely cooperative and interested in sharing their experiences of innovative teaching in tertiary science.

Student Experience

The students' perspective on the value of these learning processes were canvassed. From each program, a minimum of four students were requested to provide their perspective on the effectiveness of the learning strategies. Students were given a consent form and questionnaire to complete (see Appendix 5); they were advised that it was voluntary and would have no bearing on their subject grade. The lecturer/National Teaching Development Grants recipient did not see the students' completed questionnaires. Not all participants were able to provide students for survey. Of the 26 National Teaching Development Grants recipients who were interviewed, 13 consented to their students being surveyed. A total of 41 students participated from 7 of the selected National Teaching Development Grants participants' projects.

Analysis of Interview Transcripts

All interviews from either the universities or National Teaching Development Grants recipients were transcribed. All interview transcripts and student surveys were read by the authors individually, and discussed as a group. A phenomenological approach (Prosser et al.1994) was taken when analysing the transcripts, in order that categories of responses be identified where possible. From this process a variety of themes and issues were identified which informed the final analysis.

Background to the Project: The Institutions

Two Institutions of tertiary education were selected—Charles Sturt (Bathurst, Wagga Wagga and Albury-Wodonga campuses) in rural New South Wales, and Monash University (Gippsland campus) in Victoria.

Charles Sturt University

Charles Sturt University was established in 1989; its network members are known as Charles Sturt University-Riverina (Bathurst), Charles Sturt University-Murray (Albury-Wodonga) and Charles Sturt University-Riverina (Wagga Wagga). Although one of Australia's youngest universities, the University has a foundation in education as its network members were formerly the Mitchell College of Advanced Education (Bathurst) and the Riverina-Murray Institute of Higher Education (Wagga Wagga and Albury). Charles Sturt University was established to provide university standard education, having particular regard for the residents of Western and South Western New South Wales and to provide distance education for students within New South Wales and elsewhere. The University offers more than 100 courses of study and caters for more than 15,000 internal and distance education students. Charles Sturt University is a centre for distance education in Australia.

The Open Learning Institute, staff of which are located on all three campuses, provides the links between the student and the University through the Open Learning Institute help desk and the Program Management Unit. The help desk is the main contact point for distance students as it provides information on assignment receipt and dispatch, residential schools, subject materials, and tele- and video-conferencing. Instructional designers from the Institute liaise with academics to design learning materials, support the creation of learning resources, research teaching and learning strategies, identify innovative uses for educational technology and provide academic staff development.

Students are able to contact members of academic staff via telephone, facsimile, letter or email. The Open Learning Institute is provided with a list of consultation times for each member of the teaching staff. Students are provided with a geographic roll at the beginning of the year which lists students from a specified area (e.g. the South Coast of New South Wales) Students elect to be included in a particular geographical area. The student directory for each subject lists the names and addresses of students enrolled in the subject who wish to be contactable. Distance education students in the sciences and related disciplines may be required to attend residential schools. The majority of residential schools are subject based and are held in April and September and vary from 1 to 5 days, depending upon the subject. The majority of subjects have a compulsory exam component which can be sat at various Charles Sturt University examination centres around the country.

Monash University

Monash University is Australia's largest university. It was established in 1961 and now consists of five campuses in greater metropolitan Melbourne and one in the rural Gippsland. It is a diverse, multicultural centre catering to students from 70 countries, as well as Australians from non-English speaking backgrounds. International students make up approximately 13.9 per cent of the University's total student body that numbers in excess of 40,000 students.

Monash University's Distance Education Centre, located at the Gippsland campus, is a national and international provider of distance education courses. It is the

fastest growing distance and open learning centre in Australia. In 1997, 85 courses have been offered through distance education. It is also supporting an increasing number of on-campus students in flexible learning activities. Course materials are generally mailed to students and may be a combination of print, audio or video tape, computer disk or experimental kit. At this stage, electronic delivery is not common, but it is currently being researched and tested. Academic assistance is available from teaching staff by telephone, letter, facsimile or email. Of particular importance to students studying laboratory based subjects, is the possibility of optional or compulsory participation in weekend or residential schools. Residential are conducted once per semester and are typically from 3 to 7 days duration. Those subjects employing weekend schools usually run 2 per semester. The expenses incurred for such travel is payable by the student.

In order to study via distance, access to a personal computer is essential. Assignments are submitted through the Distance Education Centre by mail or fax, and examination centres are established throughout Australia and overseas. The normal study load of a distance student is two subjects per semester, which is the equivalent of half the on-campus load; hence, a qualification by distance usually takes twice as long as one taken on-campus.

Monash University is both a shareholder and a provider institution in the Open Learning Agency of Australia. The Agency, assisted by the Australian Broadcasting Corporation, is a collaboration of 29 Australian universities (n=21) and TAFE colleges (n=8), some nine of which offer students pathways to some of their certificates, diplomas and degrees. Bridging units are also available for students wishing to develop their confidence and skills prior to beginning tertiary study. The Open Learning Agency also provides access to bridging programs offered by UNILEARN, a consortium established by the University of Queensland, Central Queensland University and the Queensland Open Learning Network. The Agency has no entry requirements and no limits on places.

The Committee for the Advancement of University Teaching

This project focused on recipients of National Teaching Development Grants administered by the Committee for the Advancement of University Teaching (this function is now performed by the Committee of University Teaching and Staff Development). The Committee for the Advancement of University Teaching was established in 1992 with a mission to identify and promote good teaching, learning and assessment practice in higher education and to foster and facilitate innovation in higher education training. During the period of study, four million dollars was available annually for grants to university academic staff. The process of selection of findable projects consists firstly, of an institutional ranking and secondly, of assessment by the full Committee (Chair + 10 members); this results in recommendations to the Minister for Employment, Education and Training, who authorises payment.

Successful projects are deemed to be those that are likely to lead to significant improvements in the quality of student learning and enhance the status of teaching.

The Study Population

Distance Education Providers

Distance education staff, representative of a broad range of disciplines (see Table 1) were contacted. Of those who were not subsequently interviewed, 42 per cent responded with interest initially but did not respond to follow up, while 52 per cent did not respond at all to the initial contact. Those staff who were interviewed were from applied science (and double major combinations), medical science, health science, agriculture, chemistry, environmental science and wine science.

Table 1: Disciplines Represented by Distance Education Providers Interviewed for the Study

Discipline Area
Information technology
Food science
Paramedical studies
Equine studies
Parks, recreation and heritage
Health and human services
Ecotourism
Medical radiation science
Information studies
Nursing
Engineering
Behavioural science
Industrial mathematics
Agriculture
Medical science
Environmental science
Health science
Applied science
Wine science

Each of the courses taught in these disciplines had specific requirements for entry and exit (see Table 2) and varied in the credit packages available. Where applicable, TER scores required for entry of school leavers have been collected for the past four years (see Tables 3a and 3b).

Table 2: Course Requirements for the Disciplines Interviewed for this Study

Discipline Area	Mode	Duration	Entry	Pre-requisites	Credit	Course Requirements
BAppSci Agriculture	On-campus distance	f/t 3yrs 6s p/t 6yrs 12s	TER mature-age applications ranked	*2U maths *2U chemistry **advised** for HSC	TAFE/Uni. *Advanced Certificate *Associate Diploma	* 26 subjects (192 subject points) * ndustrial experience (farms and agriculture industry) in student vacations * Compulsory excursions * Residential schools (some optional)
BAppSci Analytical Chemistry	on-campus distance	f/t 3yrs 6s p/t 6yrs 12s	TER mature-age applications ranked	*2U maths *2U chemistry **advised** for HSC	TAFE *Associate Diploma in Applied Science (Chemical Technology)	*25 subjects (200 subject points) *6 weeks industry experience *residential schools (compulsory) *CSU Bridging Chemistry (fee paying; Dec-Jan)
BAppSci Medical Laboratory Science	on-campus distance	f/t 3yrs 6s p/t 6yrs 12s	TER mature-age, must in pathology lab. employment applications ranked	*2U maths *2U chemistry **advised** for HSC	NSW TAFE *Pathology Technicians Certificate *Assoc. Dipl. Health Sci. (Path. Tech.) *Adv. Cert. in Biomedical Techniques *Assoc. Dipl. Appl. Sci. (Biol. Tech.) *Dipl. Health Sci. (Path. Tech.) *Dipl. Appl. Sci. (Biol. Tech.) *negotiate with out of state qual. holders	*24 subjects (192 subject points) *residential schools (compulsory) *on-campus students—6 week clinical experience in approved laboratory *CSU Bridging Chemistry (fee paying; Dec-Jan)
BAppSci Medical and Applied Biotechnol.	on-campus distance	f/t 3yrs 6s p/t 6yrs 12s	TER mature-age applications ranked	*2U maths *2U chemistry **advised** for HSC	NSW TAFE *Pathology Technicians Certificate *Pathology Technicians Higher Cert. *Assoc. Dipl. Health Sci. (Path. Tech.) *Adv. Cert. in Biomedical Techniques *Assoc. Dipl. Appl. Sci. (Biol. Tech.) *Dipl. Health Sci. (Path. Tech.) *Dipl. Appl. Sci. (Biol. Tech.) *negotiate with out of state qual. holders	*24 subjects (192 subject points) *6 week professional training (2X3 weeks) preferably. in last 20mths of course—private companies; research institutes; utilities. Must be approved prior to commencement

Discipline Area	Mode	Duration	Entry	Pre-requisites	Credit	Course Requirements
BAppSci Environmental Science	on-campus distance	f/t 3yrs 6s p/t 6yrs 12s	TER mature-age applications ranked	*2U maths or *2U chem.+biol. or 4U science **advised** for HSC	NSW TAFE *Diploma of Chemical Technology	*24 subjects (192 subjects points) *residential schools (compulsory) *CSU Bridging Chemistry
BAppSci Wine Science	mixed distance	f/t 2yrs 4s p/t 2yrs 4s p/t 6yrs 12s	No school leavers intake mature-age		None	*192 subject points *compulsory excursions (2X7 days) *winery experience—CSU traineeship for on-campus students; distance students complete while working in industry
BHlthSci. Leisure and Health	distance	p/t 6yrs	general admission		negotiated for prior experience in industry	*24 subjects (192 subject points) ***no** residential schools *may exit early—session 8 (4yrs)—Assoc. Dipl. Hlth Sci.
BHlthSci. Gerontology	distance	p/t 3yrs 6s p/t 4yrs 8s	**level A**: 1. relevant Ass. Diploma &/or 2. Diploma or Degree from tertiary institution +minimum 2yrs experience in gerontology **Level B:** 1. relevant TAFE Adv. Certificate &/or 2. Registered nurse + minimum 2 yrs experience in gerontology			*Level A—12 subjects (196 subject points) *Level B—16 subjects (128 subject points) ***no** fieldwork or clinical experience
BAppSci	on-campus; distance	f/t 3yrs p/t 6yrs	TER mature age	Preparatory study—physical science and mathematics		*144 credit points *residential schools for laboratory based subjects *Access to personal computer
BAppSci/BBus	on-campus; distance	f/t 4yrs p/t 8yrs	TER mature age	Preparatory study—physical science and mathematics		*192 credit points *residential schools for laboratory based subjects *Access to personal computer

Table 3a: The TER Scores for Various Courses at Charles Sturt University from 1992 until 1996

Degree	Course Description	Campus	1993	1994	1995	1996
B.App.Sci	Medical Laboratory Science	Wagga	74.80	53.55	53.80	54.00
	Medical & Applied Biotechnology	Wagga	71.55	50.00	54.60	54.35
	Analytical Chemistry	Wagga	70.15	52.15	56.50	55.00
	Environmental Science	Wagga	64.406	52.455	52.00	54.00
		Bathurst	0.60	0.00	—	—
	Agriculture	Wagga	51.45	51.05	52.00	55.05
	Wine Science	Wagga	77.90	50.00	nc	nc

Table 3b: The TES or TER Scores for Various Courses at Monash University from 1993 until 1996

Course Description	Campus	1993	1994	1995	1996
Appl.Sci./Business	Gippsland	120	120	81.75	73.30
Biol., Chem., Phys.	Gippsland	101	97	I	45.15

Note: The 'I' indicates that offers were made to all or the majority of applicants and that TER (or TES) was not the sole determinant.

National Teaching Development Grants Recipients

National Teaching Development Grants recipients contacted were from all the science disciplines—biological, physical, chemical, mathematical and earth sciences—as well as agriculture, engineering and processing technology and the health sciences. Of those approached, 34 per cent did not respond at all to the initial contact, whilst 13 per cent refused to be involved for reasons which included lack of time, inability due to study leave constraints and directives from their institution, as well as the perception that their answers would not be relevant to the study. Twenty-one per cent of those contacted were initially interested in participating in the survey but did not continue with their assistance for whatever reason, and finally 32 per cent were interviewed. Those interviewed represented all disciplines originally approached and their projects were equally diverse in nature (see Table 4).

Table 4: Characteristics of the Projects Undertaken by the National Teaching Development Grants Interviewed

Science Area	Key Aspects
General	Collaborative learning; Problem solving; Workplace related;
Biology	Support for distance education; Video supported practical classes; interactive CAL;
Chemistry	Vertical teaching in laboratory; Problem-solving; Metacognitive development;
Chemistry	Distance learning; computer-based teaching/assessment; Staff development;
Physics	Student diversity recognised; Science study skills; Problem solving, Error analysis;
Human Biology	Multimedia; Open-learning; Self-directed learning;
Engineering	Learning through laboratory work; Communication/organisation skill development;
Science	Self-assessment software; Email; Remedial; Misconceptions challenged;
Agronomy	CAL—case studies, field simulation; Problem solving/decision making;
Environmental Science	Group work; Interdisciplinary; Individual differences recognised; Prior learning;
Anatomy	Peer learning/mentoring;; Cross disciplinary; Confidence building; Deep learning;
Thermal Physics	Resource kit—diagnostic Q/demonstrations; Large classes; Concept development;
Immunology	Student centred; Collaborative learning; Board game; Non-threatening envt;
Materials Engineering	Computer simulation; Small groups; Decision making; Workplace practice;
Paediatric Dentistry	Multimedia package—clinical case studies, definitive diagnosis; Problem-based learning;
Biology	Video group learning; Laboratory skills development;
Biology	Interactive computer tutorials; Student weaknesses addressed; Q & A sequence;
Motor Control and Learning	Student choice—learning preference; Lectures/small group/CBL/self-directed learning;
Maths	Support system; Computing and communication techniques;
Biochem.	Laboratory procedures targeted; Self-paced;
Engineering	Distance learning; Computer-based; Theory applied to practical situations
Biology/Ecol.	Skills devt; Computer simulation—animal experimentation; Animal ethics issues;
Organic Chemistry	Video; Microscale technology; Prac. work preparation—experimental techniques;
Agric./Resource Management	CAL—multimedia; Interpretation of practical experience; Self-directed/paced learning; Experiential learning;
Engineering	Mixed mode teaching; cbl tutorials, printed teaching material, computer managed assessment;
Information Science	Computer information systems; Game environment; Development of Technical, behavioural, communication and organisation skills; Learning integration

The Students

Only a small number of distance delivery students responded to the questionnaire—nine from Charles Sturt and none from Monash University at the time of submission of this report.

A total of 41 students who had experienced an innovative teaching strategy supported by a National Teaching Development Grant, responded to the survey questions. These students were from varying years of degrees such as Engineering, Science (Agronomy, Chemistry, Immunology, Physics, Ecology/Physiology) and Nursing (Anatomy). Their ages ranged from 18 to 47, with the mean age being 23.13 years of age. Sixty-one per cent of respondents were males whose average age was 20.32 years; of the remaining female respondents, the average age was 27.19 years.

2

Literature Review

Open Learning and Distance Education

In Australia and overseas, the term ‘open learning’ is often confused, and used synonymously, with the term ‘distance education’. This may, in part, be due to the fact that in Australia, there is a long and established tradition of distance learning, though the *philosophy* of open learning is a much less familiar and less well understood concept. Throughout our report, we recognise open learning to be ‘ .... both a process which focuses on access to educational opportunities and a philosophy which makes learning more client and student centred’ (Paine 1989). This means that not only is access to education made more equitable, providing everyone with the opportunity to start on the path to a qualification via higher education, but also that the learning experience itself is more flexible. Flexibility provided in the mode of learning and attendance, the resources that are made available, the pace of learning, the interaction between learners and between learner and teacher, learner support and the methods of assessment. For our research purposes, we have used the umbrella term ‘open learning’ to include the work of educators who have been innovative in one or more of these potential areas of flexibility.

The term ‘open learning’ was first used in Australia in 1973 (Walker and Walker 1994), in relation to a Western Australian project whose goal was to devise an educational system which ‘caters for individual student needs, which is not simply a substitute for the existing system and in which the acquisition of formal qualifications is not a major purpose (and) provides flexible programs to meet changing technological, economic and human situations’ (Lonsdale 1973). Now the term is well known in the general community, thanks to various resource providers such as Open Learning Australia. However, there is still confusion as to the precise definitions of open learning and distance education, particularly with respect to the interrelations between them. As Holmberg (1989a) asserts, in itself the term ‘open’ ‘ .... has nothing to do with “distance education” since if openness relates to place, time, content of learning, some distance teaching organisations should be considered as closed’ (Guri-Rosenblit 1993: 88). However, distance education is encompassed by the term ‘open learning’ in that the learner does have some control over the time, place and to some extent, pace at which learning takes place, and hence the inclusion of such teaching institutions and their educators in this research.

What is Distance Education?

The term distance education is a relatively new one, and the origin of its common usage obscure; whatever its origins, the term was officially adopted at the 1982

Conference of the International Council on Correspondence Education, resulting in the name of the subsequent conference being changed to the International Council on Distance Education (Module 1, Graduate Diploma in Distance Education). In this report we use the term distance education to describe the circumstance whereby there is no regular face-to-face contact between teacher and learner. The student receives learning resources and benefit from the planning, guidance and tuition of a tertiary teaching institution enabling him/her to obtain an award at that institution without the need to attend classes (Holmberg 1989b). Communication between the teacher and learner is traditionally facilitated by print, but more and more this is becoming enhanced by electronic technology. The various ways in which such non-contiguous teaching is achieved characterise the differences between the institutions that provide distance education. This process of instruction, however, does not preclude the necessity for occasional compulsory attendance at residential schools held at that tertiary institution. In fact, such residential schools are considered essential for the successful completion of most laboratory based disciplines.

> The science that is needed by an advanced industrial society cannot be learned by watching mother, sitting next to Nelly, watching 'Tomorrow's World' or 'Horizon' on the TV, reading the newspapers, poring over 'teach yourself' books in the evenings, or even by apprenticeship to a practical craft. Our technological civilisation .... would slowly collapse if tens or hundreds of thousands of people were not spending some of the formative years of their lives learning science systematically from professional teachers.
>
> (Ziman 1986)

During the last 30 years, there has been tremendous growth in the number of distance education providers throughout the world. The system each institution adopts depends, to a large extent, upon whether they believe distance education is as a mode of education in its own right or simply a substitute for conventional face-to-face education. Those with the latter view tend to treat students as if they are members of a class, albeit a dispersed one; there is an insistence on supplementary face-to-face classes and prescribed pacing (Holmberg 1989b). The same restrictions are then placed on distance study as are placed on contiguous study—classes of limited size, pacing, division of the year into terms of study, regular meetings, prescribed examination dates, vacations, etc. The former view—distance education as a mode of education in its own right—results in an institution that tries to accommodate individual students (not classes), as well as developing courses for large target groups. The learning experience is adaptable, as required by students distributed geographically and constrained to periods and length of the study that are acceptable or possible. The individual student decides on goals, he or she is responsible for pacing the length of study. Both approaches occur in distance learning institutions throughout the world, and are successful, as are variations that partly resemble either or both of them.

Distance education is in a constant state of evolution, inundated by a stream of new ideas and technologies balanced against widespread resistance to change

(Jeffries 1995). Traditionally distance education has been held up for comparison with the more common route to learning—'contiguous' (Moore 1972) or 'face-to-face' (Keegan 1980) learning. Such comparisons imply a superiority of traditional education over distance education, with the off-campus student seen as being disadvantaged. As a consequence, distance educators have mainly focused their efforts on minimising the disadvantages considered inherent in this mode of delivery—spatial and temporal distance. However, there is also a measure of distance in face-to-face teaching, communicative distance between the teacher and the learner, which includes differences in values, maturity, beliefs, intelligence, cognitive processing, personality and emotional states (Bagnall 1988). Perhaps an educational event cannot be without it own distance unless it is a learning experience that is fully self-directed by the learner. Distance education is able to breach geographical and temporal barriers and, as a result of allowing the learner to take more responsibility for his or her own learning, it can surmount some of the psychological ones as well.

In many developing countries, there is widespread use of distance education, as a result of political democratisation. It is seen as the most cost-effective way to expand educational opportunities to all sections of society. Many countries in Asia, Africa and Latin America face the problem of shortage of schools, insufficient provision for the training of teachers, administrators and professionals and the lack of appropriate textbooks, instructional material and laboratory facilities (Wijeyesekera 1990). Millions of people are in the position of wanting to further their education whilst remaining in their present employment, an impossibility within the conventional system.

Throughout the last 20 years, distance education has gained in respect and credibility. The quality of teaching and learning in this mode is widely recognised, as is its potential for generating interest in educational, commercial and political circles (Turnbull 1988). One of the primary strengths of distance education is its student-centred approach to learning.

Distance Education—The Student

No longer is distance learning based purely upon the duplication and distribution of lecture notes in print form. Programs and study materials are now, in the main, developed by teams of professionals—subject experts and instructional designers as well as educational and technical experts. The students, who are recipients of such materials, have also changed. In the developed world, they are now more sophisticated, having access to far more resources. Many now *choose* to learn via distance rather than are *compelled* to do so. There is a far greater variation in the ages, gender and social background of distance education students in the 1990's (Foks 1988). Types of distance education students now encompass learners from widely varied backgrounds (Wijeyesekera 1990) who:

- are generally older, are voluntarily seeking further education and are highly motivated and self-disciplined (Willis 1995a);

- may be intelligent adults who slipped through the net of formal education, often with a thirst for knowledge, or for which a salary increase is dependent upon them upgrading their skills;
- may be adults interested in reskilling or considering a career change,
- are possibly disenchanted learners who are dissatisfied with the traditional system of education;
- individuals who may have been excluded from conventional institutions due to resource constraints;
- are increasingly female, who are interested in changing their role in society; they may be seeking education once their children are grown, or resuming an interrupted career; and
- are adults, young and old, in developing countries.

Whatever their background, students are now more often regarded as consumers of educational services and the educational authorities are recognising the importance of marketing their products and services. Students are in a better position to direct and control their own learning and to demand personalised educational services designed to meet their unique needs. Learner support strategies have emerged, in which tutors regularly engage in two way communication with their students providing meaningful feedback and encouragement throughout the learning process. No longer is the individual student expected to cope with correspondence materials in isolation, he or she can choose how much or how little contact is made with the institution.

Distance Education—The Technology

The painstakingly slow dialogue via the print medium is being enhanced and in some cases superseded by interaction via telephone, computers, audio and video recordings and conferencing as well as radio and television broadcasting. The technologies now available to the distance learner and the educational institution (Willis 1995b) are:

- voice telephone, audio-conferencing, short-wave radio (interactive); audiotapes, radio (passive);
- video slides, film, videotape, audio- and video-conferencing;
- data-computer assisted instruction (CAI) whereby the computer is a self-contained teaching machine to present individual lessons;
- computer managed instruction (CMI) whereby the computer organises instruction, tracks student records and progress; the instruction, however, need not be delivered via computer;
- computer mediated education (CME) computer applications are used that facilitate the delivery of instruction (e.g. email, fax, computer conferencing, world wide web); and
- print foundation element of distance education programs—text, study guides, workbooks, course syllabi, case studies.

Recent developments in technology are removing some of the disadvantages associated with media in distance education (Jeffries 1995). Although technology plays a key role in the distance education delivery mode, it is the instructional outcome that is the focus, not the technology of delivery. ‘Learning seems to be affected more by what is delivered than by the delivery medium’ (Schramm 1977: 273). Distance education students, once considered disadvantaged, are now being educated via a system based on sound pedagogical principles, a system with the potential to lead the way in advancing education. Increasingly, due to the rapid development of information technologies, the distinction between traditional and distance education are becoming blurred, resources nominally developed for use in one mode are being successfully adopted in the other.

Distance Education—The Possibilities

Recent research into distance learning, both at school and tertiary levels, have found that the class performance of off-campus and on-campus learners is comparable, with the former often out performing the latter (Muth 1995). Such findings are particularly true when the method and technologies used are appropriate to the instructional tasks (Beare 1989; McCleary & Egan 1989), when there is some form of student-to-student interaction, and when there is timely feedback to the students about their progress (Moore & Thompson 1990; Verduin & Clark 1991). Distance educators often comment that the focused preparation required in their teaching, improves their overall teaching and empathy for their students. (Willis 1995c). Faculties who are beginning to incorporate distance teaching into their courses, face many challenges and the success of such enterprise ‘requires changes in the practices and attitudes of faculty in an environment that is still suspicious of, or threatened by the nontraditional. Only the system which effectively rewards it will succeed at change’ (Dillon 1989: 42). Distance education is more learner-centred, requiring teachers to ‘acquire new skills to assume expanded roles, not only to teach distance learners, but also to organise instructional resources suitable in content and format for independent study’ (Beaudoin 1990: 21). Distance education has contributed to the improvement of academic teaching and has the potential to continue to do so (Guri-Rozenblit 1988) by:

- improving the quality of university level textbooks as a result of the strict quality control inherent in the design and development of self-study materials for distance learning courses;
- enhancing independent study, as distance students because of their separation from the teacher, are close to the ideal of the autonomous learner;
- improving the pedagogy of university teaching by addressing the difficult questions that underpin quality in higher learning;
- promoting interdisciplinary courses due to the academic teamwork involved in developing quality self-study materials;
- contributing to inter-university collaboration by cooperation in the preparation of teaching curricula;

- advancing the integration of multimedia to the learning and teaching systems of the universities as such facilities and programs lend themselves so well to overcoming the distances of space and time. The results of experimentation, with such strategies in the distance mode, are gradually penetrating the more conventional campuses; and
- promoting research on adult learning as distance education students are often older than their traditional counterparts, providing an environment suitable for the investigation of various components of adult learning and contributing to a better understanding of variables affecting students' learning.

Not only do the educators involved in distance teaching have the opportunity to be at the forefront of advances in education, the student also stands to benefit. Students engaged in learning via distance, have the potential to develop skills that enable them to become successful learners throughout their lives, in whatever context they find themselves with respect to lifelong learners.

Lifelong Learning—the Expectation of the Future

Why Lifelong Learning?

The term 'lifelong learning' includes all formal and informal learning, whether intentional or not, which occurs at any time across the individual's lifespan (Candy 1995). The concept of lifelong learning was first proposed in 1972 by UNESCO, recognising ' .... lifelong education as involving a fundamental transformation of society, so that the whole of society becomes a learning resource for each individual' (Cropley 1979). At that time, it was widely condemned (Hager 1995) but it has since become the catch cry of the 1990s in Australia, initiated by the Aulich Report (1990: 3) in which it was stated that:

> Australia is producing graduates who all too frequently are not familiar in any disciplined sense with the society in which they are going to practise their chosen profession, who are not critical, analytical and creative thinkers, whose education does not provide the basis for adequate flexibility, who are not sufficiently attuned to the need for lifelong learning and who are not good communicators. In short we are producing highly trained technicians who are under-educated in the broader sense of the term.

A commissioned report of the Higher Education Council (1992: 20) supported this claim:

> It is broadly agreed that if higher education is to enable graduates to operate effectively in a range of activities over a period of time, a lifetime in effect and not just immediately after the studies are completed, then it must develop the characteristics that support learning throughout life. Discipline specific skills in many areas have only a short life, and what will be needed in even the medium-term cannot be predicted with any great precision.

In fact there is a world-wide trend towards the adoption of a policy of lifelong learning in the 21st Century as indicated by the 'World Initiative on Lifelong Learning' published in 1995.

Candy (1995), in his keynote address to the Fourth Annual Teaching Learning Forum at Edith Cowan University, highlighted six factors which he believes have brought the notion of lifelong learning to the forefront of educational policy:

- the continuing shift to an information society—the amount and complexity of information has increased as has the sophistication with which it is stored, accessed and transmitted;
- the competing influences of specialisation and generalisation within professional careers;
- increasing internationalisation of the marketplace—global perspective of the workplace;
- the explosion of knowledge and technology—resulting in an individual's preparation for an occupation being obsolete soon after its completion;
- microeconomic reform and the changing workplace; and
- the emergence of new occupations and careers—resulting in an individual having multiple careers in his or her working lifetime.

Moreover, recent research into workplace learning indicates that university graduates are not prepared to be proficient practitioners in the workplace (Hager 1995). More and more, society is demanding that graduates stay up-to-date with the changes taking place in the workplace, formal education becomes the beginning of a lifetime of learning, not its finale.

By definition, lifelong learning encompasses all learning from the moment of birth until we die, however, for the purpose of this report, we will be referring to the learning which takes place post-compulsory education, and even post-formal. Such learning can fall into a number of categories (Candy 1995), which include workplace-based learning, continuing professional education (offered by a professional association), further formal study and self-directed learning. An individual will not necessarily be successful in any of these learning contexts without the proper skills, characteristics or inclination of mind, these he or she

must learn. Candy et al. (1994) have developed a portrait of the ideal lifelong learner, an individual who has:

- an inquiring mind—is curious and dogged in his/her approach to learning;
- 'helicopter vision'—a breadth of vision, an understanding of the connectivity of knowledge;
- information literacy—knows what questions to ask, where to go and what to do, to find the answer
- a sense of personal agency—has a positive sense of him/herself as a capable and autonomous learner, is organised and can manage his/her learning; and
- a repertoire of learning skills—understanding of what it means to learn, and how he/she learns best.

It is the role of educators, at all levels of formal learning, to help individuals develop the skills and motivation necessary to learn throughout their lifetime and survive in the workplace of the 21st century. As Gooler (1990: 321) stated ' .... individuals may need to engage in a lifetime of learning not as a matter of choice but as a matter of survival'.

In Australia, most undergraduate degrees encompass a vast amount of disciplinary content. Content forms the heart of the degree, with generic and transferrable skills, and any contextualisation of the learning, taking second place (Candy et al. 1994). In response to the information and technology explosion, many science-based undergraduate courses have elected to squeeze even more content into the undergraduate degree, further undermining the breadth of such education. Generic skills, which include learning-to-learn and the ability to continue learning, even in unfamiliar circumstances, are seen as supplementary to the 'real' learning of technical knowledge.

Undergraduate Science Education

The major goals of science education (Hodson 1996) are to enable students to:

- acquire/develop the conceptual and theoretical knowledge of science;
- develop an understanding of the nature and methods of science, which involves a principled process of inquiry and the complex interactions amongst science, technology, society and the environment; and
- engage in and develop expertise in scientific inquiry and problem solving.

Tertiary science education has remained primarily didactic, relying on lecture delivery, demonstration, textbook reading and memorisation (Bezzi 1996). Such methods of instruction have been shown to be inadequate in developing conceptual understanding or motivation (Bishop & Anderson 1990; Hewson & Hewson 1988), nor do they provide opportunities for the students to engage in objective, intellectually open-ended investigations.

Modern Educational Theory and the Way We Learn

Approaches to Learning

Modern educational research indicates that students adopt different approaches to their learning depending upon their prior experiences of studying, and the content, context and demands of the learning task (Richardson et al. 1987). Students may adopt either surface, deep or achieving approaches to learning, the main features of which are summarised in Table 1 (Biggs 1987).

Table 1: Features of the Three Approaches to Learning, as Defined by Biggs (1987) and Entwistle (1987) and Adapted by Richardson (1994: 73)

Learning Approach	Defining Features
Deep Approach	Intention to understand; vigorous interaction with content; relate new ideas to previous knowledge; relate concepts to everyday experience; relate evidence to conclusions; examine the logic of the argument.
Surface Approach	Intention to complete task requirements; memorise information needed for assessments; failure to distinguish principles from examples; treat task as an external imposition; focus on discrete elements without integration; lack of reflectiveness about purpose or strategies.
Achieving/Strategic Approach	Intention to obtain highest possible grades; organise time and distribute effort to greatest effect; ensure conditions and materials for studying are appropriate; use previous exam papers to predict questions; be alert to cues about marking schemes.

Surface approaches are typified by the students focussing on the content and processes they are studying, as isolated facts and not concepts or relationships (Tang 1994). Their motivation is extrinsic, they are carrying out the task for some kind of external reward. Students who adopt a deep approach are interested in understanding what is being learned, their motivation is intrinsic and based upon a ‘need to know’. Relationships are gleaned between different aspects of the information, as well as between the new information and previous learning and/or personal experience (Tang 1994). The third approach, the achieving or strategic approach, is adopted by those whose motivation is to gain high grades. Such students may use either deep or surface approaches; getting high grades as a result of rote-learning (surface-achieving) or getting such grades through understanding the meaning of the content (deep-achieving) (Tang 1994).

The conception of learning, that an individual maintains, determines how (what approach is adopted) and what is learned (Biggs & Telfer 1987). Gibbs (1992) developed a scheme which identifies five levels of conception of what learning is, as understood by the learner:

1. *learning as an additive product*—passive reception and accumulation of knowledge;
2. *learning as memorising and recalling*—knowledge acquired but not transformed;
3. *learning as acquiring facts, procedures or formula*—enables repetition at a later date;
4. *learning as making sense*; and
5. *learning as understanding reality*.

Only students in the latter two levels, of conception of what learning is, are able to perceive the demands of the learning task and can use either deep or surface approaches, depending upon which is most appropriate (Berman Brown 1994). The connection between an individual's conception of learning and the approach he/she takes to a learning task is very strong, and can be used to predict the quality of the learning outcome (Gibbs 1992).

The ideal course is so designed to counter the circumstances where surface learning applies, for example memorisation is not required or, most importantly, not examined (McCartney & Berman Brown 1994). Where rote learning strategies are appropriate, the underlying reasoning for such a requirement, must be made explicit. 'It is necessary to rote learn scientific formulae, as part of learning to think like a scientist; the mistake is to conclude that that is the way scientists think' (Biggs & Telfer 1987). A deep approach to learning produces outcomes that are structurally complex (Biggs 1979; Watkins 1983) whereas a surface approach is useful for recall of unrelated detail. Students studying science have recourse to use both approaches, however in order to really understand the complex nature of science and to work productively as a scientist, a deep approach has to be fostered. Biggs (1989) identified features that encourage a deep approach to learning and those that are associated with a surface approach (Table 2).

Table 2: Features that are Associated with Encouraging Students to Adopt Surface or Deep Learning Approaches (Biggs 1989)

Learning Approach	Associated Features
Deep Learning	• motivational context—internal, rather than external, a 'need to know'; students involved in the selection and planning of what is learnt; • active learning—understanding comes from doing, being active and not passive; • interaction with others—discussion/reflection, negotiating meaning; • a well-structured knowledge base—new knowledge related to existing knowledge/experience;
Surface Learning	• heavy workload—no time for reflection and discussion • high levels of contact time—no time for discussion of learning • excessive amounts of course material—contributes to workload, decreases the students' chances to relate meaningfully to the components of their learning • lack of opportunity to study subjects in depth • lack of choice in what is studied, and how—poor motivation threatening or anxiety-provoking assessment methods

Both these sets of features need to be considered when appraising the worth of any course content and subsequent designing new courses.

The Constructivist Theory of Learning

Constructivism has roots in philosophy, psychology, sociology and education, it is not a theory of teaching but one of learning and understanding. Its basic tenet is that human learning is *constructed* by the individual in order that he or she may better function in the world. Learners build on prior learning when they seek to understand or solve a problem, and play an active role in the construction of this new knowledge (Piaget 1983; von Glasersfeld 1989). Constructivist views of learning and instruction challenge the wisdom of traditional teaching practice, based upon behaviourist principles in which learning is seen as the passive transmission of knowledge from one individual to another in order that 'competence' is attained (Mestre 1994). For pedagogic purposes, this means that students need to be actively, purposefully and energetically engaged in the process of learning, in order that meaningful learning takes place. An individual's prior knowledge must be made explicit throughout the learning experience, and used as a springboard for future learning. Such construction of knowledge takes time, the

learner needs time to negotiate his or her understanding by interacting with other learners, to revisit the knowledge from a number of contextual viewpoints and time to reflect upon what has been learnt and what strategies were used to do so.

If adopted as a foundation for teaching, teachers are no longer instructors but facilitators who provide students with opportunities (Brooks & Brooks 1993) whereby:

- individuals can confront their own understanding and test its viability in new situations;
- student autonomy is encouraged, within the guidelines of the learning goals, enabling learners to establish objectives that reflect their own interests and needs;
- social discourse is encouraged to allow students to reflect on their own ideas, change them if need be, or simply to reinforce their existing understanding, through discussion and debate;
- they can make predictions and generate varying hypotheses, continuing on to test them via concrete experiences and discussion with others;
- learning is related to the 'real world' with students using raw data, primary sources and concrete materials wherever possible, and
- time is available for reflection about the new experiences and how they relate to existing understanding.

Constructivist pedagogy is becoming widely accepted throughout the disciplines, it has the potential to reform education, but if nothing else, its most important contribution to learning may lie in its student-centredness.

Understanding Science—Dealing with Misconceptions

Science students come to class with their own, personally constructed preconceptions, (Di Sessa 1988; Driver 1990), which are 'beliefs about the meaning and application of concepts within scientific settings' (Mestre 1994). Such preconceptions may interfere with their accepting scientific explanations (Champagne et al. 1982; Anderson and Roth 1989) when preconceptions are in conflict with scientific concepts, they are called misconceptions. Such misconceptions (alternative conceptions or naive theories) are often resistant to change (Ausubel 1968) even after formal instruction (Clement 1982; Halloun & Hestenes 1985). They often resurface some weeks after the student has initially displayed an understanding of the scientifically accepted view. Students develop their understanding during the years prior to formal learning, and up until that time, such understanding has proved useful in dealing with everyday phenomena, consequently students are loathe to give up their beliefs (Mestre 1994). Moreover, each student possesses a unique cognitive framework that constrains what and how information will be stored (Driver et al. 1985; Osborne & Freyberg 1985).

Traditional transmission teaching does not take this framework into account, and a learner passive environment does not challenge any alternative conceptions that the individual maintains and hence they may continue to interfere with the individual's future learning. The challenge for science educators is to provide learning experiences that promote understanding, given that much of their scientific knowledge is often incomplete and/or inaccurate.

Learning Science—the Tradition

As in many other disciplines, the traditional approach in science is transmission teaching, via lecture, tutorial and practical/laboratory sessions. This approach to undergraduate science education satisfies few of the requirements of a constructivist environment as recommended by contemporary educational theorists.

The Lecture and Tutorial

Lectures whereby ' .... teaching strategies are predominantly a process of instruction, which are reinforced by memorising and testing to ensure that the teachers' messages are received by students just as they were sent...' (Cosgrove 1995) are very common. In this 'conduit' model of lecture interaction (Cottle & Hart 1996), the lecturer assumes the role of information 'sender' while the student is the 'receiver' (Roth & Roychoudhury 1994), passively transcribing information. Tutorials, if offered, involve students individually working on assignments, only participating actively when they have a question to ask the tutor (Cottle & Hart 1996). Tutorial class sizes have been increasing gradually over the years, now containing as many as 30 students per tutor. There is usually little open and relaxed discussion or debate about any of the concepts introduced in lectures, there being little time for that, and often students only ask questions if they are 'stuck'.

The Laboratory

Laboratory sessions are an integral part of 'doing' science at university. The motivation behind their inclusion can be summarised in five categories (Hodson 1995):

1. to motivate, by stimulating interest and enjoyment;
2. to teach laboratory skills;
3. to enhance the learning of scientific knowledge;
4. to give insight into scientific method and to develop expertise in using it; and
5. to develop certain 'scientific attitudes' such as open-mindedness, objectivity and willingness to suspend judgement.

For the most part, undergraduate laboratory classes are designed to verify known phenomena, rather than to explore questions, make observations and formulate principles (Mestre & Lochhead 1990). During laboratory sessions, the students generally follow a recipe, the method and content do not change and the procedure's beginning, middle and end are predetermined. Such a procedure does not necessarily stimulate the interest and enjoyment of the majority students. There is nothing personal about the experience with little measure of control or independence on the part of the student.

Skills development has become an end in itself in science, rather than a prerequisite for engaging in practical work as a means to further learning (Hodson 1995). In tertiary science education, there is little research with regard to enhancing the learning of scientific knowledge (Boud et al. 1986; Hegarty-Hazel 1990), and what there is, is not necessarily focussed on concept development. However, when you consider what happens in the laboratory, where large numbers of students, only a small number of whom may have read the lab manual (Gunstone et al. 1996), are often assigned to groups without any consideration of group learning theories, and often lacking any synchronisation between the lectures and practical work, you have to question the likelihood of conceptual development. Moreira (1980) found that the students performing practical work often have only a basic understanding of what they are doing and why it is being performed, in that particular way, at all. Some students may go through the whole practical, misunderstanding its purpose and misinterpreting their results, effectively compounding their preconceptions (Hodson 1996). In fact, Gunstone et al. (1996) found that one of the greatest problems with learning in laboratories is the students' lack of understanding of the concepts underpinning the laboratory, when they arrive at the bench. 'What one already understands is a substantial determinant of what one might learn by undertaking an experiment' (Gunstone et al. 1994: 18).

Recipe-style practical work does not give insight into scientific method or attitudes, in fact such practical work carried out by the individual, or groups of individuals, can serve to distort their understanding of scientific methods (Klopfer 1990). There is the implication, throughout such recipe-style activities, that there is only one appropriate method, hence the term 'experiment' is not really appropriate. 'The idea of authentic scientific inquiry is replaced by the dictum to follow the rules and learn the required material' (Schank & Cleary 1994).

Assessment—the Hidden Curriculum

The impact of assessment on student learning is often underestimated, in fact it forms part of the powerful hidden curriculum of education. The assessment tools adopted by the lecturer give messages to the student about what type of learning will enable him/her to pass the subject. The student may pay more attention to the assessment demands than to the learning task being undertaken (Gibbs 1995a). In addition, assessment methods generally focus on the recall of routine factual knowledge rather than problem solving and critical analysis (Resnick & Resnick 1992).

Science Education—the Potential for Change

Recent studies have shown that such methods of instruction and assessment are inadequate in developing conceptual understanding or motivation (Bishop & Anderson 1990), and do not provide opportunities for the students to engage in objective, intellectually open-ended investigations, which lie at the very heart of science practise. Furthermore, such pedagogical practice does not result in students developing deep thinking skills, critical analysis, cooperative behaviour or communication skills, essential in an employable science graduate (Business/Higher Education Round Table 1992; National Board of Employment, Education and Training 1992).

Conventional teaching and learning methods were developed in the days when there were far fewer students and these students were of a more homogenous nature. Smaller class sizes were possible and there was adequate contact time with tutors. Funding cutbacks, and larger intakes of students, have put an end to such luxuries. Moreover, in recent years, graduate recruiters, in the United Kingdom and Australia, have expressed disappointment at the quality of university graduates, in particular in their lack of communication and teamwork skills, as well as their lack of experience in working cooperatively (Gibbs 1995). The experience of higher education is very different from modern working life, as it is usually tackled alone and in competition, and hence is not adequate in preparing students for their future lives. We must also prepare students for learning from resources, as the rate of expansion of knowledge and the change in the professions necessitates the development of more extensive information gathering skills (Exley and Gibbs 1994). Students must be equipped with skills that enable them to be independent lifelong learners in order to cope with a marketplace, that is constantly changing. A more flexible, student-centred approach to learning must be developed in undergraduate science, not just in the students' final year(s) but from the moment they enrol.

The Student Body

Who are the students embarking on careers in science? Many are straight from school, having just completed a gruelling year focussed on gaining entrance to tertiary institutions. They are used to 'covering' the syllabus, rather than developing skills in identifying and using information sources. Many have succeeded in school as a result of learning what the rules are and slavishly following them (Schank & Cleary 1994). Such students are used to the lectures and practicals, these helped pace them in their work, enabling them all to 'keep up'. In fact, their school experience is similar to that found in the traditional university, but with less individual responsibility and independence. As a result of their final year experience, and perhaps their whole experience of schooling, the majority of students will arrive at university with a 'conduit' model of lecture interaction. Their expectations and conceptions of learning will commonly feature the teacher being 'active' and the student 'passive', and many will have learnt to regard the lecture as the only valid vehicle for learning (Exley & Gibbs 1994). Students may ' .... leave school completely dependent upon being continuously

instructed and are unable to continue learning in the absence of organised teaching' (Bezzi 1996).

Their first experience of student-centred learning will be difficult and frightening. In fact, unless convinced of the effectiveness of any novel teaching approach, they may be resentful and unwilling to become involved (Moss 1994). If the education strategies they are used to are removed and not replaced with techniques that maintain their pacing and motivation, enable the sorting out of problems and clarification of understanding, the student may become isolated and lose touch with the course and indeed, have good reason to be resentful. Developing independent learners does not mean they are cast adrift, support systems and skills development are an integral part of their first experience of university. Along with traditional skills of note taking, essay writing and so on, students need to be taught reading and study skills, organisational and time management skills for independent study, as well as group learning techniques. Students need to be made aware of their own conceptions of, and approaches to, learning, and be given the opportunity to compare theirs with others, and to explore the alternatives. Members of the teaching staff have to be clear about the reasons behind the teaching/learning strategies being used in their subject, students need to know what is going on and why and be allowed the opportunity to voice their opinions. The teaching staff must also be aware of their own attitudes to teaching and learning and be prepared to acquire new knowledge, skills and attitudes.

Not all traditional ways of teaching science need to be discarded immediately, or indeed at all; innovative student-centred approaches can be gradually introduced to replace old practices as, and when appropriate. When changes are made to the conventional system, it is extremely important that students be inducted into the new procedures where they are given an overview of how it works, the assessment system, why it is being introduced, educational benefits to the students and what they can do if a problem arises.

Lectures—from 'Sage on the Stage' to 'Guide on the Side'

Lectures have traditionally been the main source of information dissemination in science—why is this so? In such an environment, it is hard to concentrate for such long periods of time, there are distractions all around, it is difficult for students to ask questions or receive answers and very difficult for the lecturer to elicit answers to his/her own questions. Misconceptions generated in this way (albeit inadvertently), and any ambiguities in the material presented, remain unclarified. The whole lecture, generally 50 to 60 minutes long, is usually devoted to the presentation of new knowledge, and as there is little or no opportunity for discussion in this format, very little of the information will be assimilated. The lecture notes, viewed by most students as the sum total of knowledge to be examined, will be filed away until just before the exams when it will be 'studied'. What alternatives do we have to this didactic method of teaching? There are many, ranging from the complete disbanding of lecture driven courses, as seen in problem based learning and resource based learning approaches, to modifying the lecture

format to become more interactive, incorporating ‘buzz sessions’ and question times, and reducing the amount of content covered.

Interactive lecturing

Lectures change from being 60 minutes of lecturer talk to sessions (1 to 3 or 4 hours) of smaller segments where the lecturer talks for only some of the time and the remainder of the time, the students are active. Lecturing in short bursts is followed, or preceded by the introduction of a small learning task which involves student groups (2 to 4 students) applying principles (Jenkins 1992). Instead of spending their time copying down information, the students can be given this information in the form of a course guide and in additional handouts at the beginning, or prior to the ‘lecture’. Students obtain much of the originally ‘spoon-fed’ information, on their own, from sources made readily available to them. It is not possible to present as much information in interactive lectures as it is in conventional ones, so it is necessary to reduce the amount of factual information covered in the course, however, what is covered is done in a more meaningful manner (Jenkins 1992). There is a large array of activities that can be incorporated into lectures (Gibbs et al. 1989; Jenkins 1992), important concepts can be introduced by way of newspaper articles, video clips, journal articles, experimental demonstrations and so on. The group tasks, performed in the lecture, are linked to other learning activities carried out in the laboratory or practical sessions and during independent study. Such interactive lecturing can be introduced gradually over a period of years, as the printed support material is collected over time. As the resource is being developed, short tasks can be introduced, then discussion tasks and ultimately longer problem solving tasks (Jenkins 1992).

Resource-based Learning

Resource-based learning is the use of mainly printed materials, written, collared or signposted by tutors as a substitute for some aspects of teaching and library use (Exley and Gibbs 1994). Electronic technology is not a central feature but it can be incorporated into the resource package. The students take more responsibility for their learning, they teach themselves and each other as they interact with the resource materials and the tasks they have been set. The students can vary the time spent on topics or the order in which the topics are tackled. The lecturer is then freed from being the conveyer of information and is able to concentrate on the design of the materials, providing support and remedial help and the assessment of the students’ learning outcomes. The limited contact time available for staff and students can then be used to stimulate interest and debate and to allow problems to be solved jointly.

There is a wide array of resource materials that can be made available, from course and textbook study guides, to a set of open learning materials, lecture notes, lab guides, seminar guides and so on. A resource room can be set aside for students to use limited reading sets and have access to a learning space for discussion with others. Students are regularly assessed, allowing them to see how they are doing and enable them to make decisions about how they are working. Resource-based

learning does not have to implemented in one go, it is possible to work towards it gradually, through a series of stages, each building on the last. For a comprehensive discussion of how to implement resource-based learning in undergraduate science courses, see Exley and Gibbs (1994).

Problem-based Learning

In the United States, whole universities deliver courses using problem-based learning, and many medical and health related professions base their education programs on this method of learning. Problems can be incorporated into small or large group formats, laboratory experimentation, interactive lecturing and computer assisted independent study (Wilkerson & Feletti 1989). No longer is the course, lecture-driven, the problems themselves are the centrepoint, they raise real issues that stimulate the students' 'need to know'. Students undergo a learning process which fosters deep learning, it enables the student to take responsibility for his/her own learning and to develop independent learning skills required for lifelong learning. No longer does the student rely on the lecturer to 'cover the syllabus', rather the lecturer purposefully selects problems illustrating the important concepts to be learned and the student generate their own learning issues with guidance from the lecturer/tutor. It allows the individual time to reflect, not only on how to solve the problem, but also metacognitively.

The lecturer has a great deal of choice as to how to replace the traditional format, he/she can:

- disband lectures, freeing up time for tutorials utilising small group discussion of the problem(s);
- begin the lecture with a case discussion by the class, in which the problem may be introduced via a video clip, an article from a newspaper etc., this serves to interest the students and activate their existing knowledge base as a first step to learning new material (Wilkerson & Feletti 1989). The lecture is then based on the comments made by the students. In this way, lectures are used, not to transmit new information, but to address conceptual difficulties raised in the process of solving the problem; and
- use resource based learning (computers, audiovisual, books, journals etc.), based upon problem solving, which can replace the entire lecture program. The students take control of when, where and how they learn but still have recourse to meet with tutors on a regular basis.

A course can make use of one or all of these strategies. Though such a teaching approach was initially developed for medical education, using clinical case studies, it can be easily incorporated into the teaching strategies of all disciplines.

Project-based Learning

Project-based learning requires students to work in teams, the main goal of which is the completion of the task. Projects are now common in undergraduate science, in the form of coursework assignments and major pieces of final year work. Projects can take a variety of forms, theses and extended essays, case studies, project design and experimental or investigative work. The degree of structure can vary as can the independence of the student in accessing the resources. In its implementation to the extreme, lectures can be replaced, leaving the important concepts, formerly covered in this manner, to be discovered via the project's research. Projects can be developed in such a way that they incorporate a wide range of knowledge and skills with a small part of it allowing the students to specialise and study a topic of their own choice in depth. Students undertake small projects first building up to the larger projects, wherein they have greater choice, take a more dominant role in decision making and are required to integrate more sophisticated skills into the project task.

Such work is usually closely supervised with regular meetings between staff and student(s). As students are required to work in teams, consideration must be given to designing the task for teams (Verran 1993), setting them up (Platt 1988; Storey, 1989; Thorley & Gregory 1994), monitoring team development (Gibbs 1995b), how the product and process will be assessed (Falchikov 1988; Gibbs 1995a) and how the outcomes are to be reported (Gibbs 1995a). This requires a large investment of time on the part of the lecturer/tutor, but once the initial energy is expended in putting the task together then, his/her time is required only for team monitoring, for reference and assessment. Once the project work is finished, students must be given the opportunity to report their work, allowing them to support and debate their findings as well as to critically assess their progress during the work (Hodson 1995). Project work is ideally suited to the study of science as it gives students practice in research, problem solving and analysis linking concepts from different topics and the use of various methodologies (laboratory experiments, case studies etc), as well as enhancing professional skills development. It can be used to take the place, not only of the traditional lecture format but also to provide the basis of laboratory, experimental or field work.

Tutorials—A Powerful Pedagogical Tool

In undergraduate science, tutorial sessions are often either not available or are purely voluntary. Such meetings are traditionally used as discussion sessions about the students' current assignment, however this time can be used as an opportunity to expose students to a much wider range of learning experiences. Strategies such as role playing, simulations and games, debate, case studies and computer-based learning activities can be utilised to extend the students' appreciation of scientific practice. Race (1992) quoted research which summarised the extent of undergraduate learning that takes place through a variety of teaching approaches (see Table 3).

Table 3: The Extent of Undergraduate Learning through Different Methods and Materials (Race 1992

Materials and Methods of Teaching and Learning	Extent of Learning
Lecture	5%
Books	10%
Audio-visual presentation	20%
Dramatic lecture with audio-visual presentation	30%
Discussing (with other students)	50%
Explaining (with other students)	75%
Teaching (students teaching material to other students)	90%
Assessing (lecturer, peer, self)	95%

The most powerful strategies that enhance student learning and motivation are peer discussion and explanation of ideas and understanding, teaching materials to other students and assessing your own work and that of others. Tutorial sessions, conducted using appropriately structured groups and operating in a relaxed, congenial atmosphere, provide opportunities for students to discuss scientific concepts, issues and problems, and reflect upon their own understanding and that of other group members. There needs, however, to be a link between tutorial sessions and the theory being covered, either in lectures or by way of the resource package the students are currently working on, and the experimental work being undertaken. The tutor does not the one run the sessions, rather he/she acts as a facilitator, responding to the needs of the students and ensuring that the groups are functioning successfully.

Laboratories—from Novice to Expert

In order to facilitate learning in the laboratory environment, there has to be a major shift away from the ‘recipe-style’ practical which forms the basis of most undergraduate laboratory work, towards group project work. In doing so, group learning theory (Belbin 1981; Jacques 1991; Thorley and Gregory 1994) must be considered, rather than the usual procedure whereby students choose their own, or are arbitrarily assigned groups. In well-functioning groups, individuals can clarify their own ideas and thinking about scientific concepts and their application, through group discussion and reflection (Brown and Palincsar 1989). The importance of student-student interaction cannot be stressed too highly. When students have to work together, they are required to make their personal knowledge explicit, and consider the viewpoints of others. By contrasting interpretations, individuals identify areas of conflict in their own understanding, leaving them dissatisfied, and eager to investigate further. Such a learning environment encourages deep learning and conceptual change (Bezzi 1996; Kagan 1992). In addition , collaborative learning helps the students to develop their interpersonal skills and learn to be more flexible, adaptable and respecting of the opinions of others (Daniels et al. 1996), crucial skills in today’s’ workplace. Instead of the traditional, prescribed laboratory format, students could undertake a more open-ended, problem based project in which investigative skills can be developed alongside technical laboratory skills, teamwork, time management, problem solving and communication skills (Stefani & Tariq 1996). Students

undertake ‘structured inquiry’ (Mestre & Lochhead 1990), an approach that lies somewhere between open-ended lab activities, which are time consuming but more closely mimic ‘real’ research, and cookbook labs, which serve only to teach skills. Laboratory work changes from the prescribed and mundane to being exciting, stimulating and relevant for all participants, staff included. If the activity requires laboratory skills not yet attained by the student, and learning them during the work will interfere with its successful development and completion, then time needs to be set aside to practice these skills. At this time, it should be made clear to the students that they are being taught those skills as they are valuable and/or required for the pursuit of other learning (Hodson 1995).

Projects can vary in size, from a short experiment, carried out in one practical session, to longer projects that can go on for weeks. Their presentation to the students can simulate real-life situations, setting the scene for relevant research. Well developed projects create opportunities for students to identify and explore their own ideas, testing their ability to explain phenomena, and allowing them to develop, modify and change their ideas where necessary. For the larger projects, a member of staff needs to be available, acting in the capacity of consultant, facilitating group discussion and functioning. They need to ensure the groups are on the right track, and proceeding with feasible and safe experimentation.

Reflective journals are a useful tool in the laboratory, as they are in other areas of the learning experience, giving students the opportunity of ‘ .... exploring ideas, taking them apart, and then reforming them .... the essence of thinking’ (Reinertsen & Wells 1993: 182). Such journals take the place of practical reports, giving students the opportunity to practise the data collection and analysis skills used by research practitioners. In conjunction with this role, free writing in the journal allows them to think about the process of scientific inquiry—how and why questions are posed, methodology and analysis are used, and why further research may be important.

Peer Teaching in the Laboratory

Rather than having students from the same year group, working on the project, it is possible to develop groups consisting of students from successive years working collaboratively. Such an arrangement has the advantage that students are working in multilevel groups in which the more junior students are exposed to the strategies adopted by senior students. The latter students practice leadership skills as well as undertake the more difficult or advanced tasks. Such peer group learning and problem solving, also simulates professional practices in workplace laboratories, with scientists taking on senior or junior roles in the research, depending upon their experience.

The Research Laboratory and the Undergraduate

Another variation of flexible learning in the laboratory, is to bring the students into the research laboratory of staff members, the former being assigned various roles, according to their previous experience. One of the advantages for the student is

that the learning experience is embedded in a real-life setting. In this way students are exposed to an exciting, dynamic environment where they can develop their technical skills, but more importantly, are given insight into scientific methodology and the opportunity to practice open-mindedness and objectivity. There has been little research conducted in this area, looking at how successful such programs are in enhancing learning in the laboratory, however, a study by Bleicher (1994) indicated that learning took place on three dimensions—theoretical/conceptual scientific knowledge; practical laboratory skills and socio-communicative skills.

The Laboratory and Information Technology—'Dry-labs'

When the scientific knowledge to be learnt in an experiment requires a skill that is beyond the students' current abilities or is dangerous or one that is of interest or value, but not an essential skill, then the option exists to present this experiment as a tutor demonstration or as a computer simulation. In Australian universities, and overseas, such simulations or 'dry-labs', are becoming more common and serve to enable students to become familiar with the use of some equipment, teach them principles of experimental design, data collection, data processing as well as the correct usage of laboratory equipment (Pamula et al. 1996). Such programs can also be written to provide accurate and immediate feedback of the students' understanding of the subject material or while they are processing experimental data (Stewell & Delpierre 1992; Pamula et al. 1996).

Information Technology—Its Potential for Enhancing Science Learning

There is a great deal of pressure on universities to embrace electronic technology in their teaching and keep up with advances in this industry; however, this focus on electronic technology can overshadow educational principles which must be considered. There are some studies which suggest that computer usage can promote deep learning (Krajcik et al. 1988; Parlar 1986); however, this is not to say that all educational software packages are successful in doing so. High quality teaching is not dependent upon a sophisticated teaching method but it *is* possible to hide poor teaching behind a facade of technology (Martin 1994). Merck (1995) identified some worrying features, whilst reviewing scientific educational software, including factual errors, misspellings, poor syntax, poor hypertext linkages and the presence of little to extend the student's thinking. Such criticisms can also be extended to the internet, a forum whereby anyone can set up a web page, but not always with expertise (Cosgrove 1995). It is essential that educational considerations underpin the develop of all software systems; what do we want the students to learn, how do we want them to do so and what technology is available to enhance the process (Newby et al. 1996). It is not the computer itself that promotes higher level cognitive development, rather the extent to which the software engages the student in questioning and reflective activities whilst providing opportunities for considering and testing new ideas. As with all learning environments, some students feel quite comfortable using computers while others will prefer a particular medium of learning, such as working in groups or referring to books. Consequently, computer packages must be designed, not only to act as a learning resource but also to provide instruction that is as individual as possible.

Universities throughout Australia are using computers in a wide variety of ways (see Table 4—adapted from Chambers 1995) but most computer assisted learning packages are designed as teaching support material rather than for completely independent learning.

Table 4: Educational Uses for Information Technology in the Sciences (from Chambers 1995)

Uses for Information Technology in Science
• to present information and concepts; can be supported by sound, video and animation
• to simulate complex and/or dangerous situations
• to assist in developing generic skills
• to provide a venue for the graphing and manipulation of data
• to extend talented and motivated students
• to provide remedial help
• for revision and review of material
• for assessment—automated/immediate feedback; to reduce costs of marking

Their use in science education ranges from drill and practice to complex interactive simulations. Some packages are designed to enhance theoretical knowledge enabling simultaneous communication with a large number of people, a particularly useful tool in science as an adjunct to practical work (Pamula et al. 1995). It is possible to produce packages that allow both the tutor and student to control the learning process, enabling each to use the software at their level of need. Packages with links to the internet giving students the chance to delve more deeply into specific areas of interest or need (Pennell & Deane 1996).

Interactive multimedia holds great potential for the sciences, simulations can be developed that mirror real work experiences, that might otherwise be unavailable to the students due to lack of time, equipment and money or because the procedure is too dangerous or logistically impossible. The applied nature of some software enables the students to appreciate the methods scientists use themselves and compare them with their own solutions (Weiner & Weiner 1996). Through interaction with the software, students become model makers, developing a representation of the way they understand some aspect of science, and testing it out in a non-threatening environment (Martin 1994; Cosgrove 1995). Students are given the opportunity to visualise, manipulate and develop an understanding of the complex relationships that make up scientific knowledge (Chaloupka & Koppi 1996). By engaging with the materials, with the aim of understanding or solving a problem, students are active in their learning and hence more likely to obtain a higher level of cognition. Hypermedia and multimedia packages can be developed to provide information about the process of learning and problem solving,

differentiating between the performance of students with different levels of expertise (Kumar 1997). With help cards and email links to members of staff, assistance with problems can be almost immediate.

Electronic technology has the potential to enhance lecture presentation, software packages that enable the integration of text, pictures, animations and sound, all serve to retain student engagement. Lecture notes prepared in this manner, can be made available to the students prior to class allowing them to prepare and attend more closely to the lecture rather than transcribe text. Electronic technology enables the visualisation of the concepts to be studied, the development of pre-recorded laboratory demonstrations or video footage, all of which serve to engage the learner and set the scene for small group discussion. However, it is still not common for lecture theatres to be set up to enable presentation that is dependent upon a sophisticated level of technology.

If the package is attractive, user friendly and interactive, it serves to motivate the user. At present, computer technology still has a novelty value for students, and so acts to retain their attention and help them engage with the materials. Such a phenomenon may wear off as students become more familiar with the tools (Phillips & Moss 1993). Computer users will still have difficulty concentrating upon material which is presented on screen, just as they do in any other presentation medium, and they may become lost in large hypermedia systems (Jonasson 1988; Machionini 1988). Another key issue to consider when developing course material that is dependent upon electronic technology, is whether students will have adequate access to computers, either on campus or at their home or workplace. The lack of cooperation between individuals and campuses across Australia, is also a problem, resulting in a duplication and waste of time and effort. Educators in science can use the advances in IT to enhance both the quality and experience of learning in tertiary education but only if we realise that it is the servant and not the master.

Student-centred Assessment

With the adoption of more student-centred teaching strategies, assessment strategies must become more diversified, allowing for the assessment of student skills as well as knowledge, the process of their learning rather than just outcome. If a lecturer persists with traditional assessment tasks while adopting a more student-centred approach, it is possible that the benefits of learning in this manner may not be apparent in the results. For example, medical students who have undertaken their course via problem-based learning may not do as well on conventional tests of recall straight after studying but they do a lot better two months later, indicating the long-term benefits of learning in this manner (Gibbs 1995b).

As with all assessment systems, when introducing student-centred assessment tasks, it is important that students are aware of the criteria for assessment, have effective induction into new skills prior to assessment and are given adequate support via the assessment structure to guide and focus their work towards useful

learning outcomes (Gibbs 1995b). Student centred assessment tasks can incorporate the use of concept maps (Fraser 1996; Gowin & Novak 1984) and repertory grids (Bezzi 1996), diaries, logs and journals (Ballantyne & Packer 1995; Gibbs 1995), profiles (Gibbs 1995) and portfolios (Hamm & Adams 1991; LeBuffe, 1993) negotiated assignments and contracts (Brown & Baume 1992) and clinical and stimulated recall interviews (Hewson & Hewson 1989); providing alternatives in which students have a better chance of showing what they have learned.

Table 5: Ways to Overcome the Inequity of Assessing Group Work (Brown et al. 1994; Gibbs 1995b)

Limiting the Emphasis of The Group Work	the group mark doesn't represent too large a proportion of the total mark
Judging Individual Contributions	individual contributions, as assessed by the tutor, are added to the group mark resulting in each member receiving a different total mark. Diaries or logs provide useful evidence as does tutor observation, vivas or project exam questions (testing the individual's knowledge and understanding of the work undertaken)
Contracting	the project is broken down into distinct areas, with an individual being responsible for a specific area and is marked accordingly
Sharing Group Grade	whereby the group decides upon the relative contributions of its members and divides the total up amongst its members
Peer Assessment	individual contributions to both the process and content of the project, are judged by each member of the group and given marks

One of the most common forms of student-centred learning is group project work which causes problems with assessment, as it is necessary to, somehow allocate marks to individuals. There are obvious difficulties in doing so, if the product and process of group work is not assessed, there is no incentive for students to put a lot of effort into the task. If a group mark is assigned to all students, the weaker students will benefit, the lazier students will put in a minimum of effort and the better students may have their marks reduced as a result. There are a variety of ways to overcome these problems (see Table 5 above, Brown, Rust & Gibbs 1994), and these should be considered by the lecturer, during the development of the task, and made explicit to the students. More and more lecturers are involving the students in the assessment process, giving them practice in self and peer-assessment thus allowing them to develop their judgement abilities. Students can be involved in all phases of the assessment process, from setting and choosing the task and its assessment criteria, to making self and peer-assessment and negotiating and assigning the marks. Students need to be open to receiving feedback from their

peers as well as getting practice in assessing by developing their own criteria and working through those set by a tutor.

Open Learning—the Future

Embracing the philosophy of open learning requires the lecturer to be highly motivated and willing to commit a considerable amount of time and energy to the process. If staff, both on-campus and distance educators, want to adopt practices of student centred education and innovation, it is essential that they have the support of their teaching institution. The concept of good teaching must become policy, and innovations be supported, maintained and promoted (Lublin & Prosser 1994). In many universities, academics are overloaded with teaching responsibilities, they have little time to devote to becoming scholars in research or in teaching (Boyer 1990). Teaching and research are central aspects of academic culture and they can be mutually beneficial, the former being enhanced by the acquisition of new knowledge.

Section 2: The Study

Introduction

This report is based on detailed analysis of responses from 36 academics (26 National Teaching Development Grants recipients and 10 distance educators) and 48 students (41 National Teaching Development Grants students and 9 from Charles Sturt University). These responses, although essentially of a qualitative nature, have been analysed both quantitatively and qualitatively for the emergence of specific themes. Overall this project has sought to examine both the philosophy and outcomes of open-learning with respect to both individuals and institutions, to present a profile of the successful application of open-learning principles and to critique the necessary personal and institutional support necessary for its implementation.

1. National Teaching Development Grants Projects

Motivation

The reasons individuals applied for Committee for the Advancement of University Teaching grants are as varied as the projects themselves. Though, consistently, at the heart of all their applications was a genuine concern about some issue pertaining to the teaching and learning environment. Most applications appeared to be motivated by the teacher's 'gut feeling' or other anecdotal evidence, such as informal student-staff interaction, to justify the need for a change to the teaching and learning environment of their particular subject, rather than any in-depth engagement with an educational theory or concept. Only a small number of recipients (n=8) initially surveyed students or members of staff, to verify their 'gut feeling' and, in parallel, most National Teaching Development Grants respondents did not follow up with significant outcome analysis.

What motivated you to apply for the Committee for the Advancement of University Teaching grant and undertake the development of your project?

What exactly were you trying to achieve?

Category	No. (%)	Justification
A. Concern	25/25 (100%)	– poor student understanding – integration of scientific understanding with problem solving/workplace (clinical/manufacturing etc.) – flexible learning provision – distance education—support/remedial; experience in prac. – development of student skills—lab., 1st yr., group – lecturer needs↔student needs – streamline marking practice/student assessment
B. Verification	22/25 (85%)	– surveys/evaluation – grant as a result of identified need – previous trials – anecdotal knowledge
C. Integrated Teaching Aim	15/25 (58%)	– integration of prac, lecture and decision making – academic skills ± workplace – 1st year study skills development – team work—research, field work, workplace – problem-based learning – peer tutoring

Specific concerns were related to:

· skills development

'I was trying to demonstrate apparatus and technique clearly to each student at the time when they needed it.'

'They needed to have skills in the practicals to handle data and the opportunity to hone these skills and to do it better.'

- the quality of student learning outcomes

' .... had been worried about the quality of the students' science knowledge .... In the third year of the nursing degree, where they try to put everything together, the students were not able to remember what they had done before.'

'They need to develop a process of thinking about the dental problems that they will encounter.'

- the teaching needs of staff

' .... reduce the need to repeatedly mark workbooks until the students got the work right.'

'The resource was for academics to take into the lecture theatre.'

- or the delivery methodology

'The aim was to provide an equitable product for all students .... Wanted to even out the learning process.'

'Want to give off-campus student the opportunity to do experiments that they wouldn't normally be able to do without spending lots of money, and give them the flexibility to do so in their own time.'

Over half of the respondents (58 per cent) had an integrated teaching aim to which they adhered.

'We wanted to use laboratory experiments to teach the course content. We believe that this style motivates students and also gives them opportunity to acquire hands-on experience in the subject.'

'By using peer tutoring you can get to the heart of the students' learning'

' .... students are taught in a learning environment whereby they have a common level of ignorance .... want to harness the ranges of experiences of the students and the variation in their educational backgrounds.'

' .... have had an interest in providing flexible learning processes to allow for individual differences in learning—ability, motivation, timing etc.'

Two comments from lecturers teaching nursing students, indicated student needs beyond the academic and skills based ones, these dealt with the negative feelings students often had coming into first year.

' .... about half of the students are mature-age so they haven't go much science background and in the past, girls didn't have much science or confidence coming into nursing .... '

'All students experience a certain amount of fright in coming into first year, my project aimed to overcome the fear and set up an environment where self-confidence is nurtured.'

Support—Psychological

Initial

Support for individuals to apply for National Teaching Development Grants to finance changes in the teaching and learning environment, was minimal with only seven respondents indicating they had the support of their peers.

Not all recipients felt, however, that they needed this support either because they held a position of influence within their academic unit, controlled the subject area, were confident of their own capabilities or worked in a genuinely supportive atmosphere.

‘ There is no resistance in this department. It is a newly established school (1993), ... with an innovative Head, who is very supportive of flexible learning etc. Consequently, those employed in the department tend to be like-minded.

Sometimes, however, the support was for less than educationally sound reasons.

‘The Head of Department supports anything that is a money spinner .... ’

‘The Dean was also very supportive but perhaps for financial reasons rather than educational.’

The reasons cited for the lack of support ranged from scepticism about the perceived benefits of their proposals to personal conflicts and jealousy amongst staff.

‘As for peers, no, I was on my own and viewed with considerable scepticism. The staff treated my ideas with scepticism, as there is no overt acknowledgment that you can teach better.’

‘They felt that applying for CAUT for teaching development was not a good career move, I should stick to ARC grants.’

‘ .... people in the department did not want to know about it, they see education as a soft option. Teaching is seen as an instinctive skill, you either have it or you don’t.

‘No Way! Most saw it as a way of wriggling out of teaching commitments, particularly the practicals. They felt practicals run using simulations was the easy option.’

‘No, most of my peers were antagonistic, even now. I think it is mostly jealousy.’

Support—Physical

Initial

All National Teaching Development Grants recipients indicated they required financial assistance to provide the impetus for the introduction of their teaching/learning ideas. When asked to indicate what other needs they may have had with respect to effective delivery, most indicated the need for physical resources, and the assistance of other experts.

Were there particular needs of your staff with respect to effective delivery (i.e. resources)?

Staff Needs	No. (%)
Computer programming assistance	8 (31)
Expert assistance	6 (27)
Staff/student training	6 (23)
Research Assistance	5 (19)
Time commitment	5 (19)
Time release	3 (11)
Hardware/software purchase/availability	7 (27)
Extra staffing	2 (8)
Collegial discussion/brainstorming	1 (4)
Student cooperation	1 (4)
None	3 (11)

Seven recipients felt the need of expert assistance in one or more areas outside their own discipline, in the areas of design, modelling, media production, education/educational quality, instructional design and distance education staff, clinical and/or workplace expertise. A large number of the projects required computer programming assistance and/or access to computing facilities. Such assistance was seen as essential for the development and implementation of the project. In the main, their needs were met through financial assistance which paid for salaries and/or time release, hardware purchase and resource production.

What facilities and/or support staff did you need to successfully develop and implement your project? (25/26 needed assistance; 1/26 needed none)

Facilities/Support Staff	No./25 (%)
Computer programming assistance	11 (44)
Computer facilities	11 (44)
Multidiscipline experts	6 (24)
Technical staff	5 (20)
Research assistance	2 (8)
Student leaders/student support	2 (8)
Head of Department's support	1 (4)
printing facilities	1 (4)

As many of the projects were implementing practices that were new to staff, staff training or re-educating was a recognised need.

'The staff are 'greencard' people who teach by the hour, not on campus all the time. They weren't always confident in their own understanding of the problem. They needed helpful backup.'

'The peer leaders are considered staff and require training in the skills they need.'

'It was a learning curve for me though, a change in my way of thinking to process rather than content.'

Time was perceived to be an essential requirement for staff members developing the projects, this was often not as available as originally intended.

'I didn't ask for teaching relief but I believe I should have done. The work is much more time consuming than I had anticipated.'

It is worth noting that only one recipient mentioned student support/cooperation as an important need.

'It also required that the students be risk-takers.'

Support—Psychological

Continuing

Less than half (n=10) of those interviewed felt they had psychological support as the project proceeded. Some found no support (n=7), for others it was sporadic (n=4) and others not needed (n=2).
'There is little support in science for my work, I believe this is due to a difficult Head of Department who is now Dean. It is a political thing.'

'The project has been largely ignored by the department.'

'After the two bosses disappeared, I had little support. I was a young and naive academic who did not 'know the ropes' or where to go for the support I needed. The other people in the department were not affirmative in providing help.'

'There were some encouragements from some colleagues but not much from places that count.'

'Not very much from the department. Not much from the bureaucracy either.'

What facilities and/or support staff does the project require for ongoing implementation? (25/26 believe support is needed; 1/26 believe it requires none)

Statement	**No./25**	**(%)**
Staff/student mentor interest	16	(64)
Continued and/or ↑ access to facilities (lab., computers etc.)	14	(56)
Money (salaries etc.)	8	(32)
Maintenance	4	(16)
Case file/demos. etc. addition	5	(20)
Change of medium of presentation	3	(12)
Marketing	2	(8)
Programming assistance	3	(12)

Paradoxically, 64 per cent of recipients believed that for the project to have a future in the department, it required either their own continued support, or the interest of their co-workers. Only 42 per cent, however believed they had such support.

'It needs me to keep it going and maintain the momentum.'

'I think the project will fall apart if I'm not here, that is why I'm interested in getting other members of staff in agronomy writing case studies so that they will keep it going.'

'At present it will only last as long as I keep using it. It needs a team to pick up the concept and run with it.'

'And of course lab staff and demonstrators who are prepared to use the videos.'

Those recipients whose colleagues have not wholeheartedly supported the Committee for the Advancement of University Teaching innovations gave a variety of reasons for such a response, ranging from:

- competition within academia;

'They're fairly critical, possibly competing for funds, so they are not completely on my side.'

'There's been more interest from other institutions (including overseas) than here.'

- disharmony within individual institutions;

'No resistance from those in the school, however there is pressure from the rest of the university for them to become more traditional.'

'There is a lot of resistance from my peers and from the rest of the institution. It seems that everyone has a siege mentality at the moment.'

- disagreement about what constitutes good teaching and learning; or

'I also think it may be a personality thing—perception of what things are important—games?'

' .... encountered some resistance from the scientific community—computers don't solve scientific problems, need hands-on experience.'

'There are still some sceptics, even after all this time. Many staff believe that motivation (on the students' part) *is all it takes.'*

- simply not selling it right.

'These people were presented with the project late in term when they had other things on, a lack of planning and communication on my part.'

Alternatively, those who have received good feedback about their work, sometimes had reservations about it.

'However, alternatively, some people see technology of this sort as the answer to all the teaching/learning problems being faced in dentistry.'

'*We did receive good comments from colleagues .... (but) no-one else has come forward to adopt our method in their teaching.'*

Whilst 50 per cent of Committee for the Advancement of University Teaching recipients encountered resistance to change within their institutions, 54 per cent those interviewed believed that a cultural change was needed amongst their colleagues when it came to introducing change into the teaching/learning environment. Some believed there had to be a radical change at the heart of the way education was viewed, not only by the individual teacher but by the institution itself.

'Needs to be a cultural change in the way scientists think about using the computer as a tool, an adjunct to teaching.'

' .... I want people to ask questions about why they are doing what they are doing, particularly with respect to the laboratory work—What are you trying to achieve?'

'A lot of people use computers but not for enhancing learning. They pay lip service to the desire for bettering their teaching. The emphasis is still on research and getting points from publications.'

'Needs a younger generation of staff to take up the teaching challenge.'

'The institution should give solid support to teaching innovation and good teaching practices, not just an offer of teaching excellence prizes and a lip service.'

'In order for there to be a change in attitude, there has to be a change in high levels of power, not going to happen through the work of individuals.'

Have you encountered any resistance to change amongst your peers or within your institution? If so what strategies have you used to counter this? Do you think there is a cultural change needed?

Statement	**No. (%)**	**Statement**	**No. (%)**
Resistance		*Cultural D*	
Yes	10 (38)	Yes	14 (54)
No	10 (38)	No	7 (27)
Some	1 (4)	Not any more	2 (8)
Inertia	1 (4)	n/c	3 (11)
indifference	2 (4)		
n/c	2 (8)		

A number of recipients mentioned fear as a driving force for preventing change.

'Yes—many fear the notion of (self-) *directed learning. Perhaps it might expose their knowledge gaps.'*

'Yes—there is a general fear of change, but in the context of the current upheaval in universities, this resistance is understandable.'

Support —Physical

Continuing

Over half of the projects (n=14) required continued or increased access to computer and laboratory facilities, with a substantial number (n=8) needing the input of more money to keep the projects viable. Financial input of this kind must be considered when determining the cost-effectiveness of teaching and learning innovations. The majority of those interviewed (n=20) believed the new method of delivery would be more cost effective, if not at the beginning, due to the considerable initial developmental costs, then over time.

Adequacy of funding was an issue for a number of those interviewed. Some of the project leaders underestimated the cost of developing and implementing the programme. Eight (31 per cent) respondents actually experienced a shortfall between the funds made available through the Committee for the Advancement of University Teaching and the actual cost of developing the project, resulting either in a product less complete than anticipated or the need to supplement the project from other sources. This is particularly true of those that developed projects with a computer-dependent component.

'Multimedia authoring is an extraordinarily time-intensive process. We seriously underestimated the development time required for these tutorials and would be much more modest in our aims in any future proposals.'

One individual stated that he had greatly underestimated both the time and resources required, by about 50 per cent due to the newness of what he was trying

to do. A number of projects required significant upgrading of the computer facilities available to them, in one case costing up to $750,000. Such upgrading was essential for the implementation of the projects in question and would not have been possible without the support of the recipients' institutions or other external funding.

Do you believe this is a more cost-effective mode of delivery? If so, please explain.

Statement	**No. (%)**
Yes	9 (35)
Yes in time	11 (42)
Difficult to say	3 (11)
Same	1 (4)
No	2 (8)

Category	**No. (%)**
A: Cost-effective = Money Spent	26 (100)
B: Cost-effective = ↑ Outcomes	10 (38)

All believed that cost-effectiveness is measured in terms of dollars and cents spent and saved, but a significant number (38 per cent) indicated that other factors need also be considered.

'Cost-effectiveness is a difficult thing to justify. All the results thus far have been qualitative .... have learnt a great deal about teaching and learning in the development of the programme, a benefit that is impossible to put a price on.'

'You can do the sums .... However, what is not taken into account is the fact that the performance of students is enhanced and the peer leaders are also benefiting.'

'In terms of the time taken, by both the students and the staff, it is being reduced.'

'If the programs have achieved their aims, then they are certainly a more cost-effective mode of delivery than conventional tutorials.'

The Projects

Project Aims

All projects focused on some aspect of student need, the perception of which needs were to be addressed varied between projects and many projects addressed more than one.

What were the particular needs of your students?

Category	No. (%)	Justification
A: Undergraduate Skills	26 /26 (100)	– student control of learning (n=8) – workplace skills development (n=7) – integration of knowledge (n=7) – areas of weakness (understanding) (n=7) – problem solving (n=6) – conceptual understanding (n=5) – resource access (n=4) – self-confidence, school to uni. transition (n=4) – group work (n=3) – study skills (n=2) – laboratory skills (n=2)
B: Integration	10/26 (38)	– content↔workplace practice – student control of learning – skills↔workplace practice – content/practical integration – generic skills

These encompass a common focus on:

- the necessity to increase student control of the learning process;

'Students need to have experience in a team work situation where they have to take control of their own learning. Students learn so little when everything is laid on for them in the normal laboratory.'

- the enhancement of conceptual understanding;

' .... wanted the students to concentrate on understanding rather than equation plugging. Physics misconceptions needed to be addressed .... '

- the integration of knowledge and its use in problem solving; and

'Students spend 8 weeks on farms where they have to do an individual analysis of the farm situation. This requires a firm understanding of the important concepts.'

- the development of an understanding of the workplace into which graduates would be heading.

'I am trying to establish an environment whereby there is better student learning and a more realistic learning mimicking the workplace that they will experience upon graduation.'

Only seven of the projects actually addressed a specific area of weakness in understanding and of these, only two projects were entirely concerned with this single need. Fifteen projects (58 per cent) aimed to break down barriers, either:

- the barriers between subjects within a degree;

‘ .... students need to learn to collect data, as do practicing scientists, and to manipulate and explore underlying concepts and the interrelationships between physiology, behaviour and ecology.’

- between delivery methods within a single subject; or

‘... .to assist in the integration of lecture and prac. work and gain wider experience in management decision-making.’

- or between what is learnt during the undergraduate experience and what will be expected of the graduate in the workplace.

‘The software enables the students to immerse themselves in the working environment.’

Project Descriptions

The approaches adopted to meet student needs were in the main (n=18) supported, or driven, by some form of technology, such as computers or video.

Categories of Description for the National Teaching Development Grants Projects Surveyed

Project Description	No. (%)
Computer-aided learning	7 (27)
Interactive multimedia	4 (15)
Simulation/animation	3 (11)
Technology enhanced resource	3 (11)
Video	2 (8)
Laboratory based learning	2 (8)
Problem based learning	2 (8)
Skills development	1 (4)
Game	1 (4)
Peer mentoring	1 (4)

Project Development

The majority of those interviewed found it necessary to change their original ideas or the procedure involved in their project as it developed.

Did your original ideas, or the procedure involved in the project, change as it developed? If so, can you explain how and why they did so?

Type of Change	**No. (%)**
Broad aim → fine-tuned	10 (43)
Specific aim → expanded	4 (17)
Change of delivery agenda	4 (17)
Less complete than expected	4 (17)
Minor additions/fine tuning	4 (17)
Major changes-past students now mentors	6 (26)
– software obsolescence	
– experimental design	
– problem-based learning → CAL	
– student feedback/behaviour incorporated (n=2)	

Such changes generally involved a finetuning of the original ideas, sometimes as a result of student behaviour or feedback.

‘ .... didn’t anticipate the need for the pep talks when students became downhearted about how the work was going .... These things arose as the students hadn’t been exposed to such a situation before.’

‘I realised from that, I had to start from where the students are, I had to have animations (very important) that showed the machines making the product. I felt it was important to introduce humour and fun into it, making it gamelike and stimulating.’

‘Past students who had themselves done the program, volunteered to help with the project, becoming ‘student mentors’. This was an unanticipated development of the project.’

‘The project originally developed as a result of animal ethics issues. It has now developed into a student control in the teaching/learning process.’

For some, time and financial constraints were the motivators for modification.

‘I did however restrict the scope of the original proposal (i.e. number of tutorials written) due to time limitations.’

‘However realistic you think you are, a CAUT project will take at least twice as much time and at least twice as much effort as you originally believed. And it will cost more than CAUT will grant you.’

Outcomes—Measuring the Effectiveness of Teaching/Learning Strategies

The Staff Perspective

All staff who were recipients of National Teaching Development Grants and involved in the development of new and/or innovative teaching and learning techniques, were aware of the need for measuring their effectiveness. Part of the CAUT/CUTSD application process is to detail the types of strategies to be used in this regard but the rigour with which such measurements were conducted varied with each project.

Half of the National Teaching Development Grants recipients felt that they had met the perceived needs of the students as stated in their original project. Of the remainder, eight (40 per cent) had either only recently completed their projects or were still in the process of doing so and felt unable to answer this question. Five of those interviewed expressed mixed reactions about their successes.

'In short, the results are mixed. Some students clearly learned a great deal and found it excellent preparation for the workforce .... Others still haven't a clue .... Eventually one-third of the students gets the idea (mostly mature-age students) but the other two-thirds are not interested.'

'Outcomes (are) *hard to assess unless studied long term. No change in performance but improvement in withdrawal rates is becoming evident.'*

'Not sure .... The students like the course more but there was no sign of increase in assessment level after normalising (the tests aren't necessarily asking the right questions).'

The is still credence placed upon such comments as *'The students like the course more, bu t...'* or '(no) *clear evidence of improvement in students' understanding .... however .... they enjoy using the programs'*, which is problematic in objective evaluation of outcomes. This did not mean that respondents were unaware of assessment tools but had varying degrees of commitment to their use.

The most popular method of measurement (85 per cent) involved the use of student surveys, via questionnaire, to indicate the degree of student satisfaction with the programme. A smaller, but significant number (40 per cent), considered that exam grades or 'results' were an indication of effectiveness.

' .... took the normal exam in which the tasks from previous years were examined. The test items looked at the students' capacity to handle numbers and do calculations. The results improved.'

'The one theory examination I have conducted has not provided any clear evidence of improvement in students' understanding of the concepts compared to previous years. However there is strong feedback from students that they enjoy using the programs and that they feel they have assisted their understanding of the material.'

'The exam results did not show any differences between the three classes. The exams were not really focusing on deep learning, probably only middle learning.'

What tool did you use to measure the effectiveness of your teaching strategies? (yes 75 per cent)

Tools Used	**No./20 (%)**
Questionnaire	17 (85)
Exam/Tests/Grades	8 (40)
Interviews	7 (35)
Observation	4 (20)
Independent evaluation	3 (15)
University evaluation	2 (10)
Focus groups	2 (10)
Reflective notebooks	2 (10)
Entry/exit quizzes	2 (10)
Withdrawal rates	1 (5)
Group evaluation	1 (5)
Video	1 (5)

Such comments highlight the importance of critiquing the use of summative assessment as an instrument for measuring the effectiveness of novel teaching an learning strategies. This is particularly so when the learning aim is to enhance students' conceptual understanding by focusing on deep learning. The retention of summative assessment techniques of old may not adequately address the results of such learning. Very few of those interviewed went as far as using student/staff interview, pre- and post-test/questionnaire, or independent evaluation/observation as measurement tools.

- some grant recipients expressed confusion or a dissatisfaction about the whole issue of evaluation of effectiveness; and

' .... as scientists, we need to appreciate the value of qualitative data as well as quantitative.'

'There doesn't seem to be enough people who are developing ways in which these programs can be evaluated effectively.'

‘ .... have received criticism of my evaluation plans from the CAUT people upon initial application , they said I didn’t have enough in there. However, I struggle to know how to get around it.’

- the way in which these evaluations could be constructed.

‘Students come into the classroom with a varying level of knowledge and experiences. If we do not design the experiment carefully, the comparison may not serve any purpose.’

‘Comparison with a more traditional subject at another university may be of passing interest, but it’s a bit like comparing apples and oranges and finding a significant difference since there are too many extraneous variables which could not be controlled for, and which would make the comparison of little value.

‘Yes but how do you get the required level of experimental control required for quantitative experiments—and what would they prove anyway?’

‘ .... have thought about it (controlled experimental design) but believe that there are too few students and too many variables from year to year.’

Some respondents indicated that their programs were so radically different from anything that had been done before that comparisons became meaningless and/or impossible to conduct.

‘ .... comparisons between what I am doing with the software and the way it has been taught in the past is too difficult, as the methods are too disparate.’

‘No because our numbers are not that great and anyway it was just such a waste before that we don’t want to go back to the old time consuming way.’

Whilst problems were encountered by some who wanted to effectively evaluate the success of their innovation, including:

- lack of time for extensive analysis; or

‘ .... have data from both streams in the course, the traditional and the peer group learning streams...have yet to analyse them due to lack of time.’

‘ .... had entry and exit quizzes...have not really been evaluated as there has not been enough time or people contributing.’

- ethics issues.

‘I have considered it (controlled experimental design) but identify equity issues as a problem.’

'We have considered running a control experiment with a percentage of students utilising this package and comparing their exam performance. Such an experiment needs to be cognisant of student rights for equal access to teaching aids.'

'It is difficult to do experiments with students, they are not rats. You can't divide the students up and make some do the course via the program and others not.'

Student Perceptions

Most students (71 per cent) undertaking National Teaching Development Grants funded subjects or topics, did so as the material was compulsory for the successful completion of their degree.

Why did you chose to do this subject/topic?

Reason Given	**No. (%)**
Compulsory	29 (71)
Recommended by staff	3 (7)
Personal interest	3 (7)
Career considerations	4 (10)
Easy credits	1 .5)
Needed skills	1 (2.5)

Due to the varied nature of the subject/topic delivery of the projects, student respondents mentioned a range of work styles that were part of the presentation. These included laboratory and field work, Computer Assisted Learning (CAL), Supplemental Instruction (SI) and Board Games.

How did this differ from other subjects that you study?

Description	**No. (%)**
More active learning	7 (17)
Enhanced presentation/objectives	5 (12)
Game	2 (5)
Supplemental Instruction	8 (20)
Computer Assisted Learning	4 (10)
Student-centred/motivated	3 (7)
Autonomous learning	3 (7)
Peer/group learning	2 (5)
Work related experience	2 (5)
Alternative approach to assessment	4 (10)
Enhanced learning	1 (2)
More time consuming	3 (7)
Enhanced study/communication skills	3 (7)
n/c	3 (7)

Moreover students identified differences between the National Teaching Development Grants subjects and other subjects in their programs. The differences ranged from:

- involving more active and student-centred teaching and learning techniques;

'It was participation rather than face-to-face learning.'

'Not notes written on blackboard; experiments formed large part of work; got answers to typical questions in class.'

'It was more student centred and relaxed. There was not the 'I'm the teacher, this is what I'm teaching, you are the student, learn it' barrier that exits. There was a level of informality that encouraged student interaction'

- promoting student autonomy in their learning; and

'Multilevel practicals, I think provide you a chance to learn to be independent, self reliable and above all gaining extremely lot of experience , in comparison to the normal prac. classes.'

- enhanced presentation and teaching/learning methodology.

'Much clearer objectives which actually related to the assessment tasks!

' .... other subjects did not use 'fun' methods such as the game.'

Students recognised the uniqueness of one project, in that it sought to deal with skills seldom taught explicitly in a general science course.

'It also dealt with topics seldom encountered during the rest of our course i.e. how to write a book review.'

Ninety-three per cent of students felt that parts of the National Teaching Development Grants subject/topic undertaken contained unique teaching/learning strategies.

Were there any parts of the subject/topic delivery and/or its assessment that you thought were unique, please explain?

Response	No. (%)
Relaxed approach	4 (10)
Computer presentation/assessment/support	15 (37)
Field/practical work	5 (12)
Enhanced delivery	3 (7)
Board game	3 (7)
Peer learning	4 (10)
Interactive lectures	6 (15)
Increased class involvement	4 (10)
Student support	3 (7)
SI	7 (17)

Such strategies were almost entirely concerned with delivery and student support networks, only a few of the projects introducing assessment strategies that could be described as innovative. These aspects included:

- more student-centred delivery;

'PASS (SI) *sessions were unique because they were run by students, people on our level, so it was much easier for us to ask them for help and we had access to other students in the group that we could ask for help.'*

'Working with first and second years is cool. They seem to want to learn from their peers—that's us.'

'Yes, the general relaxed nature and one-to-one interaction between staff and students.'

- learning that required the student to be more active; and

'More student participation; questions raised and students encouraged to participate and discuss.'

'You have to think during the lecture; learning was less passive, less tendency to simply go to sleep.'

- and delivery that made used of technology.

'The computer setup used for assignments each week. Able to get help through the computer. Computer questions with very explicit solutions and help functions. Ability to talk to tutors and lecturer through the 'client' on the computer. The lecturers 'want' for questions in lectures and much feedback.'

One student was particularly unhappy about the subject delivery he was involved in. He was not given a choice in the way in which he was required to undertake the work and his answers throughout the questionnaire indicated his dissatisfaction with the system under which he was expected to work.

'Unique is one way of describing the assessment. It would appear that the way the groups are set up, there is no way of accurately assessing the work and who is doing it.'

Over half of the students surveyed felt that an important role undertaken by the lecturer/tutor in their subject delivery was to be a source of information, and a resource.

'As a resource; a bridge to understanding the complex style of our textbooks.'

'Lecturer provides the theory for the subject and explains the concepts through examples and demonstrations; questions also raised for students to think about and also participate in for discussion.

What role(s) did the lecturer and/or tutor play in the subject/topic delivery?

Description	**No. (%)**
Information delivery	22 (54)
Learning assistance	10 (24)
Resource	7 (17)
Administrator	6 (15)
Discussion	6 (15)
Student support	5 (12)
Problem solver	4 (10)
Guide	3 (7)
Very little	2 (5)
Team member	1 (2)

Students commented on the person-centred aspects of their learning, particularly the role of lecturer and tutor as partners in the learning process.

'Lecturer was main instrument—directed students to relevant material—computer, notes, experiments etc. Tutor—very good for reinforcement and clarification of lecture material.'

'For this subject, they gave valuable advice so they were there mainly to supervise and also discuss any problems or solutions to problems we might have.'

'The lecturer is the most important aspect! His enthusiasm, genuine care for students' progress and love of the subject are very important.'

'The lecturer and tutor were available much of the time in their rooms and nearly all the time over the computer system called the 'client' where questions can be

answered by the lecturer or tutor. Able to come down to the student's level to teach the concepts.'

The majority of students (83 per cent) were happy with the extent to which they had access to the members of staff involved in their subject/topic delivery, and the same number felt that they received as much support as they needed.

'Yes, re the various components of the subject—lectures, CAL, prac and PASS (SI) *support was always readily available.'*

'Yes, because if the lecturer was out of his office for a short time, he would respond to any queries on the computer forum as soon as he returned. This was usually very promptly (within the hour).'

'Yes, I was capable of receiving even more help than I needed. Several resources were available to me, however they did not prove necessary since the class was more than enough.'

The remainder were mostly satisfied with the help they received, some choosing to seek alternative sources of help before seeking out members of staff.

'Didn't require help from the lecturer, sought other sources (e.g. friends/books first).'

'I felt that the lecturer was available if I needed him. I didn't need him, but it was the thought that counted.'

'It did not make that much difference because I get most of my help from friends who already understand the course.'

Over three quarters of students (78 per cent) felt that the delivery method was successful in allowing them to meet the subject objectives.

'The (approach) was very helpful in meeting subject objectives because it allowed me to identify areas of knowledge deficits BEFORE assessment tasks were attempted. It was also helpful to hear other students answers and knowledge.'

'It was definitely beneficial to me because being required to finish a set of questions every week meant that I was getting practice and understanding of each topic before going onto the next, whereas normally if I did not like a topic I would neglect practicing it.'

'I think this method was extremely effective, students were taken from being rather shy and reserved to freely talking about a range of problems and topics.'

'Yes. The computer animations helped with the understanding , since the blackboard is static, the computers showed us moving diagrams that clarified the most complex items.'

It is interesting to note that some students expressed the opinion that, if the methodology used was different from the normal delivery, particularly if it is fun or interesting, it is helpful to the learning process.

'It is fun and makes a change from the often boring routine of lectures and tutorials.'

'The (approach) *was a nice break from the usual routine and because it was something different I found things easier to remember.'*

'Yes because this is a new and interesting way of learning instead of the normal boring way. The demonstrations helped my understanding of subject.'
'The (approach) *allowed you to test your information level and also induced questions that were asked of the tutor. The* (approach) *allowed the class to have fun and enjoy learning ....'*

A number of students were less convinced that the delivery method was an improvement.

'Yes and No. Some lectures were boring and therefore concentration and absorption of data was difficult.'

'It assisted in understanding, but more as a rote learning tool, and all the questions were from a fairly narrow spectrum.'

'It would help if the objectives were clearly set out in the first place. From all appearances it would seem that the only objective is to have a good time.'

'.... I felt that whilst the subject delivery was good, I could not keep up with the constant changing of methods used. It was far too busy—not enough time was given to allow for absorption of subject matter.'

Getting students more involved in the learning process and including collaborative learning techniques in the methodology were seen as beneficial strategies.

'As different people's opinions are heard, you think more which helps you understand concepts better which in turn helps you remember them.'

'The benefits are unquestionable, the collaborative learning lessens individuals' feeling of inadequacy due to the sharing of knowledge.'

'You are not subject to the hierarchy of a 'teacher' vs 'student'. Its all-in approach provides for a much more relaxed learning environment.'

What do you feel are the benefits of learning in this manner?

Response	No.	(%)
Collaborative learning	10	(24)
Fun/enjoyable/interesting	8	(20)
Enhanced learning/understanding	8	(20)
Student-centred	8	(20)
Enhanced presentation/approach to learning	7	(17)
Increased assistance/support	6	(15)
Peer learning	5	(12)
Non-threatening	5	(12)
Autonomous learning	5	(12)
Skills development:		
communication	3	(7)
decision making/problem solving	1	(2)
technical	2	(5)
group	1	(2)

Some students felt that the need to be responsible for your own learning was helpful, and learning via technology an advantage.

'You find out yourself many of the problems that can be encountered. Also got us thinking about solutions instead of being told.'

'You get to know a member of staff, your starting knowledge of university life is increased, you know what level of achievement and presentation is required.'

'You can work through problems at your own pace. Graphics packages enhance visualisation and understanding. By reading the 'forum' you often find people with the same misunderstandings on problems as you do. This is great when you are working alone or stuck for ideas.'

'For dynamics the computers can show much more than can be represented on a blackboard.'

There will always be exceptions.

'So who's learning anything? So far, the only thing that has come out of my fellow students are programmed responses. People think this is learning, but it would be a good topic for debate.'

What are the disadvantages?

Response	No. (%)
Lack of clarity	3 (7)
Stay on task	3 (7)
None	7 (17)
Suitability to all?	7 (17)
Time/work constraints	6 (15)
Student motivation	3 (7)
CAL problems	
– access	1 (2)
– rigidity	2 (5)
– technical	1 (2)
– impersonal	1 (2)

A small percentage of students were aware of some disadvantages to learning in the manner in which they did. Complaints included:

- the inconsistency of behaviour of fellow students;

‘ .... some people may not take the (approach) seriously. It is a game but should also be used as a learning tool. One can get as much or as little out of it as the effort one puts into playing properly.’

‘Can get in a group who want to study at a lower level, hard to find people to ‘push’ me.’

_ problems with the depth of delivery;

‘The answers in the (material) didn’t always provide the depth of the questioning you wanted to be answered, it was great to have the tutor to answer any further questions.’

‘A less complete set of notes at end of course.’

_ rigidity of delivery; or

There were no marks awarded for working and there was only a right or wrong answer, which made it hard if it was simply a calculation error.’

- not corresponding with individual preference.

‘Three hours less time to do homework. The tute was arranged in the afternoon, I would have preferred morning.’

‘Mostly it would be the ability for people to sit still or stay interested in a lecture theatre environment.’

One student's statement makes all the effort worthwhile.

'There are none, the whole course is the best I've seen at uni. The lecturer and his assistant are supportive and the computers let us revise, explore and really understand the subject.'

A large percentage of students (51 per cent) felt the need of generic skills, such as organisation, planning, communication and autonomous learning, to be essential for effective learning.

'Commitment to attending all lectures and tutorials and preparing for the tutorials in the workbook in advance to get the most out of tutorial time.'

'To work on the problem and persist at it instead of just looking at the answer. To spread work over a time frame so you could meet the deadline.'

'The drive to learn and help others learn, also communication skills, time management. The confidence in yourself to help others.'

What skills did you need to work in this manner?

Skills Needed	**No. (%)**
Generic skills	21 (51)
Concentration/self-discipline	11 (27)
Knowledge base	6 (15)
Motivation	4 (10)
Computer skills	4 (10)
Interpretative/problem solving skills	5 (12)
Study skills	5 (12)
Patience	2 (5)
Confidence	2 (5)
None	6 (15)

For effective devolution of responsibility for learning to the student it is necessary for the students to develop confidence in themselves and their own individual abilities. Although such skills were not specific to innovative teaching strategies.

'An ability, a willingness to want to communicate with fellow students. You need only a little confidence to be able to contribute and become involved.'

'The drive to learn and help others learn, also communication skills, time management. The confidence in yourself to help others.'

'Needed to be prepared i.e. read material before lectures, attention needed; also needed to be able to jump between styles—aural, oral, written, questioning etc.'

'Must be able to listen and pay attention for a full hour.'

Over 70 per cent of students felt they were equipped with all or most of the skills required to function successfully in the learning environment. Of those who responded further, the majority (62 per cent) felt they had received enough support to develop the required skills. One student indicated that the support for skills development is problematic.

'Yes and no, but I believe that at this stage of education we should have to look after ourselves a bit at least.'

Of the three students who were unhappy with the level of help they received in developing their skills, only one provided an explanation for this dissatisfaction.

'Most lectures are the same. There is no help provided for people who can't concentrate on what is said.'

Almost 50 per cent of students were happy with the subject/topic delivery as it was presented to them, though a significant percentage (39 per cent) felt that it could be improved upon. Suggestions for improvement ranged from an extension of the time available for the work to small refinements to the computer or lecture delivery, the latter gaining the most criticism.

Do you think any parts of the subject/topic delivery could be improved upon? Please explain.

Response	**No. (%)**
More time needed	3 (18)
Programme refinements	3 (18)
Lecture/notes refinements	8 (47)
Technical refinements	2 (11)
More practical work	1 (6)

Only a small number of students (17 per cent) actually approached the lecturer/tutor with their criticisms or suggestions for subject development, though 78 per cent felt that the staff member would be open to their point of view.

'Yes. During 1st semester some people (students) *were quite noisy, some of us complained as a group re this, and it has been much more controlled by lecturers this semester.'*

'Yes certainly. At all times I felt able to approach those lecturers involved in this unit. I got the impression they were happy to receive feedback.'

'Yes, always very open, honest, helpful and always invited students to come and seek personal help if we need it!!'

'Depends who it was. Some lecturers/demonstrators are easy to talk to than others.'

For those students who felt the lecturer/tutor would not have been open to suggestion, perhaps personal experience and attitude may have coloured the perception. The following statement may be one such opinion—as the course he was talking about was a total reversal of traditional laboratory practice, thus weakening the strength of the student's statement.

'This course hasn't changed much in the last 20 years, is there any reason to think that the same people who originally designed the course will change it now? Have you ever tried to open a gate that's been rusted closed for that long?'

The majority of students (75 per cent) felt that the delivery of their other subjects could be enhanced. Overall, they were dissatisfied with the clarity of explanation and presentation of learning material, be it via technology enhancement or active learning activities.

Do you think the delivery of other subjects could be enhanced? Please explain.

Response	**No.**	**(%)**
Increased clarity of presentation/explanation	11	(35)
Increased computer usage	6	(19)
increased lecturer access/interest in students	5	(16)
'Fun' activities—break routine	3	(10)
Supplemental Instruction	3	(10)
Hands-on approach	3	(10)
Increased relevance of content	2	(6)
Up-to-date material	2	(6)
Increased interactivity in lecture	2	(6)
Problem-based learning	1	(3)

A proportion of student dissatisfaction involved the role of the lecturer in subject delivery and the interest they exhibit in their students.

'YES. Other subjects have no interest in the students. Other lecturers come to lecture and then leave. Some never listen to students ideas and feelings. MOST cannot come down to the students level to lecture. MANY are unable to lecture a subject they feel is SO easy. Several subjects ignore the learning needs of students .... '

'Yes definitely. Most lectures need to be taught how to teach effectively. They should take interest in their teaching and not be so arrogant.'

*'Absolutely! Lecturers **should** be more sensitive to students needs, and be more approachable. They should actively seek feedback, not for merit from the university, but for their own professional development.'*

'Yes, some lecturers simply do no have the time for students. They present their lectures quickly and do not mind if students understand or not.'

A change from the routine method of teaching was also seen as beneficial.

'More interactive learning would definitely be beneficial as compared to straight forward lecture notes being copied down.'

'Yes, other subjects could try and include some learning activities that are fun and break the routine for a change. The workload at uni. is quite heavy, and the constant routine of lectures and tutorials can be quite discouraging after awhile.'

Outcomes—Lifelong Learning

Staff Perceptions

Few recipients had included the cultivation of lifelong learning as an aim when developing their projects but, upon reflection, the majority of recipients (54 per cent) believed their projects did cultivate such skills, in conjunction with delivering specific competencies (81 per cent). To most staff, delivering specific competencies, generally meant to train students to become technically competent.

How effective do you believe your program is in cultivating life-long learning in individuals and/or delivering specific competencies?

Success Rating	No. (%)	Reasoning
Effective	10/19 (52)	problem solving n=3 work-related experience n=3 study skill development n=2 integration of content/process self-directed/autonomous learning seeing self as learners team work development distance education focus
Difficult to assess	5/19 (26)	
Don't know	6/19 (60)	small exposure n=3 too early no measurements done

When given the opportunity to rank how well the project does in the area of life-long learning, just less over half ranked their project as being quite effective.

'The content is important but I feel that the process of seeing themselves as learners more so.'

'We believe that understanding the principle of this approach will be learnt "for life"'.

'Our whole focus is self-directed autonomous learning which will hopefully translate into an understanding of learning for life.'

'I think it makes an important contribution to life-long learning through the specific skills of working and learning cooperatively in a team. And I expect a latency effect—which I will probably never have the opportunity to measure .... '

Some of those who admitted that the main focus of their project was to deliver a specific competency, felt there was potential to deliver lifelong learning competencies.

'Specific competencies are being addressed. As we are trying to address common misconceptions in engineering, we hope to be affecting lifelong learning.'

'The aim of the project is to deliver specific competencies in maths. At the same time, it is possible that by the nature of the project the students are learning to think about themselves, their learning and assessment of their own abilities—metalearning. In such a way there may be a spin-off for lifelong learning.'

A number of recipients mentioned the fact that what they were doing, and trying to achieve, was only a small component of the course structure for the individual student, and hence would probably have little effect.

' .... I think it takes more than this one subject to change an individual's attitude. If the course was taught with a common thread throughout it would be different.'

'However, let's be realistic, it's only a component of a methodology subject, and one cannot change attitudes, establish and hone skills in a couple of hours. I believe that the capacity to work in teams requires much more explicit attention in a university education than as a component of one subject.'

'This course is one of three modules in the semester, it is very hard to determine whether such a small exposure will develop any life-long learning skills.'

Only one respondent expressed a more pessimistic attitude toward the possibility of change.

'Frankly, I think most things that instructors do have little impact on this aspect of learning. I believe that most students learn in spite of what we do to them...Life long learning is a personal attitude you either have, self develop or you don't'

Outcomes—Flexibility of Delivery and/or Increased Access?

Staff Perceptions

As a large percentage of the National Teaching Development Grants funded projects in this study were technology based, and the respondents believed the

potential for the product to increase student access and facilitate flexible delivery was great. The majority of those interviewed believed that their product was already successful in this area and in the future would provide even greater access.

'The reason the project was undertaken was to allow flexibility of delivery and access to revision of the topic at the student's own pace.'

'It has great potential to make learning more flexible. Coupled with new electronic mediums (www etc.), it would free up lecturers to interact in different ways—small group problem solving etc.'

'It is flexible in that the students only have to put the effort into the maths modules that require the work, it is tailored to the individual's learning needs.'

'It is not relevant to course access but it is flexible in terms of what we can do in the lab.'

'This year the www will be available to the students. The large number of students will have access, so they can revisit the work and contact me via email.'

This focus on computer access, however, does raise the issue of student access, either with respect to their own home computer/modem access or the freedom of availability of computer laboratories on campus.

Student Perceptions

A large proportion (41 per cent) of student respondents felt that their skills were enhanced by the learning experiences they had encountered in these projects and that they had been encouraged in their learning (22 per cent).

'The subject developed study skills, lecture note taking skills to enable me with further study at university.'

'I think it helped in the first year of my course, I was able to learn things in a relaxed atmosphere that otherwise I would have had to learn in pressure situations along the way.'

'It will help in problem solving and the consequences of selecting a certain decision.'

How do you think this subject/topic delivery will help you with your work/study in the future?

Response	No. (%)
Enhanced skills development	17 (41)
Aids/encourages learning	9 (22)
Aids understanding	13 (32)
Work-related experience	2 (5)
Resource	2 (5)
Networking	1 (2)
n/c	4 (10)

'As lecturer delivered the subject well, it is better understood. As concepts are understood—can be applied to the study. As interaction was encouraged it develops thoughts and opinions which are important for learning.'

'It has opened my eyes to pasture establishment and monitoring etc. I shall apply this as best I can to our property.'
' .... The game—yes, made a subject I had never found terribly easy more accessible.'

Some individuals increased their autonomy and individual responsibility for learning and at least one student became more metacognitive in her approach to learning, all extremely valuable for future learning.

'Yes it helped you to take the first step in understanding by yourself before you get help from lecturer.'

' .... I feel that if I apply a similar approach to my other subjects, exam time will be a lot less stressful and my results will be better.'

'Made me aware of need to understand my own learning needs and to identify areas of knowledge deficit before exams commence.'

2. Distance Education Deliverers

Motivation

For staff involved in distance delivery (n=10), motivation was more a construct of institutional intent than driven by individual desire. Course structure and mode of delivery were significant factors in influencing the introduction of innovation, as was the nature of the student cohort. However, some individuals indicated some impetus to introduce different teaching/learning strategies. These, in common with National Teaching Development Grants recipients, were focused on perceived student need.

Course Structure

Most of the courses that were examined in this study were offered in both on-campus and distance modes (80 per cent), only the two Health Science courses were offered only in the distance mode. Residential schools were used in 80 per cent of subjects, with 100 per cent of subjects using print as the major delivery vehicle.

As laboratory based disciplines, all the Applied Science courses had either compulsory or optional residential schools.

'I feel that science residential schools, Environmental Science in particular, allows the lecturer to be very accessible to the students in a relaxed atmosphere during lab. and field work.'

' .... it is difficult, if not impossible, to get away from having residential schools. The laboratory work could be done in the students' workplace but its cost has to be taken up by somebody.'

'I also think that an important part of a degree is the contact with other students which for distance education students only comes during residentials.'

What is the mode(s) of delivery used in your subject?

Mode of Delivery	**No.(%)**
Distance Education only	2 (20)
Distance education/Internal	8 (80)
Residential School	7 (70)
Optional residential school	1 (10)
No residential school	2 (20)
Internals : <10 students enrolled, tutorial and residential school; >10 enrolled, lecture/prac. format	2 (20)

Delivery Resource	**No. (%)**
Print	10 (100)
Audio	2 (20)
Video	2 (20)
Multimedia	1 (10)
Tele- and video-conferencing	2 (20)
Computer Assisted Learning	1 (10)
Computer bulletin board	2 (20)
Remote interactive TV	2 (20)
Mobile workshop	1 (10)
Open Learning Agency of Australia	2 (20)

All subjects are dependent upon print delivery with only a few courses beginning to utilise modern technology.

‘ .... print material—print onto paper what you want to present in the lecture but with modifications.’

‘The feedback about the video is positive as the students come to the residential a bit more familiar with the equipment they are going to use.’

Part of this print predominance may be as a result of the lack of access that typical distance students have to high technology.

‘There is a great need for computing equipment in Environmental Science .... Unfortunately probably only 30 per cent of the ordinary distance education student (as distinct from those already in the field) have access to computers and these may not necessarily be of the right sort. If and when more of the student gets into computers, then we can think more about the web and email etc.’

Flexibility of access was limited despite the inherent flexibility provided by distance delivery.

Does the course have flexible, or multiple entry and exit points? (eg. course modules etc.) Please explain.

Category	Flexibility	Characteristics	No.	(%)
Entry	Some	Credit package/recognition of prior learning	9	(90)
		Multidisciplinary entry	1	(10)
		Dual intake (start and mid-year)	2	(20)
		Modules (no choice available)	1	(10)
		Ease of movement: internal ↔ external	2	(20)
	None	Enrolment beginning of year only	8	(8)
Exit	Some	Flexible exit: Diploma or Degree	1	(1)

Does the course have flexible times of delivery?

Category	Flexibility	Characteristics	No.	(%)
Internal students	Some	Non-traditional timetable	3	(30)
		1st yr. subject offered 2x/yr	2	(20)
	None	No organised flexibility	3	(30)
		Timetable driven	2	(20)
External students	Some	Some—w/n uni. structure	1	(10)
		No residential school	2	(20)
		Optional residential school	1	(10)
		Mobile workshop/seminars	1	(10)
	None	Compulsory residential school	7	(70)

Student Characteristics

The diverse nature of the courses examined in this study was reflected in the diversity of the student body. The dropout rate of distance students ranged from less than 10 per cent to almost 50 per cent, with most of this attrition occurring in the 1st year of study. The age range of distance students also varied significantly from those in their early 20's to those in their 60's. Some were already employed in the professions related to their program of study. On the whole, most lecturers were impressed with the quality of distance students, mentioning their high degree of motivation, confidence and organisational abilities.

How would you describe the student body that undertakes your course?

External Dropout Rate	**No. (%)**
<10 per cent dropout	1 (10)
10—20 per cent dropout	1 (10)
~ 30 per cent dropout	2 (20)
~40 per cent dropout	3 (30)
40—50 per cent dropout	1 (10)

External Age Range	**No. (%)**
20—60 year range	2 (20)
30—50 year range	1 (20)
25—40 year range	2 (20)
20—30 year range	1 (10)

Student Type	**Characteristics**	**No. (%)**
External	many in the profession	3 (30)
	mostly female	2 (20)
	highly motivated/serious	8 (80)
	need flexibility	10 (100)
	well organised	4 (40)
	high level of confidence	1 (10)
	knowledgeable/curious	3 (30)
	competent	2 (20)
	lacking basic skills	3 (30)
	low self-esteem	1 (10)
Internal	17-18 year old	8 (80)
	'point of entry deficiency'	4 (40)

Students needs were as varied as the students themselves. Whilst some needs were considered to be unique to particular discipline groups, other needs were evident in all groups. Health Sciences students, for instance, were felt to have special needs because of low self esteem and the need for a high level of support. These students

were mostly female, often returning to study after a long absence. Commonly expressed needs were for assistance in developing skills to enable them to study successfully, and such needs varied with the semester, tapering off as the student 'learns the ropes'.

'The main hurdle for the students is to get back into writing and study skills.'

'The students' needs vary with the semester. During the 1st semester, there is a hard core who need a lot of support'.

'At the beginning, the distance education students require support to develop realistic study patterns, where they should start and what they can cope with. It is a self-discovery process.'

'Many of the students are returning to study after a long absence and need reassurance just to hang in there and let themselves settle in. Their self-esteem is usually low, they do not see themselves as academics. This tapers off in semester 2 but some students need continual reassurance'

'They have life crises, quite different from those experienced by 18 and 19 year olds. Most of the women are in traditional marriages which requires the women to run the household and squeeze study in around the family's needs.'

For science academics ,the diversity of intake brings its own problems, as the needs of individual students vary so greatly.

'Their needs vary enormously due to the breadth of intake. The student body varies from a DSc through medicos and professional people to those who left school at 13, 30 years ago who have been accepted due to their mature age status. All their varying needs must be met.'

What are the particular needs of your students?

Characteristic	No. (%)
Skills development assistance	8 (80)
Communication skills	3 (30)
Reassurance/support/feedback	6 (60)
Student support network	3 (30)
Flexibility	4 (40)
Inadequate background in science	4 (40)
Industrial experience (internal students %)	1 (10)
Financial support	1 (10)

In contrast, on-campus students, typically 18–19 year olds, undertaking the same programs were seen to have needs quite different from their distance counterparts.

'On-campus student have different motivation. They often arrive at university not knowing in what direction they wish to go, they need guidance in that area.'

Half the respondents believed they were adequately meeting their students needs. The majority of those interviewed believed their students needed a very supportive staff who were highly accessible, though lack of finances constrained the level of support they felt they were able to offer.

'I send out letters as soon as I have names and addresses of the students. I spend a lot of time on the telephone to each student, a lot of energy is expended in this way.'

'There are problems as the student numbers keep going up but there is no increase in staff numbers.'

'Distance Education students really need a person available to them on the end of the phone at all hours .... but there is not the manpower .... The students who are assertive and chase me up with questions etc. are okay but those I do not hear from are a cause for worry as there is not the money in Applied Science to chase them.'

'The demands on time of the more senior lecturers are great (committees etc.) and hence there is very little time left to put into the development of flexible approaches.'

'I would like to be able to send a member of staff around other institutions to see what is being done and to come up with a plan .... but I cannot find a replacement for the staff member.'

How do you aim to meet their needs?

Category	**No. (%)**
Bridging courses	1 (10)
Supportive staff	7 (70)
Practical experience	1 (10)
Study skills development sessions	3 (30)
Student mentoring scheme	1 (10)
Assessment flexibility	2 (20)
Assignment representative of student interests/needs	2 (20)
HSC revision	2 (20)
Science Support Centre	3 (30)
News groups—d.e. and on-campus	2 (20)
Open Learning Agency of Australia pathway	2 (20)
Distance Education Centre efficiency	2 (20)
English as a second language assistance	1 (10)

As there is a large dropout rate amongst distance students, feedback concerning the success of the support strategies outlined in the table is skewed.

'I don't know about the ones who disappear into obscurity. It has helped some of the students.'

Even though the student body was so diverse, few of those interviewed could say that their subjects were designed with their individual learning needs in mind. Although, where possible, small changes were being tailored to facilitate the learning for these students.

'The audio tapes are popular as the student is able to put the tape in the player whilst driving to and from work.'

'Students at the D and HD level are extended, therefore in 1995 .... the students assignments were structured so that they could be given as papers for peer review.'

'I have tried to make assessments more accessible to the students .... emphasising their survey skills etc. rather than their writing ability.'

How are the subjects designed to meet the individual learning needs of your students?

Characteristic	No. (%)
Recognition of prior learning	3 (30)
Audio	1 (10)
Video	1 (10)
Student-run workshop/seminar	1 (10)
Student individual goals set	1 (10)
Change in coursework to suit individual interests	5 (50)
Change in coursework due to student feedback	1 (10)
Variety in subject design—d. e.	2 (20)

However, not all changes were seen to be successful or warmly received.

'In theory the course is taught in modules but this is just putting boundaries on the information for the moment .... the students do not get to choose the modules, they have to do them all.'

'Like most science and maths departments, we are not into individual learning contracts with students. We have not gone as far as people in the humanities.'

Support—Physical

All of those interviewed indicated a reliance upon the two distance education centres established at each of the universities. Both centres being essential for the dispersal of the print packages and for receiving and processing student assignments and marks. Both of these bodies were also concerned with staff development activities and the development of subject material for distance students and, both received criticism, particularly with respect to the training of new staff.

'I was seconded to the position in the university, I knew the subject area but nothing about distance education. There was nothing set up at .... to help me to slip into the distance education area.'

'I had to seek out the experts, they weren't immediately obvious.'

'I believe more active staff development for new staff would be very helpful.'
'There is probably still not enough time given and training provided for new members of staff. I believe the whole system needs improving.'

'Good for experienced staff, not so good for new staff.'

Respondents expressed a need for ongoing physical and psychological support for resource development and delivery.

' .... there are a lot of problems related to distance education, not specifically to my subject, that the staff need to discuss together. New staff need to be aware of the (distance education) *problems and bypass them if possible .... I feel quite isolated in my work .... '*

'They need to be constantly accessible to the students and have the support of other distance education teaching staff.'

'Distance education staff have to lecture face-to-face at residential schools, as do on-campus lecturers, cramming a semesters work into a 4 day session. Any mistakes, or bad impressions made during this time cannot be easily rectified.'

Respondents made comments on the level of funding.

'The level of funding is inadequate, the university pushes the staff to be innovative but doesn't support these initiatives financially.'

' .... they need time off but neither the department nor the university as a whole has the money to develop these things or allow staff members time off to do so.'

What infrastructure support in i) the university as a whole and ii) within your own department, is available and/or needed by you for your subject?

University Level	No. (%)	Departmental Level	No. ()
Distance Education Centre/ Open Learning Institute	10 (100%)	Commercial winery/vineyard	1 (10)
Dean's support	1 (10%)	Clerical support	1 (10)
Reference committee	1 (10%)	time release	1 (10)
Science Support Centre (int. Students %)	1 (10%)	Science Support Centre	1 (10)
Maths Support centre (int. Students %)	1 (10%)	Financial support (teleconferencing, print %)	3 (30)
Student Support Services	2 (20%)		

Although it was thought that these needs would change and attempts were being made to meet these needs.

'A lot of subjects are taught jointly, the staff members help and cover for each other if needed. The difficulty arises if there is only one person in the discipline area.'

'With the onset of new technology in the delivery of course material, the needs of the staff are changing as they try to learn the new procedures.'

What are the particular needs of your staff teaching the distance education subjects?

Category	No. (%)
Development officers	3 (30)
Administrative support	1 (10)
Course promotion	1 (10)
Distance education support/needs recognition	4 (40)
Distance education discussion groups	2 (20)
Distance education material development assistance	4 (40)
Lab. assistance—residential schools	2 (20)
STD telephone access	2 (20)
Time/availability	3 (30)
Anticipating/knowing student needs	1 (10)
Learn new technology	2 (20)
New staff /staff training —distance delivery	6 (60)
Support from other staff	2 (20)

How do you aim to meet these needs?

Category	No. (%)
New staff—support	1 (10)
Distance Education Centre/Open Learning Institute—support/instructional design	4 (40)
Educational development training	1 (10)
Team teaching	1 (10)
Voice mail	1 (10)
n/a	2 (20)

Many distance education staff were also concerned with on-campus delivery but hard specific concerns about distance delivery students:

· the physical separation of staff and student; and

'The problems that the internals face can be dealt with immediately, but those of distance education students can hang on.'

'On-campus lecturers can usually retrieve any mistakes that have been made. The student are also more available so that potential problems can be sorted out more easily.'

- the problem of timing with respect to resource development.

'The on-campus staff have time to prepare their work as they go along whereas distance education staff have to prepare everything six months in advance. They have to think ahead, anticipating how the students will react to the work .... the distance education staff share some of the alienation of the students.'

'Distance education staff also need the time to develop material they are happy with as all the information etc. goes out in the mailed packages at the beginning of the year.'

How do you feel these needs differ from those staff involved with/working in on campus delivery?

Category	No. (%)
Specific problems related to distance delivery	5 (50)
Availability out of hours	4 (40)
Lack of time	3 (30)
Lack of money for materials development	1 (10)
Resource preparation problems	2 (20)
Alienation	2 (20)
On-campus staff—motivating contact with students	1 (10)

At times there seemed to be conflict between the needs of on-campus and distance delivery.

'The present formula holds face-to-face teaching in high regard, therefore the distance education people don't get much recognition.'

'We are being constrained by the university calendar and the staff feel powerless to change it. The timetable is generated by on-campus needs, not giving due consideration to of-campus students.'

'If the staff were only teaching externals or only teaching internals then the staff would be better able to do more of their own research.'

'Distance education staff are treated as the poor cousin. Most of the resources are going to on-campus delivery with distance education working on a shoestring .... there is not equitable sharing of resources.'

'The staff have a lot of enthusiasm for preparing learning materials for distance education, what they learn from doing so enhances their on-campus delivery.'

Support—Psychological

Most of those interviewed felt that there was little freely available psychological support for staff and what was available was not backed up with resources. Only 2 per cent of respondents believed they had such support.

'The content is dictated by the course coordinator with some industry input, but not as much as we would like as this input costs money.'

'From top down there is the pressure to be more flexible .... The university is supportive psychologically but hasn't the resources to be physically supportive as well.'

'The winery gets a lot of support from the university as it is part of the whole public relations of the university.'

'University staff are not very well supported to help them improve their teaching .... there is a lot of support to go for DEET grants to increase the staff member's expertise in distance education.'

' .... find myself struggling with some distance education issues that I feel would benefit from open discussion with more experienced lecturers.'

The Courses

Innovations in Delivery

More than 50 per cent of respondents believed they were using unique strategies in their subject delivery.

'One of the core subjects—"history of ageing" wherein the students look at literature (poetry, drama, novels, etc.) in order to understand how society has treated its aged over the years. They look at the dilemmas facing old people not just the medical side; students have a major assignment on this work.'

'The conference presentation whereby high-fliers are given the opportunity to present their own research finding, encouraging independent learning.'

'Audio tape development—a chat tape about the introductory work of .... which is philosophically based and is better done via discussion. Trying to teach grey material via distance education is difficult; you can't sit down and discuss it, argue through the issues etc.'

'I have the students do their assignments on audiotape. One assignment involves the students doing a professional seminar (talk) .... they also have to do a 10–15 minute tape of a interview with a farmer, in this time they have to create a word picture of this experience.'

Is there anything in the way you teach this subject, or how you coordinate the course, that you feel is unique?

Category	No.	(%)
Netface—computer bulletin board	2	(20)
Conference presentation	1	(10)
Multidiscipline approach	1	(10)
Teleconferencing—assessed	1	(10)
No residential school	1	(10)
Student-run workshop	1	(10)
Mobile workshops	1	(10)
Audiotape communication	2	(20)
University field environment	1	(10)
Farm stay project	1	(10)
Optional residential school	1	(10)
Send home exam	1	(10)
Professional development focus	1	(10)
Interactive teleteaching	2	(20)
Teaching fellows	2	(20)

Teachers within the science programs believed they have to deal with the same problems inherent in science education in other tertiary institutions, and have developed specific strategies to address these issues:

'We try to get some content across to the student, but most of this will be outdated in five years. I believe the most important thing to get across to the student is a positive work ethic.'

'Each year Teaching Fellows are appointed for 12 months, from secondary schools. They are involved in the teaching at first year level as well as doing some research into the needs of students who come into the university straight from Year 12.'

Are there any characteristics about your student body that have prompted/ necessitated you to develop your subject delivery?

Characteristic	Delivery	No. (%)
Peers, professionals (knowledgeable, motivated, demanding %)	A-Class material/delivery; reflective learning/practice	2 (20%)
Difficult material via d.e.	Audiotape discussion	1 (10%)
Thinking skills deficient	Laboratory and teaching approach design	5 (50%)
Experience in d.e. delivery	Change in internal delivery	2 (20%)
Specific Needs	Flexibility of approach/ adoption of technology	3 (30%)

Some problems, however, were unique to distance students:

'The external students are very knowledgeable and demanding. They are highly motivated and curious, so you have to teach your subject well and present A Class material.'

The students are professionals and my peers. There is no teacher delivery, instead they each engage in reflective practice, both in the teaching and learning.'

'The practical work that the internals and externals do is not greatly different but the students do differ, the internals are not as confident or rapid in their work, whereas the externals are experts.'

'In the theoretical subjects the distance education students are not as good but in technical subjects they are better.'

One positive outcome from staff interaction with these students has been a change in approach to teaching on-campus students.

'Our experience with distance education students has changed the way we now teach the internal students. We want the internals to be more independent in their learning and adopt life-long learning techniques.'

In common with National Teaching Development Grants recipients, the issue of developing and enhancing student thinking skills was also seen to be an issue of importance for most of those interviewed at Charles Sturt University and Monash.

'Students need to be able to think, this is the most important skill to be developed, hence the approach to laboratory work.'

Innovations in Assessment

Most staff (n=8) admitted to very little innovation in the way they assess their subjects. Two respondents indicated they had changed their methodology, to the use of group assessment and teleconferencing assessment.

What assessment strategies do you use?

Category	No.	(%)
Exam r.s. exam 20 per cent, exam 40 per cent, assignments 40 per cent (n=1%) r.s. exam 10 per cent, exam 40-60 per cent (n=1%) exam 50-60 per cent (n=2%)	7	(70)
Residential school exam	2	(20)
Practical Exam	1	(10)
Assignments/essays	10	(100)
Practical work—reports	6	(60)
Seminar	3	(30)
3-tiered assessment (self-formative, summative %)	2	(20)

Those few whose courses gave more recognition to individual learning needs were also the ones who were aware that assessment flexibility and feedback is essential.

'There are no exams in the core units or the course, I decided to cut them out after the first year as they were not giving the students any feedback.'

'I give a short 1 hour exam at the residential school (~10 per cent) in order to give them early and rapid feedback about how they are going. For distance education students, working at home often give them a false sense of security about how well they are going.'

Outcomes—Measurements of Effectiveness of teaching and Assessment Strategies

All those interviewed have measured the effectiveness of their courses, in the main via student questionnaires, often organised by the institution itself, via the distance education centres.

Have you measured the effectiveness of your teaching and/or assessment strategy(ies)? What tool did you use to do so?

Category	No. (%)
Yes	10 (100)
Student questionnaires (n=10%)	
Course review (n=2%)	
Informal student feedback (n=3%)	
Teaching development unit (n=1%)	
OLI/DEC surveys (n=10%)	
Exam results (n=1%)	
Employer feedback (n=1%)	
External review (n=2%)	
Peer assessment (n=2%)	

Such surveys, however, were often generic, not necessarily focussing on specific aspects of the teaching and learning environment.

‘ .... not as well as we would like. Assessment of teaching approach is not something that has been thought about.’

The results of these surveys may indicate the popularity of particular courses, but these may not necessarily have the best learning outcomes.

‘I believe it is a bit of a minefield as my course is not all that popular with the students as it has different expectations.’
‘The philosophy is to provide feedback to the individual lecturer, not to provide an overview of what is going on.’

‘Distance education materials are very public documents, therefore it will get peer assessment very quickly and vocally, both formally and informally. The potential for getting things wrong in a distance education document is higher than on-campus, and if it is wrong in print, then you get to hear about it very soon.’

Most respondents (80 per cent) felt their courses did not deal well with the individual learning needs of the students, but some had tried to introduce some strategies to address this problem, particularly by the use of more tailored assignments.

‘The students were allowed to research topics that were of interest to them, and allowed to run with it. The assessment was different depending where the assignment ended up.’

‘Assignments are universal but have a wide variety, there is not just one type of assessment.’

To what extent are these teaching and/or assessment strategies tailored to the individual learning needs of your students?

Strategy	No. (%)
Individual research topics	1 (10)
Flexible assessment	2 (20)
Assignment extensions	2 (20)
Assignment variety	1 (10)
Journal	2 (20)

Constraints on Innovation

Tailoring course teaching and assessment strategies to the individual needs of students was seen to be problematic in a learning environment governed by a rigid institutional structure.

'The external materials go out without any modification according to the student.'

'It is easier to negotiate with internal students, the distance education material has to be worked up 6 months in advance and in this package, you have to include your assessment strategies, this is the culture of distance education at Monash.'

Time constraints were a concern as was the availability of learning resources.

'We try to use the three-tiered assessment strategy—self-assessment, formative assessment followed by the summative assessment .... It is difficult to do the three tiered assessment with the increasingly short semesters.'

'I have to be careful about the topics as the more topics I set, the more reading I have to send out as there is no information in the library.'

Assessment was seen as a time consuming task for staff, which inevitably impinged on their other roles in academia. This is of particular relevance in the present Higher Education climate where academics are required more than ever to perform across a range of institutional responsibilities.

'We are willing to try anything that will help the process .... We want to keep looking for techniques that will save time and therefore allow more time for research.'

Outcomes—Student Performance

Gathering student performance data from individual lecturers was problematic, much of the information they had available was anecdotal.

'Students conform to the university norms and are sought after in the workplace.'

'There is a large diversity of students in first year, therefore there is a large spread in the marks.'

Similarly comparative data for on-campus and distance students was either not available or anecdotal.

'Generally the distance education students do a bit better than the internals, sometimes markedly better. The two results seem to be coming closer together as the pressures on distance education students become more intense.'

'Distance education students have an advantage as they come into the course with a broader educational background, and they choose the subjects that they are interested in, therefore their motivation is higher. Internal students really have no idea.'

Outcomes—Effectiveness of Course Design

Nearly all of those interviewed (90 per cent) felt happy with the way in which the different components of their courses worked for the student. Respondents felt that such issues were adequately addressed in the initial design of the course.

'The course is a multidiscipline approach to ageing. Race, class and gender perspectives are pulled together into the main philosophy of the course.'

'For most part the components are fine, it's the timing that is important. Most of the people are into the practical work, they can't get in touch with the need to have the theory.'

'Our aim is to start from the normal and continue onto the pathological .... We try to link them together as closely as possible.'

'When preparing the courses, there is now more of a focus on how the subjects go together. We now have to state the generic skills being addressed in the subject. There is a course advisory committee .... who give very valuable advice.'

How well do you believe the different components of the course work together for the student?

Category	No. (%)	Components
Good	9 (90)	Debate/discourse (n=2) Multidiscipline Careful timing of delivery (n=1) Task variety (n=1) Reduced importance of exams (n=1) Group and individual work (n=3) Problem solving skills development → 3rd year project Generic skills addressed (n=1) Theoretical framework provided (n=2) Subjects building on each other (n=1) Flexibility (n=1) Course advisory committee assistance (n=1)
Okay	1 (10)	Weak in oral skills development (n=1)

Outcomes—Lifelong Learning?

Staff Perceptions

Whilst all respondents believed that their program was aimed at cultivating the capacity for lifelong learning, they varied in their belief that this particular ambition was fulfilled.

‘ .... this development is seen by the progression of the students, their work changes as they go along. The challenges set within the learning material is taken up by the students.’

‘There have been requests from the students to do masters courses. Some of the students have gone back to the workplace and become involved in staff development. Others have gone on to become teachers themselves.’

‘Students are required to do literature reviews, find information and know how and where to do so, and develop writing skills. All these skills are lifelong skills.’

The necessity to deliver specific competencies was seen as fundamental to few respondents (20 per cent), though 70 per cent felt that they were doing a good job in delivering both specific competencies and cultivating lifelong learning.

‘I feel a lot of the generic and transferable skills are picked up incidentally. However people are thinking a lot more about what sort of skills are being developed in their subjects. I want the students to have the experiences of using particular instruments, because it is then easier to pick up other instruments.’

Nevertheless, the measurement of such outcomes was seen to be open to question.

‘ .... Difficult to measure. Not too many undergraduates have any concept of lifelong learning.’

‘.... must be doing something right as graduates of 15 and 20 years ago still have their subject notes, they are widely photocopied and passed around in the industry and are seemingly well regarded.’

Student Perceptions

Most of the students (78 per cent) who responded to the survey were undertaking the course in order to obtain qualifications, the remainder were studying to upgrade their existing their qualifications. The particular subject under consideration, was undertaken by all students as it was compulsory for the successful completion of their degree. All the students responding were studying via distance, hence for the most part, the subject material was presented in print form and dispatched via the mail. The print package consisted of study guides, notes, readings and recommended text. One subject supplied a video for presentation of laboratory techniques. The majority of students (89 per cent) were required to attend residential schools. On the whole, students were happy with the resources supplied to them. Forty-four per cent mentioned the good level of library support for their assignment research. However, problems related to physical distance necessitated by study via distance education were apparent.

‘The main disadvantages are again those of distance education (e.g. time taken to request/receive data by post).’

‘Hard to find out exactly what was required to be learnt/known.’

Though such problems can be overcome.

‘Simple suggestions and useful techniques that help to understand university study.’

Work undertaken was typical of independent study, with home study taking up to 10 hours per week. Many students mentioned the need for computer access to enable Internet and library database searches for assignment research. Slightly less than half (44 per cent) of the student respondents felt that the subject under discussion was different from others they had experienced. The differences mentioned included exceptional field trips, information delivered at a level of difficulty not often encountered and staff who were trying to encourage deep learning.

‘I was impressed with the helpful attitude of the staff in this subject, the emphasis being on thoughtful learning rather than fact assimilation.’

The skills required for study via distance related very much to the development of autonomous learning skills. Time management rated highly as a desirable skill (44 per cent) and other generic skills were mentioned frequently. A number of students felt that you had to be able to interpret and assimilate a great deal of information in order to do well in assignment work.

'Skills for rapid assimilation of facts and interrelated reaction in practical work.'

'Extreme self motivation and ability to read and comprehend massive amounts of information in short times and turn this into quality assignments/essays.'

Fifty-six per cent of students felt that they had the necessary skills to function in the learning environment, with a further 22 per cent developing the skills as they proceeded with their learning. The majority of students (67 per cent) felt they were given enough support to help them develop the required skills, though a significant number (33 per cent) were unhappy with what was provided.

What skills did you need to work in this manner

Skills Required	**(%)**
Time management	44
Information interpretation skills	22
Laboratory skills	22
Dedication/perseverance	22
Motivation/interest	22
Study skills	22
Exam technique	11
Communication	11
Organisation	1
Computer journal search	1

The role of the lecturer/tutor was of less significance to the distance students when compared with National Teaching Development Grants respondent students, though the value attached to the instruction giver/information provider was still apparent.

What role did the lecturer and/or tutor play in the subject delivery?

Staff Role	**(%)**
Lecturing/information provision	44
Facilitate understanding	22
Feedback	11
Residential school—instruction	22
Very little	11

Most students (66 per cent) felt that their lecturer/tutor was readily available when required, but only 44 per cent felt that they gave students as much support as was needed.

'I am trying my best to develop this skill but am not aware of any additional services that I would have the time to take up in addition to the massive amount that this course already presents.'

'I'm a bit unlucky in labs. When I look around for demonstrators they're often engaged in explanations to others (probably because I'm slow so come to the tricky bits after).'

'I usually find self-assessment questions provided in study modules useful in determining progress, for which reason one requires the answers to these questions. These were not made available supposedly because of cost of postage. This I find difficult to believe for a university involved in distance ed.!!'

Many of the students felt their distance courses (77 per cent) had unique qualities, both in their method of delivery, particularly with respect to the delivery of practical work during residential schools, and in the assessment strategies used.

'Plenty of time to ask questions due to the nature of the experiments (requiring long times for things to occur etc.) and read to totally understand what we were doing because the practicals involved knowledge which we had not covered as yet with the course work.'

' .... except for perhaps losing a third of a mark for each incorrect answer in a multiple choice exam. I think this is quite fair as scientists need to be exacting in their knowledge and calculations.'

Unique qualities were not always good ones, though it is unclear if this comparison of uniqueness was being made between this subject and others undertaken at university or being compared with workplace practice.

'The way the labs. were run was poor. Methods/instructions not explained fully .... .A lot of pressure in labs for equipment. Everything was done in a hurry so a lot of thought could not be put in. Our aim was just to get a result. We couldn't get much of a depth of understanding from the prac. work. A shame as the pracs. should be designed to get the maximum understanding from them.'

All students were aware of qualities in the delivery of their subjects that were beneficial to their learning.

Are particular aspects of this subject delivery that were beneficial to your learning?

Benefits	**(%)**
Information gathering/research skills	11
Study organisation	11
Practical work—skills development	44
Holistic approach to learning	11
Introductory lecture—enhanced understanding	11

Students were appreciative of the skills that they developed as well as the sense of community embodied in the residential school.

'Residential schools are almost essential for distance students for clarification of ideas and concepts, finding compatible fellow students for mutual help, study and support and brief social and academic contacts with other students and lecturers.'

'The essay requiring up-to-date journal reviews was difficult and time consuming in gathering the information as it was a new skill for me. But this essay really placed the fundamental learning strategies in my head! So for a learning outcome, this was excellent (in hindsight!!!).'

Distance students (56 per cent) were also aware of problems with learning in the manner in which they did. Aspects that were highlighted as being detrimental to learning included the voluminous amounts of information required to be understood, as well as its often ambiguous and inconsistent nature.

' .... mainly inconsistencies in the notes which should be avoided as should ambiguity.'

Some assessment systems were of concern.

'The negative marking system as it did not allow the students who were bad at exams to gain extra marks in assignments unless they had everything correct.'

These same students had suggestions for improvements, including better organisation/presentation of information incorporating the use of flow diagrams, less assumptions about prior knowledge, revision of the basics and better timing of both the delivery and assessment of material. No students approached the lecturer with such suggestions but the majority (86 per cent) felt that the relevant staff member would be open to their suggestions, even though improvements might prove problematic.

'Yes—they considered my alternative methods in the prac. classes and we discussed the 'fors and againsts' for such method.'

'Probably, but I suspect the solution is out of their control.'

Equal numbers (44 per cent) of students felt that the subject delivery methodology would help them with future work or study.

'Surprisingly enough I haven't found a subject yet (it's sill early days) that I have directly or indirectly implemented in to my work practices that either I didn't already know or could improve upon.'

'The labs and parts of the subject taught you good lab. techniques for getting reproducible results and handy information if one had to set up their own lab. in a winery.'

'No more and no less re course work. But the skills of researching current literature through Medline will.

Sixty-seven per cent of respondents judged that the delivery of other university subjects could be enhanced.

Do you think the delivery of other subjects could be enhanced? Please explain.

Recommendations	**(%)**
Alternative/extended explanations included	33
Audio/video tape usage	22
Increased relevance to workplace	11
Individual laboratory work	11
Assignments—interesting/motivating/relevant	11
Text—up-to-date	11
Fair exams	11

'Assignments should encourage you to go out and find your own answers and material.'

'Video tutorials or lectures on some new material would be different and effective.'

'Unfortunately too many course notes are merely summaries of relevant points in the given text. Examples included can throw light on the meaning of given facts and should be included where relevant. Probably most lecturers familiar with their material do not realise how ambiguous their written notes may be.'

Though appreciative comments were forthcoming from distance students as they were from National Teaching Development Grants students.

'I really believe the distance education unit does a superb job and the resources are more than adequate.

Outcomes—Student Employment Profiles

Employment profile data from Charles Sturt University is presented in public documents and briefly summarised in Appendix 1. No such information was available, or if available was not forthcoming, from Monash University. Information available from individual lecturers was mostly anecdotal. Due to the recent introduction of two of the courses studies, at the time of the interview, no students had graduated.

The perception amongst academic respondents was, however, that the majority of distance education students were already employed and seeking, by way of their degree, to gain promotion, formal accreditation or a change in career path.

'Most of the students are external and they have jobs already. The internal students usually change to external while looking for jobs in the industry. We have not yet had a surplus of graduates.'

'At present, most are dealing with people in institutions, mainly the elderly. In the future, graduates will be in community services more than institutions.'

Summary

Twenty six National Teaching Development Grants recipients and 41 of their students contributed to this investigation. To achieve this target number, 82 academic and 41 students, spanning the broad discipline of Science, were contacted. This apparent low level of willingness to be engaged in the broad discourse surrounding open learning issues is not indicative of lack of interest, as these individuals were selected on the basis of their commitment to the principles of open learning. It is, however, indicative of the constraints under which individual academics operate. The majority who declined to participate did so because of time constraints.

This stress of commitments and allied feelings of lack of support are reflected in the discourse of individuals who did contribute to the study. For many, the obstacles presented by other staff and their own institutions led them to believe their work would die with them. Counterbalancing this negativity was the genuine belief they were giving something better to their students. Although this anecdotal *'gut response'* was not frequently backed up by what some would view as hard-core objective data, this perspective on evaluation, interestingly enough, narrows the picture presented by an analysis of initial motivations for change experienced by those individuals; in the majority of cases, the initial ideas and their implementation were drive by 'gut reaction'. However, it is also worth noting that the subsequent development of their ideas and activities was driven by student responses.

From the students' perspective, the strategies adopted by National Teaching Development Grants recipients were on the whole seen as effective, although insufficient time had elapsed to critique the long-time impact of these innovations. Of the two distance delivery institutions selected for this study, the most willing

and informative responses came from Charles Sturt University. To achieve the target of 10 individuals involved in distance delivery, relevant courses at both institutions were selected and the institutions contacted to nominate individuals coordinating or teaching in these courses. This process through Charles Sturt University ultimately resulted in 8 individuals who committed to the study out of 23 contacted. At Monash University it only resulted in 2 (out of 6). Similarly, access to students and associated performance data was problematic, with constraints imposed by perceived difficulties with issues of confidentiality and lack of records. Nevertheless, 50 student respondents engaged in the study.

Innovations in teaching within the framework of distance delivery, itself a subset of open learning, were seen as difficult to implement by academic respondents. Although most viewed this mode of delivery itself as an effective strategy and which was now effectively being used with 'on-campus' students.

Constraints with respect to personal and institutional support were also identified by distance deliverers; however, problems of continuation and physical resourcing were less than that recorded with National Teaching Development Grants recipients. Problems of morale over shrinking resources were apparent.

Students who were the recipients of distance delivery were characteristically quite different from students of National Teaching Development Grants recipients. Many were already in the workforce; hence, their appreciation of their courses were often more closely tied to their own perceived workplace needs. They were uniformly appreciative of opportunity but by the same token more critical of what they perceived to be ineffective practice. The level of response from this particular cohort of students was small (<1 per cent) to date, although responses are still trickling in. Such a low level is perhaps related to the diversity of the student group; employment and domestic responsibilities and physical and emotional distance from the institution.

In total, from this study a clear picture emerges of the need to support individuals and institutions in the initiation, implementation and continuation of valuable teaching practices and their critical, objective evaluation. Frameworks for such evaluation are in place in all institutions studied; the Student Feedback Questionnaire was the most widely used tool. However, this tool primarily explores students' perceptions at the end of their course. There is no long-term, extended, objective evaluation of the impact of open learning on the generic and specific competencies of student cohorts. There is thus a clear need to close the loop with respect to undergraduate education by relating outcomes manifest in the workplace back to development and implementation of teaching/learning strategies.

Appendix 1: Distance Education Provider Statistics

Charles Sturt University Student Enrolment Data—1994 to 1996

Table 1: Total Enrolments by Faculty and Year

Faculty	1994		1995		1996	
	No.	*%*	*No.*	*%*	*No.*	*%*
Health Studies	2066	11.62	2252	11.01	2906	12.76
Sci. & Agr.	4525	25.45	4950	24.20	5352	23.50

Table 2: Total Enrolments by Mode

Mode	1994	1995	1996
Internal f/t	5,393	5,587	5,706
Internal p/t	1,106	1,286	1,121
Distance education	11,282	13,580	15,946

Table 3: Commencing Enrolments

Year	No.
1994	7,919
1995	10,128
1996	10,505

Table 4: Course Completions: by Faculty, Mode and Year

Year	1994				1995				1996			
	Int. f/t	*Int. p/t*	*Dist ed*	*Total*	*Int. f/t*	*Int. p/t*	*Dist ed*	*Total*	*Int. f/t*	*Int. p/t*	*Dist ed*	*Total*
Health	21	56	309	386	65	99	498	662	47	80	468	595
Studies	5.4%	14.5%	80.1%		9.8%	15.0%	75.2%		7.9%	13.4%	78.7%	
Sci. &	47	171	576	794	31	18424.1	548	763	41	201	636	878
Agr.	5.9%	21.5%	72.5%		4.1%	%	71.8%		4.7%	22.9%	72.4%	

Table 5: Staff Numbers/Student: Staff Ratios

Faculty	Health Studies		Science & Agr.	
	Staff Numbers	*Staff/Stud Ratios*	*Staff Numbers*	*Staff/Stud Ratios*
1994	52	14.89:1	170	16.51:1
1995	56	16.03:1	165	17.96:1

Charles Sturt University—Graduate Survey Data (1993, 1994, 1995)

Table 1: Mean Age and Salary Represented by Mode of Study, from 1993–1995

Year	Data Collected	Internal F/T	Internal P/T	Distance Ed.	Mixed
1993	No. respondents	100	8	153	43
	per cent response	25	3	61	11
	Mean age	23	32	37	29
	Mean salary	$25,453	$30,049	$38,348	$28,967
1994	No. respondents	77	20	310	70
	per cent response	16	4	65	15
	Mean age	24	36	37	29
	Mean salary	$34,376	$37,247	$37,695	$34,448
1995	No. respondents	111	21	283	65
	per cent response	23	4	59	14
	Mean age	23	36	38	29
	Mean salary	$25,729	$39,534	$37,294	$31,302

Table 2: Activities Currently being Undertaken by Graduates, Represented by Mode of Study Undertaken for Course, from 1993–1995

Year	Mode of Study	P/T Work %	F/T Work %	Seeking Work %	F/T Study %	Other %
1993	Internal f/t	19	42	9	27	3
	Internal p/t	9	73	-	9	9
	Distance ed.	13	81	3	2	1
	Mixed	20	60	7	13	-
1994	Internal f/t	17	44	8	30	1
	Internal p/t	15	85	-	-	-
	Distance ed.	14	78	4	1	3
	Mixed	23	52	11	11	3
1995	Internal f/t	14	69	7	7	3
	Internal p/t	6	58	13	20	3
	Distance ed.	10	80	5	-	5
	Mixed	16	76	3	1	4

Table 3: Employment Sectors Taken up by Charles Sturt University Graduates, Represented by Mode of Study Undertaken for Course, from 1993–1995

Year	Mode of Study	Commonlth Govt. %	State Govt. %	Local Govt. %	Education %	Private %
1993	Internal f/t	13	10	3	19	55
	Internal p/t	10	30	-	40	20
	Distance ed.	8	23	12	24	33
	Mixed	8	16	8	22	46
1994	Internal f/t	12	12	2	12	62
	Internal p/t	5	16	5	48	26
	Distance ed.	8	25	16	22	29
	Mixed	8	21	8	24	39
1995	Internal f/t	5	14	4	9	68
	Internal p/t	-	11	5	32	52
	Distance ed.	9	24	8	34	25
	Mixed	6	39	6	17	32

Monash University Student Enrolment Data—1994 to 1996

Table 1: 1996 and 1997 Enrolments, by Campus, for Science and Science/Business and Economics Degrees

Year	Degree Faculty	Clayton	Caulfield	Peninsula	Gippsland	Parkville	Berwick	Total
1996	Science	2759 (79%)	130 (3%)	1 (<1%)	600 (17%)	-	-	3490
	Science/Bus and Eco	-	-	-	31 (100%)	-	-	31
1997	Science	2763 (79%)	133 (3%)	1 (<1%)	597 (17%)	-	-	3494
	Science/Bus and Eco	45 (61%)	-	-	29 (39%)	-	-	74

Appendix 2: University Questionnaire

Interview Schedule

1. Course Name

2. Subject Name

3. How many years has the course been in operation?

4. How many years has the subject been in operation?

5. How many internal and external students are enrolled in the subject, both currently and historically?

6 (a) Does the course have flexible, or multiple entry and exit points? (eg. course modules etc.) If so, please explain.

(b) Does the course have flexible times of delivery?

(c) How are the subjects designed to meet the individual learning needs of your students?

7. What are the entry requirements for your subject?

8. What is the discipline area being addressed?

9. What is the mode(s) of delivery used in your subject?

10. (a) What infrastructure support in i) the university as a whole and ii) within your own department, is available and/or needed by you for your subject?

(b) Did you have/need psychological support as well as the physical?

11. (a) How would you describe the student body that undertakes your course?

(b) What are the particular needs of your students?

(c) How do you aim to meet their needs?

(d) Do you feel you are successful in meeting these needs? How?

12. (a) What are the particular needs of your staff teaching the distance education subjects?

(b) How do you aim to meet these needs?

(c) Do you feel you are successful in meeting these needs? How?

(d) How do you feel these needs differ from those staff involved with/working in on campus delivery?

13. (a) Is there anything in the way you teach this subject, or how you coordinate the course, that you feel is unique?

    (b) Are there any characteristics about your student body that have prompted/necessitated you to develop your subject delivery?

14. (a) Have you introduced any teaching and/or assessment strategies that you feel are unique?

    (b) What assessment strategies do you use?

    (c) Have you measured the effectiveness of your teaching and/or assessment strategy(ies)?

    (d) What tool did you use to do so?

    (e) To what extent are these teaching and/or assessment strategies tailored to the individual learning needs of your students?

15. (a) Do you have any information on the performance of students in your subject areas over the last few years?

    (b) Would it be possible to have access to this information?

    (c) Do you have any comparative data of students who undertook this course via distance education and on campus delivery?

    (d) Would it be possible to have access to this information?

16. (a) How well do you believe the different components of the course work together for the student?

    (b) How effective do you believe your program is in cultivating life-long learning in individuals or delivering specific competencies?

17. (a) Do you have any information on the employment profiles of your graduates?

    (b) Are you happy to provide us with this information?

Appendix 3: Distance Education Student Questionnaire

Student Questionnaire

We would like your assistance in helping us identify the characteristics of flexible learning in undergraduate science education. When answering these questions, try to think about the advantages and disadvantages of learning the subject/topic in the manner that you did. Was it valuable to your learning or not? Think about what it meant to you, the characteristics that you felt most comfortable with and any that you felt could be improved upon.

Please tick in the boxes, or write in the spaces where appropriate. Any answers that you give will be anonymous and remain confidential. Please answer as honestly as you can. Thank you for your assistance.

1. Sex Male ❑ Female ❑

2. Date of Birth _____/_____/_____

3. Study mode On-campus: Full-time ❑ Part-time ❑

   Distance Education ❑

   Other ❑

   If Other, please explain

4. Work experience to date

_____

_____

_____

5. (a) _____ Name of the degree being u

_____

   (b) For how many semesters have you been enrolled? c) Why did you choose to do this course?

_____

6 (a) Name of the subject under discussion

_____

(b) Why did you choose to do this subject?

7. Award given for the subject (if applicable)

8 (a) How was the subject material presented to you?

(b) What resources were available to support its delivery? How easy to use/ informative/useful were they?

9 (a) Briefly describe what kind of work you did, both on and/or off campus, in this subject (include home study, residential schools, field work etc.

(b) How did this differ from other subjects that you study?

10 (a) What skills did you need to work in this manner?

(b) Did you feel you had these skills?

(c) If no, were you given the support and/or opportunity to develop them. Please explain?

11 (a) What role did the lecturer and/or tutor play in the subject delivery?

(b) Were they readily available for you when you required them?

(c) Did you get as much help and/or support as you needed? Please explain.

12 (a) Were there any parts of the subject delivery and/or its assessment that you thought were unique? Please explain.

(b) Do you feel there are particular aspects of this subject delivery that were beneficial to your learning? Please explain.

(c) Do you feel there are particular aspects of this subject delivery that were detrimental to your learning? Please explain.

13. (a) Do you think any parts of the subject delivery could be improved upon? Please explain.

_____

_____

_____

(b) If yes, did you approach the lecturer/tutor with criticisms/suggestions for improvement?

_____

_____

(c) Were they, or do you think they would have been, open to your point of view? Please explain.

_____

_____

14. Do you think the way in which this subject was taught will help you with your work/study in the future? Please explain.

_____

_____

_____

15. Do you think the delivery of other subjects could be enhanced? Please explain.

_____

_____

_____

This Questionnaire has been developed for use in a Department of Employment, Education, Training and Youth Affairs Evaluations and Investigations Programme Grant.

Project Investigators:

Associate Professor Elizabeth Deane
Associate Professor Alison Elliott
Dr Roy Tasker
Dr Carmel Coady
Dr Sharon Fraser

University of Western Sydney, Nepean

Evaluations and Investigations Grant Project

'Doers and Thinkers: An investigation of the use of open-ended learning strategies to develop life-long learning competencies in undergraduate science students'

You have been selected, on the basis of your previous enrolment in _____, to participate in a research project investigating the effectiveness of different approaches to teaching in tertiary education. Your participation in the project is voluntary and the answers you give will be treated as confidential and remain anonymous. Your name is required in order to indicate your consent to take part in the project, it will not be used for any other purpose. Your responses will be given a number and will not be identified by name. The information you supply will not be read by your lecturer/tutor or have any bearing on your grade. Thank you for your participation.

Name: _____
Student No.:_____
Date: _____

I _____ (signature), consent to complete the questionnaire. I understand that my participation is voluntary and the information contained therein will remain confidential and anonymous. I understand that I can withdraw at any time.

When completed, please send to:

Dr Sharon Fraser
Department of Biological Sciences
Faculty of Science and Technology
University of Western Sydney, Nepean
P. O. Box 10
KINGSWOOD NSW 2747
AUSTRALIA

Appendix 4: National Teaching Development Grants Questionnaire

Interview Schedule

1. (a) What motivated you to apply for the CAUT grant and undertake the development of your project?
   (b) What were you trying to achieve?
   (c) Do you/did you, have psychological support from your peers in applying for the CAUT grant?

2. (a) What were the particular needs of your students? *(Why do you think that, did you have physical evidence?)*
   (b) How did you aim to meets their needs?
   (c) Were you successful in meeting these needs, ie what particular strategies did you adopt?

3. (a) Were there particular needs of your staff with respect to effective delivery ie resources? *(Why do you think that, did you have physical evidence?)*
   (b) If so, how did you aim to meet their needs?
   (c) Were you successful in meeting these needs?

4. (a) Did your original ideas, or the procedure involved in the project, change as it developed?
   (b) If so, can you explain how and why they did so?

5. (a) What facilities and/or support staff did you need to successfully develop and implement your project?
   (b) Did you have psychological, as well as physical support from your peers in doing so?

6. What facilities and/or support staff does the project require for ongoing implementation?

7. (a) Have you measured the effectiveness of your teaching strategy(ies)?
   (b) What tool did you use to do so?
   (c) Would it be possible for us to have access to the summarised data or a copy of the CAUT report?
   (d) Have you any thoughts about doing a controlled experimental design in your data collection? (to counter claims of anecdotal evidence?)

8. (a) How effective do you believe your program is in cultivating life-long learning in individuals and/or delivering specific competencies?

   (b) Have you attempted a direct comparison with students doing the subject through traditional means?

   (c) Do you think this would be a useful thing? Please explain.

9. How effective do you believe your program is in facilitating flexible delivery and access to courses?

10. (a) How easily/willingly do you think your ideas/teaching will be adopted or regarded by your colleagues?

    (b) Have you encountered any resistance to change amongst your peers or within your institution. If so what strategies have you used to counter this?

    (c) Do you think there is a cultural change needed?

11. Do you believe this mode of teaching is more effective than other methods you have used? If so, please elaborate.

12. Do you believe this is a more cost-effective mode of delivery? If so, please explain.

13. Have you achieved your goal?

Appendix 5: National Teaching Development Grants Student Questionnaire

Student Questionnaire

We would like your assistance in helping us identify the characteristics of flexible learning in undergraduate science education. When answering these questions, try to think about the advantages and disadvantages of learning the subject/topic in the manner that you did. Was it valuable to your learning or not? Think about what it meant to you, the characteristics that you felt most comfortable with and any that you felt were inadequate or could be improved upon.

Please tick in the boxes, or write in the spaces where appropriate. Any answers that you give will be anonymous and remain confidential. Please answer as honestly as you can. Thank you for your assistance.

1. Sex Male ❑ Female ❑

2. Date of Birth _____/_____/_____

3. Study mode Full-time ❑ Part-time ❑ Other ❑

   If Other, please explain.

4. Work experience to date

   _____

   _____

   _____

5. (a) Name of the degree being undertaken?

   _____

   (b) For how many semesters have you been enrolled?

   _____

6. Name of the subject and/or topic under discussion

   _____

7. Why did you choose to do this subject?

   _____

8. What award have you been given for the subject?

   _____

9. (a) Briefly describe what kind of work you did in this subject (include home study, practical work etc.)

(b) How did this differ from other subjects that you study?

(c) Were there any parts of the subject delivery and/or its assessment that you thought were unique?

10 (a) What role(s) did the lecturer and/or tutor play in the subject delivery?

(b) Were they readily available for you when you required them?

(c) Did you get as much help and/or support as you needed, please explain?

11 (a) Did this delivery method allow you to better meet the objectives of the subject or not? Please explain

12 (a) What do you feel are the benefits of learning in this manner?

(b) What are the disadvantages?

13 (a) What skills did you need to work in this manner?

(b) Did you feel you had these skills?

(c) If no, were you given the support and/or opportunity to develop them? Please explain.

14 (a) Do you think any parts of the subject delivery could be improved upon? Please explain

(b) If yes, did you approach the lecturer/tutor with your criticisms/suggestions for improvement?

(c) Were they, or do you think they would have been, open to your point of view? Please explain

15. How do you think this subject delivery will help you with your work/study in the future?

16. Do you think the delivery of other subjects could be enhanced? Please explain.

This Questionnaire has been developed for use in a Department of Employment, Education, Training and Youth Affairs funded, Evaluations and Investigations Program Grant.

Project Investigators

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Bibliography

Module 1: Graduate Diploma in Distance Education 1988, South Australia: South Australian College of Advanced Education.

Alexander, S. 1995, 'Commissioned Study, Evaluation of Information Technology Projects for University Learning: the CAUT Experience,' http://uniserve.edu.au/caut/notices/evaltech.html.

Anderson, C. W. & Roth K. J. 1989, 'Teaching for Meaningful and Self-Regulated Learning of Science,' *Advances in Research on Teaching*, 1:265–309.

Aulich, T. G. 1990, *Priorities for Reform in Higher Education, Report of the Senate Standing Committee on Employment, Education and Training,* Canberra: Australian Government Publishing Service.

——1991, *Come in Cinderella: the Emergence of Adult and Community Education, Report of the Senate Standing Committee on Employment, Education and Training,* Canberra: Australian Government Publishing Service.

Ausubel, D. P. 1968, *Educational Psychology: a Cognitive View*, New York: Holt Rinehart & Winston.

Bagnall, R. G. 1988, 'Reconceptualising and Revaluing Distance Education Through the Perspective of Self-Direction,' *International Conference on Distance Education (ICDE): World Conference Developing Distance Education*).

Ballantyne, R. & Packer J. 1995, *Making Connections*, Australia: HERDSA Green Guide No. 2.

Beare, P. L. 1989, 'The Comparative Effectiveness of Videotape, Audiotape and Telecture,' *The American Journal of Distance Education*, 3 (2):57–66.

Beaudoin, M. 1990, 'The Instructor's Changing Role in Distance Education,' *The American Journal of Distance Education*, 4 (2):21–29.

Belbin, R. M. 1981, *Management Teams: Why They Succeed or Fail*, Oxford: Heinemann.

Berman Brown, R. 1994, 'Chapter 10: The Language of Knowing and Learning: Bridging Apparent Dichotomies', in G. Gibbs, *Improving Student Learning, Theory and Practice*, Oxford, United Kingdom: Oxford Centre for Staff Development, Oxford Brookes University, 315–28.

Bezzi, A. 1996, 'Use of Repertory Grids in Facilitating Knowledge Construction and Reconstruction in Geology', *Journal of Research in Science Teaching*, 33 (2):179–204.

Biggs, J. B. 1979, 'Individual Differences in Study Processes and the Quality of Learning Outcomes,' *Higher Education*, 8:381–94.

——1987, *Student Approaches to Learning and Studying*, Melbourne. Australia: ACER.

——1989, 'Approaches to the Enhancement of Tertiary Teaching', *Higher Education Research and Development*, 8 (7):7–25.

Biggs, J. B. & Telfer, R. 1987, *The Process of Learning*, Australia: Prentice-Hall.

Bishop, B. A. & Anderson, C. W. 1990, 'Student Conceptions of Natural Selection and Its Role in Evolution', *Journal of Research in Science Teaching* 27:415–28.

Bleicher, R. E. 1994, 'High School Students As Apprentices in University Research Laboratories', ftp://ftp.swin.edu.au/pub/aare/aare94/conf94/bleir94.004 in *Annual Conference of the Australian Association for Research in Education (AARE)* (Fremantle. WA. Nov), sci. ed.

Boud, D. Dunn, J. & Hegarty-Hazel, E. 1986, *Teaching in Laboratories*. Guilford, United Kingdom: Society for Research in Higher Education/NFER Nelson.

Boyer, E. L. 1990, *Scholarship Reconsidered: Priorities of the Professoriate*. Princeton, NJ: The Carnegie Foundation for the Advancement of Learning.

Brown, A. L. & Palincsar, A. S. 1989, 'Guided. Cooperative Learning and Individual Knowledge Acquisition', pp. 393–451 in *Knowing. Learning and Instruction*, L. B. Resnick, Hillsdale N.J.: Lawrence Erlbaum Associates.

Brown, S. & Baume, D. 1992, *Learning Contracts—a Theoretical Perspective, Vol. 1*., Birmingham, United Kingdom: SEDA Paper 71.

Brown S., Rust, C. & Gibbs, G. 1994, *Strategies for Diversifying Assessment in Higher Education*. Oxford, United Kingdom: The Oxford Centre for Staff Development, Oxford Brookes University.

Business/Higher Education Round Table 1992, *Promoting Partnerships: Enhancing Interaction Between Business and Higher Education, Task Force Report No. 2*. Melbourne: Business/Higher Education Round Table.

Candy, P., Crebert, C. G. & O'Leary, J. 1994, *Developing Lifelong Learners Through Undergraduate Education, NBEET Commissioned Report No. 28*, Canberra: Australian Government Publishing Service.

Carr, R. 1990, *Open learning: an imprecise term*, ICDE Bulletin 22:43.

Chaloupka, M. & Koppi, T. 1996, 'The Soil Investigaion Kit: a CAL Program for Soil Science', *Uniserve Science News*, http://www.usyd.ed.au/su/SCH/newsletter/vol4/chaloupka.html.

Champagne, A. B., Klopfer, L. E. & Gunstone, R. F. 1982, 'Cognitive Research and the Design of Science Instruction', *Educational Psychologist*, 17:31–53.

Clement, J. J. 1982, 'Students' Preconceptions in Introductory Mechanics,' *American Journal of Physics*, 50:66–71.

——1995, 'Computer Mediated Learning: Designing an Interactive Multimedia Tutoring System for Foundation Science Ideas', *AARE* 26 Nov–30 November Hobart.

Cosgrove, M. 1994, 'Seeking Understanding of Electricity Concepts by Computer-Mediated Tutoring, National Teaching Workshop, 1994'. .

Cottle, P. D. & Hart, G. E. 1996, 'Cooperative Learning in the Tutorials of a Large Lecture Physics Class', *Research in Science Education*, 26 (2):219–31.

Daniels, D., Hughes. D., Lobry de Brun, L., Metcalfe, P. & Reid, N. 1996, 'The Development and Evaluation of an Interactive Unit in Tertiary Science', *ASERA* (University of Canberra), Canberra, 11 July–14 July), Canberra.

Dillon, C. 1989, 'Faculty Rewards and Instructional Telecommunications: a View From the Telecourse Faculty', *The American Journal of Distance Education*, 3 (2):35–43.

Driver, R. 1990, 'Students' Conceptions and the Learning of Science', *International Journal of Science Education*.

Driver, R., Guesne, E. & Tiberghien, A. 1985, *Children's Ideas in Science*, Philadelphia, PA: Open University Press.

Entwistle, N. 1987, ' A Model of the Teaching-Learning Process', pp. 13–28 in *Student Learning: Research in Education and Cognitive Psychology*, J. T. E. Richardson, M. W. Eysenck. & D. W. Piper, United Kingdom: Milton Keynes: SRHE and Open University Press.

Exley, K. & Gibbs, G. 1994, *Course Design for Resource Based Learning Science*, Oxford: The Oxford Centre for Staff Development.

Falchikov, N. 1988, 'Self and Peer Assessment of a Group Project Designed to Promote the Skills of Capability', *Programmed Learning and Education*, 25 (4):327–39.

Foks, J. 1988, 'Distance Education—a Developing Concept', *International Conference on Distance Education (ICDE): World Conference Developing Distance Education*).

Fraser, K. 1996, 'Student Centred Teaching: the Development and Use of Conceptual Frameworks', *HERDSA Green Guide, No. 18*, HERDSA.

Gibbs, G. 1992, 'Chapter 2: The Nature of Quality in Teaching,' *Improving the Quality of Student Learning*, United Kingdom: Technical and Educational Services Ltd.

——1995a, *Assessing Student Centred Courses*, Oxford: The Oxford Centre for Staff Development.

——1995b, *Learning in Teams, a Tutor Guide*, Oxford, United Kingdom: The Oxford Brookes Centre for Staff Development, Oxford Brookes University.

Gibbs, G., Habeshaw, S. & Habeshaw, T. 1989, *53 Interesting Things to Do in Your Lectures*, Bristol, United Kingdom: TES.

Gooler, D. D. 1990, 'Changing the Way We Live and Work in an Information Age,' *Learning to Learn Across the Lifespan*, R. M. Smith, San Francisco: Jossey-Bass.

Gowin, B. D. & Novak, J. D. 1984, *Learning How to Learn*, New York: Cambridge University Press.

Gunstone, R., Macdonald, I., McKittrick, B., Mills, D., Mulhall, P. & White, R. 'Changing Students Approaches to Laboratory Work in Undergraduate Physics', *ASERA* (University of Canberra, Canberra, July 11–14), Canberra: University of Canberra.

Guri-Rozenblit, S. 1988, 'The Potential Contribution of Distance Education for Improving Academic Teaching in Conventional Universities', *International Conference on Distance Education (ICDE): World Conference Developing Distance Education*).

——1993, 'Differentiating Between Distance/Open Education Systems—Parameters for Comparison', *International Review of Education*, 39 (4):287–306.

Hager, P. 1995, 'Lifelong Education: an Idea Come of Age?' *AARE* (Hobart, 26–30 November), Hobart.

Halloun, I. A. & Hestenes, D. 1987, 'Modeling Instruction in Mechanics', *American Journal of Physics*, 53:1043–55.

Hamm, M. & Adams, D. 1991, 'Portofolio Assessment,' *The Science Teacher*, 58:18–21.

Higher Education Council 1992, *Higher Education: Achieving Quality*, Canberra: Australian Government Publishing Service.

Hegarty-Hazel, E. 1990, 'Life in Science Laboratory Classes at Tertiary Level', *The Student Laboratory and the Science Curriculum*E. Hegarty-Hazel, London. United Kingdom: Routledge.

Hewson, P. W. & Hewson, M. 1988, 'An Appropriate Conception of Teaching: a View From Studies of Science Learning', *Science Education*, 72:597–614.

Hodson, D. 1995, 'Towards a More Critical Approach to Laboratory Work', *Paper for CONASTA 44, Conference for the Australian Science Teachers Association*, http://owl.qut.edu.au/staq/conasta/papers/HODSON.TXT.

——1996, 'Laboratory Work As Scientific Method: Three Decades of Confusion and Distortion', *Journal of Curriculum Studies*, 28 (2):115–35.

Holmberg, B. 1989a, 'The Concept. Basic Character and Development Potentials of Distance Education', *Distance Education*, 10 (1):127–33.

——1989b, *Theory and Practice of Distance Education*, London, England: Routledge.

Jacques, 1981, *Learning in Groups*, London: Kogan Group.

Jeffries, M. 1995, *Research in Distance Education*, Indiana: Indiana Partnership for Statewide Education.

Jenkins, A. 1992, 'Chapter 6: Encouraging Active Learning in Structured Lectures', in G. Gibbs, *Improving the Quality of Student Learning*, United Kingdom: Technical and Educational Services Ltd.

Johnson, R. 1990, *Open Learning: Policy and Practice*, National Board of Employment, Education and Training Commissioned Report No.4, Canberra: Australian Government Publishing Service.

Jonasson, D. H. 1988, 'Designing Structured Hypertext and Structuring Access to Hypertext', *Educational Technology*, 28 (11):13–16.

Kagan, S. 1992, *Cooperative Learning*, San Juan Capistrano, California: Kogan Cooperative Learning.

Keegan, D. J. 1980, 'On Defining Distance Education', *Distance Education 1*, (1):13–15.

Klopfer, L. E. 1990, *Learning Scientific Enquiry in the Student Science Curriculum*, London: Routledge.

Kumar, D. D. 1997, 'Hypermedia: a Tool for Alternative Assessment?', *Educational Technology Training International*, 31 (4):59–66.

LeBuffe, J. R. 1993, 'Performance Assessment,' *The Science Teacher*, 60:46–48.

Lonsdale, A. 1973, *Open Learning Feasibility Study: Consolidated Statement of Educational Objectives/Needs/Principles*, Bentley, Western Australia: Western Australia Institute of Technology.

Lublin, J. & Prosser, M. 1994, 'Implications of Recent Research on Student Learning for Institutional Practices of Evaluation of Teaching', in G. Gibbs, *Improving Student Learning, Theory and Practice,* Oxford: The Oxford Centre for Staff Development.

Marchionini, G. 1988, 'Hypermedia and Learning: Freedom and Chaos', *Educational Technology*, 28 (11):8–12.

Martin, E. 1994, 'Reflections on Teaching With Electronic Technology, National Teaching Workshop, 1994', http://uniserve.edu.au/caut/NTW1994/Reflectionsonteaching.html.

McCartney, S. & Berman Brown, R. 1994, 'Chapter 15: Learning Without Knowing: Mastering Learning on a Part-Time MBA,' pp. 463–81 in G. Gibbs, *Improving Student Learning, Theory and Practice,* Oxford. United Kingdom: Oxford Centre for Staff Development, Oxford Brookes University.

McCleary, I. D. & Egan, M. W. 1989, 'Program Design and Evaluation: Two-Way Interactive Television', *The American Journal of Distance Education*, 3 (1):50–60.

Mestre, J. & Lochhead, J. 1990, *Academic Preparation in Science*, New York, New York: The College Board.

Mestre, J. P. 'Physics Education Research Group: Cognitive Aspects of Learning and Teaching Science'. .

Moore, M. G. 1972, 'Learner Autonomy: the Second Dimension of Independent Learning', *Convergence*, 5 (2):76–88.

Moore, M. G. & Thompson, M. M. with Quigley, A. B., Clark, G. C. & Goff, G. 1990, *The Effects of Distance Learning: a Summary of the Literature, Research Monograph No. 2,* Pennsylvania: Pennsylvania State University, American Center for the Study of Distance Education.

Moriera, M. A. 1980, 'A Non-Traditional Approach to the Evaluation of Laboratory Instruction in General Physics Courses', *European Journal of Science Education*, 2: 441–48.

Moss, G. D. 1991, 'School Pupils' Reactions to Flexible Learning', *British Journal of Educational Technology*, 22 (3):28–38.

Muth, K. 1995, 'A Means to Quality: Teachers Discover Distance Education Improves Their Teaching and Learning', *Distance Education Clearinghouse*.

National Board of Employment, Education and Training 1992, *Skills Sought by Employers of Graduates*, Commissioned Report No. 20, Canberra: Australian Government Publishing Service.

Newby, T. J., Stepich, D. A., Lehman, J. D. & Russell, J. D. 1996, *Instructional Technology for Teaching and Learning, Designing Instruction, Integrating Computers, Using Media*, New Jersey: Merrill Prentice-Hall Inc.

Osborne, R. & Freyberg, P. 1985, *Learning in Science*, Portsmouth, New Hampshire: Heinemann.

Osborne, R. & Gilbert 1980, 'A Method for Imvestigating Concept Understanding in Science,' *European Journal of Science Education*.

Paine, N. (ed.) 1989, 'Open Learning in Transition: an Agenda for Action', London, England: Kogan Page.

Pamula, F. 1994, 'Computer-Aided Learning Exercise in Spectrophotometry', *Biochemical Education*, 22 (4):192–95.

Pamula, F. W., Pamula. G. F. & Wheldrake, J. F. 1995, 'The Use and Benefits of Computer Aided Learning in the Assessment of the Laboratory Exercise 'Enzyme Induction in Escherichia Coli,' *Biochemical Education*, 23 (3):158–61.

Pennell, R. & Deane, E. M. 1995, 'Use of a Web Browser for Developing Investigative Skills', *AusWeb95*, Southern Cross University.

Phillips, T. & Moss, G. D. 1993, 'Can CAL Biology Packages Be Used to Replace the Teacher?', *Journal of Biological Education*, 27 (3):213–16.

Piaget, G. 1983, 'Piaget's Theory', in P. H. Mussen (ed.), *Handbook of Child Psychology: Vol. 1, History, Theory and Methods*, New York: John Wiley & Sons.

Platt, S. 1988, *Teams: a Game to Develop Group Skills*, Aldershot, United Kingdom: Glower.

Prosser, M., Trigwell, K. & Taylor, P. 1994, 'A phenomenographic study of academics' conceptions of science learning and teaching', *Learning and Instruction*, 4:217–231.

Race, P. 1992, *Developing Competence: Professional Inaugural Lectures*, United Kingdom: University of Glamorgan.

Reinertsen, P. S. & Wells, M. C. 1993, 'Dialogue Journals and Critical Thinking', *Teaching Sociology*, 21:182–86.

Resnick, L. B. & Resnick, D. P. 1992, 'Assessing the thinking curriculum: New tools for educational reform', in B. R. Gifford & M. C. O'Connor (eds), *Changing assessments: alternative views of aptitude achievement and instruction*, Boston, Massachusetts: Klumer,. 37–75.

Richardson, J. T. E. 1994, 'Chapter 2: Using Questionnaires to Evaluate Student Learning: Some Health Warnings', in G. Gibbs, *Improving Student Learning*,

Theory and Practice, Oxford, United Kingdom: Oxford Centre for Staff Development, Oxford Brookes University, 73–88.

Roth, W-M. & Roychoudhury, A. 1994, 'Physics Students' Epistemologies and Views About Knowing and Learning', *Journal of Research in Science Teaching*, 31 (1):5–30.

Schank, R. & Cleary, C. 1994, 'Engines for Educators', *Institute for the Learning Sciences, Northwestern University, http*://novictone.ils.nwu.edu/~e_for_e/nodes/I-M-NODE-4121-pg.html.

Schramm, W. 1977, *Big Media, Little Media*, Beverley Hills, California: Sage.

Stefani, L. A. J. & Tariq, V. N. 1996, 'Running Group Practical Projects for First Year Undergraduate Students', *Journal of Biological Education*, 30 (1): 36–45.

Storey, R. 1989, *Team Building: a Manual for Leaders and Trainers*, London, United Kingdom: BACIE.

Tang, C. 1994, 'Chapter 6: Effects of Modes of Assessment on Students' Perception Strategies', in G. Gibbs, *Improving Student Learning, Theory and Practice*, Oxford, United Kingdom: Oxford Centre for Staff Development, Oxford Brookes University, 151–70.

Thorley, L. & Gregory, R. 1994, *Using Group-Based Learning in Higher Education*, London, United Kingdom: Kogan Page.

Tierney, J. 1995, *Inquiry into the Development of Open Learning in Australia*, National Board of Employment, Education & Training, Commissioned Report, Canberra: Australian Government Publishing Service.

Turnbull, A. J. 1988, 'Distance Education—the Trend Setter', *International Conference on Distance Education (ICDE): World Conference Developing Distance Education*).

Verduin, J. R. and Clark, T. A. 1991, *Distance Education: the Foundations of Effective Practice*, San Francisco, California: Jossey-Bass.

Verran, J. 1993, 'Group Projects in Biological Science', *The New Academic*, 2 (2):9–11.

von Glasersfeld, E. 1989, 'Cognition, Construction of Knowledge, and Teaching', *Synthese*, 80:121–40.

Walker, M. & Walker, J. 1994, *Open Learning in Australia: Past, Present and Future*, London, United Kingdom: Kogan Page.

Watkins, D. 1983, 'Depth of Processing and the Quality of Learning Outcomes', *Instructional Science*, 1249–58, Psych. Ed.

Watkins, D. A. 1983, ‘Depth of Processing and the Quality of Learning Outcomes’, *Instructional Science*, 12:49–58.

Weiner, D. & Weiner. J. 1996, ‘Research Mentor: a Tool to Aid in Training of Scientific Investigators’, *British Journal of Educational Technology*, 24 (1):5–14.

Wijeyesekera, D. S. 1990, ‘The Students of the 90’s: New Clients, New Needs’, *International Conference on Distance Education (ICDE): Development and Access Conference*.

Wilkerson, L. & Feletti, G. ‘Problem-Based Learning: One Approach to Increasing Student Participation’, in A. F. Lucas (ed.), *The Department Chairperson’s Role in Enhancing College Teaching, New Direction for Teaching and Learning, No. 37*, San Francisco, California: Jossey-Bass.

Willis, B. 1995a, ‘Guide #10: Distance Education: Research’, *Distance Education at a Glance*.

——1995b, ‘Guide #1: Distance Education: an Overview’, *Distance Education at a Glance*.

——1995c, ‘Guide #2: Strategies for Teaching at a Distance’, *Distance Education at a Glance*.

Ziman, J. 1986. *Science in Schools*.