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ABSTRACT

This report is a snapshot of some of the educational innovations implemented in Tasmanian schools during 1994. Descriptions of 11 projects in primary, secondary, district high, and senior secondary schools and colleges in both urban and rural settings are included. Each description is a story of how the project began including details of the doubts, successes, and difficulties encountered by the people associated with the project. Together the stories provide insight into the factors assisting or hindering the implementation of educational innovation. This guide contains information on the project context; curriculum profiles; methodology details; case studies of projects in science, mathematics, and technology education; and a section highlighting common themes from the case studies. Contains 18 references. (DDR)

Windows on Successful Practice:

Innovations in Science, Maths and Technology Education

A Report prepared for the Department of Education and the Arts, Tasmania

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Lilydale District High School (LDHS)
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Terminology

ACET
Australian Council for Education through Technology (ACET).

Advanced Skills Teacher (AST1, AST2 or AST3)
Teachers promoted to these positions have extra responsibilities regarding curriculum, organisation, professional development, etc.

AEC
Australian Education Council

Area School
Existed prior to the District High School and catered for students from kindergarten to grade 10.

Australian Education Council (AEC)
Committee composed of federal, state and territory Ministers of Education.

Australian Vocational Certificate Training System
Followed from a recommendation of the Carmichael Report to develop a new entry-level training system.

Austudy
Financial support system for secondary and tertiary students which is funded by the federal government.

CADD
Computer Aided Drafting and Design software package.

Carmichael Report
Report of the ESFC chaired by Mr Carmichael. Established to consider the recommendation of the Finn Committee on the need to develop a more appropriate system of vocational education and training.

CoRT Thinking
Cognitive Research Trust program based on ideas of Edward de Bono.

Curriculum Frameworks
Curriculum outlines produced by each state or territory government education department in each Key Learning Area based on the National Statements and Curriculum Profiles.

DEA
State Department of Education and the Arts in Tasmania.

DEET
Commonwealth of Australia Department of Employment, Education and Training.

Design, Make, & Appraise Model
Teaching model which involves students working from a project design brief to design an object or solution to a problem, make the object or solve the problem, then appraise the value of the object or the efficiency of the problem-solving strategy.

District High School
School catering for students from kindergarten to grade 10 (and sometimes 12), located in rural districts in Tasmania.

Early Childhood Education
Schooling from kindergarten to grade 2. Formerly known as infant school.

ESFC
A committee (Employment Skills Formation council) established to give effect to the recommendations contained in the Finn Report.

ESL
English as a Second Language - ESL students are those who speak a language other than English at home.

Finn Report
Report of the Committee Chaired by Mr Finn. Recommended goals for participation in education and training and the curriculum appropriate for the postcompulsory years.

High School
School catering for students from grades 7 to 10 (and sometimes 12) where different students have different teachers for different subjects in different classes.

Junior Secondary Schooling
Refers to compulsory schooling at the high school level from grades 7 to 10.

K-8 Mathematics Guidelines
Mathematics curriculum guidelines produced by the Tasmanian DEA for use in schools in Tasmania for classes from kindergarten to grade 8.

Key Competencies

Articulated by the Mayer Committee as essential for youth participation in the workforce.

Key Learning Area (KLA)

Eight content areas of learning have been identified by the AEC: English, Mathematics, Science, Technology, LOTE, Health and Physical Education, Studies of Society and Environment, and the Arts.

Key Teacher

Refers to the teacher(s) responsible for the innovation in each of the case study schools.

KLA

Key Learning Area.

Kindergarten

Non-compulsory year of schooling prior to grade 1 or prep. In Tasmania, children usually attend on a part-time basis.

LOTE

Languages Other Than English; for example, French, Indonesian, Italian.

Matriculation College

Previous name for the Senior Secondary College (in Tasmania) when it was geared for pre-tertiary students.

Mayer Report

Report of the Committee chaired by Mr Mayer. Established to advise the AEC on employment related competencies for postcompulsory education and training.

MDT

Materials, Design and Technology; a Technology subject.

MOVEET

State and Territory Ministers of Vocational Education, Employment and Training.

National Statements and Curriculum Profiles

Nationally developed documents produced by the federal government outlining a common framework for curriculum in the eight KLAs.

National Training Reform Agenda

Commonwealth of Australia government initiative to restructure vocational education and training.

Parents and Friends Association

Voluntary organisation comprised of parents and associates attached to a school and concerned with fund raising, policy and student welfare.

Postcompulsory Schooling

Those years of schooling which are not compulsory for students, namely grades 11 and 12.

Prep (Preparatory Class)

A non-compulsory year of schooling between kindergarten and grade 1. In Tasmania, children usually attend on a full-time basis.

Pre-School

Pre-school refers to situations in which children are provided with access to some form of program that is different to kindergarten or prep, such as parent-child groups, play groups and some child-care programs.

Primary School

School which caters for students from kindergarten to grade 6.

Principal Curriculum Officer

DEA officer in charge of a curriculum area; for example, Science.

Schools Board

An independent statutory body responsible for TCE syllabus accreditation and assessment.

Science Frameworks

Science curriculum guidelines produced by the Tasmanian DEA for use in schools in Tasmania for classes from kindergarten to grade 8.

Secondary Schools

Schools catering for students from grades 7 to grade 12; incorporating junior secondary schools and senior secondary schools.

Senior Secondary Schooling

Refers to schooling at the college level from grades 11 to 12.

TAFE

Technical and Further Education, traditionally involved in trades and para-professional training, but increasingly involved in more general education and training.

TCE

Tasmanian Certificate of Education, a centrally issued certificate of students' achievements, from grade 9 until they leave secondary education.

Teacher in Charge

Teacher responsible for coordinating a subject area.

TEFA

Technology Education Federation of Australia.

1. Foreword

1.1 Overview of the Study

This report is a snapshot of some of the educational innovations in Tasmanian schools during 1994. It was conducted as part of a larger OECD study to investigate Science, Maths and Technology education and focusses on innovations in these areas.

The report describes eleven projects in Tasmanian primary, secondary, district high and senior secondary schools and colleges in both urban and rural areas. Each project is told as a story which describes how the project came about in the school. The stories also detail the doubts, successes and difficulties encountered by the people associated with the project. The stories, therefore, provide an insight into the factors assisting and hindering the implementation of the project. Together, the eleven projects provide a glimpse of some aspects of Tasmanian education in the 1990s and capture some of the culture of schools in a way more formal studies generally do not.

The Department of Education and the Arts was pleased to support this project and is committed to continuing collaborative programs with the University of Tasmania. In particular, congratulations are extended to the Project Director, Professor John Williamson, and the Project Executive Officer, Ms Trudy Cowley, on the completion of the project in such a short time-frame and on the insights into educative practices in Tasmanian schools which they have been able to articulate.

1.2 The Tasmanian Context

The study occurred during a period of unprecedented national and state cooperation in educational reform, with the development of national curriculum statements and profiles being a particular impetus for change. At a state level, two critical decisions of the past five years which help to provide a context for the work reported on in this study were: a shift to school local management; and the development of policy documents on teaching and learning which emphasise a constructivist view of learning.

The shift to school local management is particularly interesting in that it has created a new dynamic between schools and the system. While the innovations reported on in this study are determined and managed by the school, the Department has provided impetus to almost all projects through such things as: the development of policy; the production of curriculum support materials; the establishment of systemic priorities which receive financial or personnel support; or the provision of building redevelopment funds. As the shift to school local management becomes more established, there has been an increasing emphasis by the system on producing more detailed policy and support materials to assist schools in their development of educational programs. Thus, the policy decision to increase school local management has seen a greater autonomy given to schools in determining many of their own educational and management priorities, while the system has placed an increasing emphasis on directing and prompting the selection of those priorities.

The incorporation into policy of constructivist perspectives on learning (see *Our Children The Future* (DEA, 1991)), is another critical decision because of its influence on subsequent curriculum guideline development and pedagogical discussion at both system and school level. As the implications of this view of learning continue to be explored, newly conceptualised curriculum materials which build on these ideas are being produced. Indeed, two of the learning areas which were the subject of this study (Science and Mathematics) are supported by system materials which explore a constructivist perspective within a 'key ideas' framework. Amongst other factors, the adoption of these materials (supported by programs such as the curriculum implementation program operating within each district), is resulting in an increased emphasis on programs which focus on quality teaching. That emphasis is clearly evident in the projects outlined in this report.

1.3 The System-School Tension.

A natural tension exists between school local management and systemic guidance. As an example, there is a tension between school determination of its own curriculum program and the systemic desire to develop a coherent statewide program to enable, amongst other things, easier movement between schools by transient students. The tension can be accommodated to some degree by the development of systemic overviews based on 'key ideas', with the school determining the context to be used in developing those ideas with students.

Better still, the system and schools become learning partners in advancing the educative cause. The system continues its important role of establishing theoretical propositions, reference materials, policies, guidelines and priority frameworks. The school remains the site which tests these propositions in practice and provides advice to the system as to the continuing development of the proposition. The system provides a stimulus to continuing evaluation of school practice by the school and vice versa. In this sense the system-school tension is healthy, challenging and creative. To achieve this state, however, a recognition is required of each partner's contribution to the process of change and learning, of theory informing practice and of practice informing theory. In other words, both system and school acknowledge the role of the other in the improvement of practice. In this climate of partnership, schools become learning communities, where the school-system culture encourages continuing inquiry and testing of practices and the information gained is a valuable resource to the system.

The system-school tension becomes unhealthy when the raft of support materials necessarily produced by the system to support schools in developing an overview of the complex demands of an education system, become themselves the object of bit by bit implementation. When the bits become the drivers rather than the informers of school practice, enormous demands can be placed on teachers and schools. As an example, a bit-driven approach to unit planning by a teacher might be reflected in an exceedingly complex planning scheme, created to take into account all of the separate *bits* required by the myriad of documents schools encounter and teachers are required to implement. On the other hand, when the bits inform the school's practices, unit planning might be based on more fundamental principles (for example, a teaching and learning centred view). While the bits are still important, they can be addressed within a more holistic planning scheme.

Some of the case studies describe the journey from inundation and bit-driven urgency to proactive learning community. The shift in culture doesn't mean life becomes easier but it does appear to become more professionally rewarding. Words such as *overwhelming* and recognising the *need to do something* are often used in describing the situation pre-innovation. Where the projects moved towards the creation of a learning community, the shift in language includes phrases such as a *greater sense of control*, an ability to link in to the *bigger picture* or *improved professional discussion*.

In several of the cases described in this report, there is a strong sense of this shift in culture. Should system-school learning partnerships develop more formally, perhaps many more schools might become partners in improving practice with the system. Then, what is now written up as innovation may become an inevitable part of our system.

Robert Phillips
Department of Education and the Arts Liaison Officer for the project.

2. Introduction

2.1 Project Context

2.1.1 OECD Project

This Tasmanian project was conducted as part of a larger OECD study to investigate Science, Maths and Technology education. For the last two decades the study of education and, in particular, teachers have been noticeable features of the OECD's range of research interests. Studies have investigated teachers' work, training and conditions of service as part of a concern among member countries to improve and sustain teacher quality. Several of the major issues relating to teacher quality and policies which support and promote it in the Australian context have been described elsewhere (Williamson, 1994).

A consideration of teachers' professional lives soon leads to the issue of curriculum innovation: its nature, development and implementation. Certainly there is a theme in most recent educational research which accepts the intimate relationship between curriculum and pedagogy.

It was in this context that the OECD undertook an international study involving 13 countries, including: Australia, Austria, France, Germany, Ireland, Japan, Netherlands, Norway, Scotland, Switzerland and the United States, to explore issues relating to Science, Maths and Technology education curriculum innovation. The project commenced in 1993 and will conclude in 1996 with the submission of a report to the Governing Board of the Centre for Educational Research at the OECD in paris.

To provide a framework that allowed for cross-country comparisons the project Steering Committee proposed a common structure for the reports. Project directors, for example, were asked to ensure there were (a) narrative components to describe the innovations and provide some background to it and, (b) components which related to evidence, analysis and interpretation. These included methodological details, perceptions from teachers and students and reflections on the main lessons or themes in the study.

The Project Director was invited to participate in the study and conduct the Australian case study. A request to the Tasmanian Department of Education and the Arts for access to schools involved in Science, Maths and Technology education was granted readily. The material presented here not only shows schools and their communities working together as never before, it also allows the *lighthouse* work of Tasmanian educational innovations to be placed in an international context.

2.1.2 Educational Changes

There have been major organisational, curriculum and governance of school changes in Australian education over the last decade. A major impetus for the series of case studies reported here were the *National Statements and Curriculum Profiles*.

Two distinct themes were apparent regarding performance standards for students in Australian schools.

(1) The adequacy of actual levels of performance reflected considerations of accountability, had an assessment focus and was considered a state and territory issue. Theme (1) had been addressed at the state and territory level by

introducing standardised testing to selected groups of students at selected grade levels throughout the twelve years of schooling. Only at the end of grade 12 were all students in all states and territories tested.

(2) The standards students should have achieved in schools reflected, in part at least, economic pressures for skill improvement in the workplace, had a curriculum focus and was considered a federal issue. Theme (2) was addressed, when in the late 1980s, pressure for more curriculum consistency across the state and territory systems was mounted by the federal Minister for Education and gained support from the business community. State, territory and federal Ministers of Education met in 1989 and identified eight broad learning areas as the overall structure of the curriculum. For each Key Learning Area, the Council of Ministers commissioned the development of a statement and profile (refer to section 2.2).

In the 1990s these new curriculum and assessment initiatives, and the earlier ones concerned primarily with assessment, had substantially came together as curriculum frameworks. A curriculum framework specified in terms of desired student outcomes provided a structure to which assessments could be keyed so that the results provided a curriculum-linked evaluation of students and teaching.

All of these changes resulting from decisions at policy level, including those discussed below, have meant a lot of changes for teachers. Teachers have taken on board these changes in varying ways and to differing degrees.

2.2 National Statements and Curriculum Profiles

The *National Statements and Curriculum Profiles* were produced and initiated by the Australian Education Council (AEC) as part of a joint project by the states, territories and the Commonwealth of Australia. This national collaboration produced 16 documents: a statement and a profile in each of the eight key learning areas - English, Mathematics, Science, Technology, Languages Other Than English (LOTE), Health and Physical Education, Studies of Society and Environment, and the Arts.

2.2.1 The Statements

The statements provided a framework for curriculum development by education systems and schools. They were divided into strands which reflected the major elements of learning (content and process) in each area. Further, they were structured in four bands, roughly corresponding to the stages of schooling: lower primary, upper primary, junior secondary and postcompulsory. The statement provided some elaboration of each strand but did not provide a syllabus.

2.2.2 The Profiles

The profiles were designed to assist in the improvement of teaching and learning and to provide a common language for reporting student achievement. They were divided into strands for each key learning area. Within each strand, eight achievement levels were developed. Overall, the eight levels reflected the full range of student achievement during the *compulsory* years of schooling.

2.2.3 The Strands

2.2.3.1 Science

Science was organised into five strands; one process strand and four conceptual strands. The conceptual strands reflected the traditional organisation of Science into the distinct areas of study of Earth Science, Physics, Biology, and Chemistry. The five strands covered selected aspects of science concepts and processes, as indicated:

(i) Working Scientifically (using science; acting responsibly; investigating);
(ii) Earth and Beyond (Earth, sky and people; the changing Earth; our place in space);
(iii) Energy and Change (energy and us; transferring energy; energy sources and receivers);
(iv) Life and Living (living together; structure and function; biodiversity, change and continuity); and
(v) Natural and Processed Materials (materials and their uses; structure and properties; reactions and change).

The process strand, Working Scientifically, was intended to be integrated with the conceptual strands.

The Statement outlined seven principles for effective learning experiences in Science. These were:

(i) taking account of students' views;
(ii) recognising that students construct their own understandings;
(iii) providing a supportive learning environment;
(iv) learning in practice;
(v) engaging in relevant and useful activities;
(vi) complementing learning in other areas; and
(vii) using scientific language appropriately.

2.2.3.2 Mathematics

Mathematics was organised into eight strands, which overlapped and interconnected. The breakdown of each strand into subheadings is indicated:

(i) Attitudes and Appreciations (attitudes; appreciations);
(ii) Mathematical Inquiry (mathematical expression; order and arrangement; justification; problem-solving strategies);
(iii) Choosing and Using Mathematics (applying mathematics; mathematical modelling);
(iv) Space (shape and structure; transformation and symmetry; location and arrangement);
(v) Number (number and numeration; computation and estimation);
(vi) Measurement (measurement and estimation; indirect measurement; approximation, change and the calculus);
(vii) Chance and Data (chance; data handling; statistical inference); and
(viii) Algebra (expressing generalisations; functions; equations).

The statement outlined four learning principles and five implications for teaching.

Learning Principles:

(i) learners construct their own meanings from, and for, the ideas, objects and events which they experience;
(ii) learning happens when existing conceptions are challenged;

(iii) learning requires action and reflection on the part of the learner; and
(iv) learning involves taking risks.

Implications for Teaching: mathematics learning is likely to be enhanced by:
(i) activities which build upon and respect students' experiences;
(ii) activities which the learner regards as purposeful and interesting;
(iii) feedback;
(iv) using and developing appropriate language; and
(v) challenge within a supportive framework.

2.2.3.3 Technology

Technology was organised into four interdependent strands:
(i) Designing, Making and Appraising (a process through which students develop ideas and imaginative solutions for learning tasks);
(ii) Information;
(iii) Materials; and
(iv) Systems.

All learning in Technology was intended to involve the Designing, Making and Appraising strand. When students design, make and appraise they:
(i) investigate issues and needs;
(ii) devise proposals and alternatives;
(iii) produce processes and products; and
(iv) evaluate consequences and outcomes.

"The tasks and activities in technology programs assist students to identify questions to explore, to synthesise ways to put ideas into practice, and to implement plans." (Australian Education Council, 1994b, 6) Students are encouraged to:
(i) build on their experiences, interests and aspirations in technology;
(ii) find and use a variety of technological information and ideas;
(iii) show how ideas and practices in technology are conceived;
(iv) explain technical language and conventions;
(v) take responsibility for designs, decisions, actions and assessments;
(vi) trial their proposals and plans;
(vii) take risks when exploring new ideas and practices; and
(viii) be open-minded and show respect for individual differences when responding to technological challenges.

2.2.4 The Key Learning Areas: Mathematics, Science, Technology

Mathematics and Science have been traditional Key Learning Areas. Technology, however, has drawn on a wide range of subject areas, including the traditional areas of Home Economics, Manual Arts, Computing and Technical Drawing.

The following definitions of the Key Learning Areas are extracts from the *Learning Area Direction Statements* (1994) published by the Department of Education and the Arts. These statements were part of a folio of materials designed to assist teachers with the nationally developed directions in curriculum.

2.2.4.1 Mathematics

> *Mathematics is often defined as the science of space and number ... [but] a more apt definition [is that] it is the science of patterns. The*

> *mathematician seeks patterns in number, in space, in computers and in imagination. Mathematical theories explain the relations among patterns. Applications of mathematics use these to 'explain' and predict natural phenomena ...* (Australian Education Council, 1991, 4)

Mathematics is fundamental to the study of other fields of learning including the Physical Sciences, Engineering, the Social Sciences, Computer Science and the Biological Sciences.

2.2.4.2 Science

Science education helps students to understand the major concepts and processes used in science and how these relate to them and their world. Science teaching is concerned with encouraging students to test their assumptions, ideas and beliefs.

Science is a universal discipline through which people investigate the living, material, physical and technological components of their environment, and make sense of them in logical and creative ways. It helps people to investigate phenomena systematically, to clarify ideas, to ask questions, to test explanations through measurement and observation, and to use their findings to establish the worth of ideas.

Science and Technology are inextricably linked. Science and Technology are contributing to an accelerating rate of change in our society. As tomorrow's adults, today's students will be required to make responsible decisions and informed choices about the ramifications of Science and Technology, both in their immediate lives and in wider local, national and international contexts.

2.2.4.3 Technology

> *Technology is often used as a generic term to include all the technologies people develop and use in their lives. It involves the purposeful application of knowledge, experience and resources to create products and processes to meet human needs.* (Australian Education Council, 1994b, 3)

Materials, Design and Technology (Design and Technology, Design in Metal, Plastic and Wood), Design Graphics, Food and Textiles, Keyboarding, Information Technology, Media Studies, Applied Power Technology, Agriculture, Computer Aided Drafting and Design (CADD) and Electronics are established areas that gain new purpose and direction in this learning area. Technology acts as a unifier of these areas, giving them all a common framework within which to work.

2.3 State Curriculum Documents

Based on the *National Statements and Curriculum Profiles*, the Tasmanian Department of Education and the Arts produced curriculum frameworks suitable for the Tasmanian context. These were relevant to classes from kindergarten through to grade 8. The Tasmanian Certificate of Education courses (see Section 2.4) provided the curriculum framework for grades 9 to 12.

The *K-8 Mathematics Guidelines* (DEA, 1992) document was produced for Mathematics and the *Science Frameworks* (DEA, 1993) document was produced for

Science.

2.4 Tasmanian Certificate of Education

The Tasmanian Certificate of Education (TCE) is a centrally issued certificate of students' achievements, from grade 9 until they leave secondary education. It lists awards in syllabuses approved by the Schools Board of Tasmania, an independent statutory authority. The Schools Board has members who represent education and the wider community, including parents.

The main purpose of the TCE is to make it possible for all those studying a given syllabus to:

(i) acquire similar subject knowledge and skills; and
(ii) be assessed on the same basis and according to the same standards.

The Schools Board is responsible for producing syllabi for all courses that it certificates, as well as providing external examinations and statewide moderation procedures. The primary audience for the TCE is the wider community, particularly its employers and its tertiary education institutions. Assessment for the TCE is criterion-based.

2.5 Key Competencies

2.5.1 The Finn Report

In late-1988 the Australian Education Council (AEC) and MOVEET (Ministers of Vocational Education, Employment and Training) established a working party to consider the links between schools and Technical and Further Education (TAFE). In December 1990 Ministers agreed to a major review into youth participation in postcompulsory education and training. Mr Brian Finn AO chaired the Committee.

The Committee produced its report in 1991 and the two major recommendations focussed on:

(i) targets for participation in education and training for the coming decade; and
(ii) the curriculum appropriate for the postcompulsory years of schooling.

2.5.2 The Carmichael Report

The Employment Skills Formation council (ESFC) was asked by the Federal Minister of Education to consider a new integrated entry-level training system for Australia, federal financial support for traineeships and apprenticeships and allowances for education and training. This committee was chaired by Mr Laurie Carmichael and the ESFC reported in early 1992.

It recommended the development of a new entry-level training system, the Australian Vocational Certificate Training System (AVCTS). The AVCTS was intended to improve the skills, knowledge and employment prospects of Australian youth making the transition from school to work.

2.5.3 The Mayer Report

The Mayer Committee was established to advise the AEC and MOVEET on employment related Key Competencies for postcompulsory education and training. The Committee was chaired by Mr Eric Mayer and the report was published in late 1992.

The report emphasised the need to prepare young people for the workplace and identified seven Key Competencies that all young people needed to be able to participate effectively in the emerging forms of work and work organisation. The seven Key Competencies identified encompassed:

(i) collecting, analysing and organising information;
(ii) communicating ideas and information;
(iii) planning and organising activities;
(iv) working with others and in teams;
(v) using mathematical ideas and techniques;
(vi) solving problems; and
(vii) using technology.

3. Methodology

The approach adopted in this project involved a series of case studies, which followed in broad detail the OECD guidelines for methodology. Like all studies of this kind, it was acknowledged that it presented a series of *snapshots* which would likely be different if conducted at a different time.

3.1 Schools Involved

The Project Director negotiated selection of and access to the schools and colleges with senior Department of Education and the Arts (DEA) officials. The DEA staff suggested 14 government schools/colleges which they identified as being innovative in pedagogy, curricula and/or staff development. The Project Director contacted all schools nominated and ten agreed to participate. Table 2.1 shows the curriculum area and the nature of the participating school/college.

Table 2.1. Curriculum Area, Location and Level of Participating Schools/Colleges

Curriculum Area	Participating Schools or Colleges
Science (n=4)	Exeter Primary (rural); Lilydale District High (rural); Cosgrove High (urban); Launceston College (urban)
Maths (n=3)	Claremont Primary (urban); Smithton High (7-12) (rural); Elizabeth College (urban)
Technology (n=4)	Lauderdale Primary (urban); Penguin High (rural); Reece High (urban); Elizabeth College (urban)

3.2 Research Team

3.2.1 Academic Researchers

A total of eight academics, including the Project Director, were involved in the project. Each of the three curriculum areas had at least two academic staff involved in data gathering, analysis and writing of initial case study reports.

3.2.2 Research Assistants

The Project Director made available a Research Assistant (RA) to each of the case study schools. The Research Assistants were selected because of their knowledge of the particular curriculum area for their assigned school, and the various data gathering approaches to be used in the case studies.

3.2.3 Project Executive Officer

One of the Academic Researchers was responsible for coordinating the work of the other Academic Researchers and Research Assistants. She was also responsible for liaison with the Department of Education and the Arts (DEA) and final report writing (with the Project Director).

3.3 Data Gathering and Analysis

3.3.1 Time in Schools and Colleges

Each Research Assistant spent a minimum of four weeks in his/her school or college. Some Research Assistants spent almost six weeks while the typical time was around five weeks. The first week in the school or college was used solely to become acclimatised to the school; its operation, students, staff and the innovation. The data were gathered in weeks which were split over Term 3 of 1994 and Term 1 of 1995.

3.3.2 Approaches to Data Gathering

It was emphasised to all project members that the aim of the study was to *describe* what was going on regarding the innovation and not to evaluate it. Methods of gathering data included the following:

(1) Observations of classes and staff meetings in action.

(2) Interviews using a semi-structured format with teachers, students and senior staff. The interviews were tape-recorded, but not all were transcribed. Some of the interviews were conducted in group mode, but the majority were one-to-one on a face-to-face basis (refer to Section 7.1).

(3) Collection of documents which related to the innovation (refer to Section 7.2).

(4) Journals completed by the students at the end of a lesson (refer to Section 7.3).

3.3.3 Data Analysis

An academic from the relevant curriculum area worked with a Research Assistant to analyse the data and materials collected from each case study school or college. The teams were requested to provide a case study report which was structured around themes identified in the OECD guidelines. In several instances, the teams were asked by the Project Executive Officer to restructure their report to conform to the suggested guidelines. This report has utilised the broad framework suggested by the OECD. However, to provide more local assistance to Tasmanian schools and colleges additional material has been provided.

3.3.4 Verification of Case Studies

Each of the draft case studies was sent to the relevant school or college for comment and feedback. A covering letter from the Project Executive Officer invited them to correct any errors of fact and to amend any statement with which they disagreed. The schools or colleges were asked to liaise with their Research Assistant or the Project Executive Officer regarding any feedback they had to give.

3.3.5 Further Data Analysis

The case study report for each school was then rewritten to include feedback from the schools and the Project Executive Officer. Copies of these reports were submitted to the schools and, in some cases, further feedback was received. A final reworking of the case study reports was conducted by the Project Executive Officer. These case studies have been included in this report.

3.4 Limitations of the Study

All studies of innovation raise questions that pertain to their conduct. This study, conducted in the schools of one Australian state, over the third term of one school year and the first term of the next school year, highlighted a number of these, including the following.

(1) Short time lines exacerbated by the fact that the Australian school year means

annual holidays are occurring when northern hemisphere schools are fully engaged.

(2) The dependence on volunteer schools; that is, those involved in innovation and perceived to be successful by outsiders. This limited their generalisability both within Tasmania and across schools and education systems in Australia.

(3) The somewhat narrow focus on issues connected with the innovation (*eg* no direct attention given to 'assessment') because of time and project personnel constraints.

(4) A *snapshot* view which did not allow for generalisation across schools or into the future. That is, we were unable to follow, in a longitudinal way, the innovations for an extended time.

(5) An inability to generalise directly to other Australian states and territories from the specific Tasmanian situation.

3.5 Structure of the Report.

Chapter 1, the Introduction, provides background to the study, both international and national. Chapter 2 reports briefly on the methodology for the project. In Chapter 3 of the report, the case study report for each school is presented. Chapter 4 presents a synthesis of the findings of the case studies according to themes identified both by the OECD and the authors of the report. The concluding chapter outlines common threads and issues which have emerged from the six case studies. An appendix is attached which includes copies of the research instruments and a bibliography.

Note that a slightly different version of this report was submitted to the OECD. That report included data from only six of the case studies, those particularly relevant to the *National Statements and Curriculum Profiles*.

4. Case Studies

4.1 Claremont Primary School: Mathematics

4.1.1 The School

Claremont Primary school, situated in suburban Hobart, caters for students from kindergarten to grade 6. In 1994 Claremont Primary School had a staff of 18 classroom teachers and an enrolment of 350 students from diverse socio-economic backgrounds. The local intake of students was supplemented by children from other suburbs as the school program facilitated the integration of approximately 20 deaf children into regular classrooms. The teaching and learning environment was comfortable and included a well stocked library. Parental interest in Claremont Primary School activities was high, with a very successful and well patronised parent help program being carried out in all classes.

4.1.2 The Impetus for Change: Origins, Purposes and People

<u>4.1.2.1 Context</u>

The DEA requested primary schools in 1993 to undertake professional development in the four priority areas of Literacy, Numeracy, Science, and Technology. However, the whole staff at Claremont Primary School made the decision to focus solely on Mathematics (numeracy) as this would enable recent and about to be released Mathematics curriculum documents such as the Tasmanian *K-8 Mathematics Guidelines* and the *National Statement and Curriculum Profile for Mathematics* to be utilised more fully. Their view was that there was insufficient time to focus on all four areas and that it would be more profitable to concentrate on mathematics only. A quote from a grade 3 teacher at the school illustrated this point:

> *... it was our school decision to say that we were focussing on that because we would like extra priority in maths. We wanted to become more aware; more confident. So that was our way to go. We said Maths and unlike some schools who have said alright we will do Maths and Social Science and Literacy - because they are all priorities and we will do them all together - we said, no we are doing only one. ... we have had a lot of feedback saying we did the right thing because you have done one properly.*

Staff at the school had realised for some time that there was a need to review the Mathematics program and that this warranted consideration over an extended period of time. The publication of the curriculum documents provided a facilitator for this process and the development of the Mathematics Overview.

<u>4.1.2.2 The Implementation of Educational Change</u>

The development of the Mathematics Overview at Claremont Primary School was internally driven by a perceived need among staff for genuine understanding of the recent nationally developed and Tasmanian curriculum documents, along with the need for a review of the existing Mathematics program. Additionally, the development of the Mathematics Overview was facilitated by the DEA District Curriculum Officer for Mathematics and supported by the Principal. Support from the DEA District Curriculum Officer for Mathematics helped ensure that the teachers were familiar with the main ideas and emphases of the recently released curriculum documents.

4.1.2.3 Goals and Content

The goal of the innovation at Claremont Primary School was the professional development of teachers in mathematics, which involved the development of the Mathematics Overview for the school. This provided a guide for teachers at Claremont Primary School concerning the progressive development of mathematical ideas and concepts for children from kindergarten to grade 6.

It was developed following a comprehensive analysis of the mathematical ideas, outcomes and major foci that featured in the nationally developed and Tasmanian curriculum documents. This process resulted in the integration of ideas from the publications into a single document, the Mathematics Overview. On this basis, it provided a guide for teachers in planning the Mathematics program for their classes in a systematic, consistent and structured manner which took into account prior and subsequent learning.

4.1.2.3.1 Materials, Equipment and Setting

Apart from the Mathematics Overview itself, and the associated curriculum documents, there was a range of mathematical aids and materials within the school for teachers to use as appropriate. One teacher commented that, "we have also bought a whole new set of resources for our maths." These were based in a centrally located Mathematics Resource Centre which contained materials that could be utilised for all sections of the Mathematics curriculum. In addition, many materials were maintained in classrooms. The materials/aids available complemented the implementation of the Mathematics Overview.

4.1.3 Teachers in Change

4.1.3.1 The Role of Teachers

Teachers at Claremont Primary School worked together to gain familiarity with the curriculum documents in order to develop the Mathematics Overview. They worked as a whole staff, in small groups and as individuals in clarifying, analysing and discussing aspects of the publications. There was provision for teachers to try out ideas in their own classrooms and to reflect and analyse their own teaching in light of the new curriculum documents. A supportive, friendly and relaxed atmosphere was maintained.

Interviews with staff showed strong acceptance of the Mathematics Overview. Even during development it was used by some teachers in the design of their mathematics programs. Maintaining a major focus on Mathematics for two years had no doubt contributed to this acceptance as had the involvement of all staff for the duration of the project. Classroom observations provided some evidence that teachers were utilising teaching approaches that were consistent with these emphases. These observations were undertaken with teachers ranging from those in their first year to those with greater experience.

Teachers commented that they developed a clearer understanding of the emphases of the nationally developed and Tasmanian Mathematics curriculum documents. For example, one grade 3 teacher stated:

> *It is not a set prescriptive curriculum, but you have got to make sure that for it to work nationally that you are looking at outcomes and seeing where you are heading ... But me personally, having gotten through it, I can look back and say my understanding of my teaching of maths has definitely broadened and I feel much more happy and I can see where I am going and the way I approach maths in the classroom has definitely changed.*

Additionally, a grade 2/3 teacher commented:

> *But I have found them good because I felt some of my knowledge of maths was pathetic. I mean, I came through a school system where having the right answer was really important; learning the process was really important; learning to think was not important and I was an excellent rote learner ... But as I got into it I began to see that there is sense behind it and it can be a useful planning tool and it has made me feel happier about what I already included in the program and it has given me a purpose and it has also made me realise you can go slower. The national profile has given me good guidelines for assessment.*

There were some queries from parents in regard ot the Mathematics Overview. In particular, there was a problem for some parents concerning a lack of traditional recording of work (*eg* sets of exercises showing full working) in children's books. Interviews with teachers indicated some concern with this and the question of accountability to parents was raised. The school intended to provide workshops for parents as a means of helping to increase their understanding of teaching and learning mathematics when utilising approaches consistent with those in the curriculum documents and the Mathematics Overview.

4.1.3.2 Teaching Methods

This process of development of the Mathematics Overview over two years enabled most teachers at Claremont Primary School to have a strong feeling of ownership of the document. They were familiar with the ideas and emphases in the publications used in the development of the Mathematics Overview. This had resulted in most teachers broadening the range of appropriate mathematical activities they used in the different strands of the Mathematics curriculum. Comments from teachers gave a clear indication that there was more awareness of approaches advocated in the new curriculum documents and that these were progressively being used on an increasing basis.

One of these approaches was increased emphasis on *hands-on* activities. A grade 3 teacher commented, "yes, we do do a lot of oral activities and yes, we do do a lot of *hands-on* activities." A grade 6 teacher reported:

> *I try to have a mixture of different things - lots of hands-on things. I try to make things that actually make sense, not just doing the things but actually understanding what they are doing ... I probably like the things that we do which are more hands-on, but, then again, they might not even realise that that is a part of maths. They just see some sort of fun activity and not actually relate it back [to maths].*

In support of this, a grade 4 student at Claremont Primary School wrote in their journal:

> *Today also we done work with shapes, we had to make animals out of shapes. I thought it was interesting.*

Teachers at Claremont Primary School also attempted to make the mathematics content more relevant to students. A grade 3 teacher stated,

> *We are trying as much as possible to apply what they are doing to real things, not just to do rote questions - to show them why you are doing it and why you need to know this.*

Another teacher at Claremont Primary School reported:

> *We have gone out a lot more - done outdoor things ... On Tuesdsay, my brother is coming in and we are finishing off space. Someone will come in and be a person wanting a house built and they will have a layout of a block - a plan and building materials and he will go through all the things they need to know - basic things - for building a house. They will build a one room shack and position it on the block with the sun and all things like that and that is part of maths but won't even seem like it.*

A grade 4 student noted in their journal:

> *We measured ourself and two of our friends that told us our weight and height and it was fun.*

Teachers at Claremont Primary School have also attempted to link Mathematics with other subjects, that is, emphasise cross-curricula work. A grade 2/3 teacher reported:

> *I have always tried to provide a problem solving area as well as some sort of spatial or measuring activity, some kind of constructional technology work and although technology is not maths, I have linked them together in that time.*

Grade 4 students recorded in their journals the following comments:

> *In today's Maths we learned about measuring in cooking.*

> *With shapes, it is like art. It was very fun. It could help in art as well as Maths.*

Teachers at Claremont Primary School also emphasised a learning focus on process rather than product. A grade 3 teacher stated:

> *To make sure they understand, well they can make a wrong answer but that doesn't matter as long as they can talk about what they did and then go through those processes and share them with the group. I*

did that before but not to the extent that this is brought out and then the kids have a chance to share and discuss and ... [realise there isn't one particular method of getting the answer.]

4.1.4 Pupils in Change

In conducting interviews with students it was difficult to determine if changes that they perceived in mathematics lessons could be directly attributed to the use of the Mathematics Overview. A grade 2/3 teacher commented that the students,

> *... probably would not see a lot of difference in my room apart from in the teacher directed group which tends to be the Number strand that is used.*

Yet, pupils did comment on approaches to teaching mathematics being different but these could well be due to normal variations between teachers, rather than being directly the result of implementation of the Mathematics Overview and associated curriculum documents.

However, there was a consistent view expressed by students in that the Mathematics program was relevant to them and they could see the importance of mathematics both now and in the future. Further, students interviewed were able to appreciate the role of mathematics in other subjects they were studying. Some quotes from the student journals augment these points.

> *Darren and I made the wrong estimates, so we went back and worked on it.* (Grade 5)
>
> *The measuring was good, so was the shape drawing.* (Grade 4)
>
> *[It was interesting] to see how to round off money and what you would need to go camping.* (Grade 4)
>
> *I found everything a bit of a bore. The best part was getting to go out and measuring my height.* (Grade 6)

It was noticeable that students were positive regarding the Mathematics program and were confident in describing what they had been studying in class, often using appropriate mathematical terms and vocabulary. A grade 3 teacher commented:

> *The kids' understanding and thinking power - I know certainly in my Maths group that I teach - it has really made them more confident.*

4.1.5 Equity Issues

The 1994 educational plan for Claremont Primary School referred to positively encouraging gender equity. On this basis it could be assumed that such a policy was implemented in the Mathematics program. This view was supported during teacher interviews.

Similarly, the school catered for the integration of deaf children into the regular classroom, and teachers, in implementing the Mathematics Overview, ensured appropriate learning experiences were provided for these students.

4.1.6 Evaluation of the Innovation

It was recognised by staff that the production of the Mathematics Overview was not an end to the process of developing a coordinated whole school curriculum. They saw that the process would be on-going and that continuous review would be necessary. There was recognition of the value of sharing of ideas so that the quest for activities in the various strands of mathematics which were appropriate for the stage of conceptual development of particular students could continue.

It was reported likely that there would be an evaluation of the Mathematics Overview at the end of 1995. This would enable teachers to make use of the document for a year and, on this basis, to make necessary refinements.

4.1.7 Conclusion

Recognition of the need for redevelopment of the existing Mathematics curriculum, along with perceived need to gain familiarity with the new mathematics nationally developed and Tasmanian curriculum documents, involving professional development of staff, were the main reasons for developing the Mathematics Overview. The decision to make mathematics a priority over an extended period provided the opportunity to achieve these goals. The support of senior staff at the school and the guidance of the District Curriculum Officer for Mathematics were both important factors in the development of the Mathematics Overview.

Through maintaining a focus and providing opportunity for discussion, reflection and assimilation at all phases, a Mathematics Overview was produced which was well understood and appropriate for staff and students at the school. Clearly, there were identifiable steps and ingredients in the process of development of this Mathematics Overview and these may well be of use for similar projects at other schools.

4.2 Cosgrove High School: Science

4.2.1 The School

Cosgrove High School is a long established school in the City of Glenorchy. The school has enjoyed and fostered a positive reputation for educational excellenc. It has valued the support and involvement of its parents, local businesses and the general community, and has promoted actively their involvement in all facets of school life. One goal of the school has been to encourage students to give service to their community.

The school's population of almost 800 students in 1994 was diverse in nature, covering the full range of academic and practical abilities. The school staff numbered around 70 persons (including teachers' aides). Cosgrove High School sought close ties with its feeder school communities, especially in the area of the curriculum.

4.2.2 The Impetus for Change: Origins, Purposes and People

4.2.2.1 Context

A group of Science teachers, led by a Key Teacher (AST3), at Cosgrove High School initiated an approach to change the existing Science curriculum at the school through a series of meetings during 1993. The Principal and other senior staff were very supportive of a new approach, since an increased focus on literacy in the school had highlighted problems in existing science teaching methods for students with low literacy levels. A further interesting aspect of the school was the high relative proportion of female science teachers (a total of four out of nine) that, according to an Assistant Principal, precipitated a rethink of the Science program.

4.2.2.2 The Implementation of Educational Change

At Cosgrove High School, a number of conditions appeared to be present within the school that fostered the new approach to teaching science. The major factor precipitating change in the school was the appointment of a new Advanced Skills Teacher (AST3) in mid-1993. This Key Teacher had taught at Cosgrove High School for a lengthy period before her in-school promotion, and immediately took a series of initiatives in the science area upon promotion. Along with a number of present and former staff, she had been pushing for change in science education at the school for some time.

Full support was given by the Principal and both Assistant Principals in terms of resource fund allocations and timetabling assistance for curriculum and professional development. Factors outside the school also were important. There was the availability of the nationally developed Tasmanian Science curriculum documents and the support of three DEA consultants, including the Principal Curriculum Officer for Science, to provide assistance with the innovation.

Soon after the Key Teacher's appointment to AST3, she and another staff member attended a Science coordinators' conference and contact was made at this seminar with three members of the DEA Science implementation team. With their help with professional development, an ongo: ; process of curriculum development was put in place.

For the innovation to continue through 1995 and beyond, it was crucial that as many staff as possible were involved in the change and that they came to appreciate the full extent of the innovation (*ie* the big picture). There needed to be simultaneous professional development of teaching staff along with the availability of curriculum consultants to support the innovation. In this way, the innovation could be embedded within the staff of the school and its continuation did not rely on a key person to *drive* it.

4.2.2.3 Goals and Content

The teachers at Cosgrove High School decided they needed to:

(i) raise the profile of science in the school;
(ii) make science more interesting and relevant to students;
(iii) cater for students' individual needs; and
(iv) improve teaching and learning strategies in the school.

The group of teachers initiated the development of a new school Science curriculum consistent with the *National Statement and Curriculum Profile for Science* and the Tasmanian *Science Frameworks* documents. A number of decisions were taken regarding the components of this innovation:

(i) the revised curriculum would commence in 1994 with grade 7, and would then progressively continue with grade 8 into 1995;
(ii) because the new curriculum would require new teaching strategies, there would be the provision of professional development programs for science teachers that would emphasise broadening the range of teaching strategies used;
(iii) resources for science would be increased through means including new computer access, the establishment of a live animal collection, and purchase of kits suitable for low-ability students; and
(iv) restructure of class configurations, including introduction of single-sex Science classes into grade 8 in 1994 and planning of double periods (*ie* approximately 80 minutes) for Science.

All staff were working with the four general umbrella headings in the *National Statement and Curriculum Profile for Science* (*ie* Life and Living, Energy and Change, Natural and Processed Materials, and The Earth Beyond). The degree to which the new curriculum and teaching methods were adopted varied between individual staff members. Some staff were working entirely with the new curriculum, whilst some others were working at integrating a highly organised series of existing personal teaching packages into the new curriculum. No one had simply repackaged their traditional lessons under the new headings.

4.2.2.3.1 Materials, Equipment and Setting

One of the decisions taken as part of the innovation was to increase the resources for Science through means including new computer access, the establishment of a live animal collection, and purchase of kits suitable for low-ability students. These resources had not been introduced yet fully at the time of the project, though the live animal collection was underway.

4.2.3 Teachers in Change

4.2.3.1 The Role of Teachers
Science teachers at Cosgrove High School were allocated time out of class to work together to develop a new approach to curriculum planning and delivery for science. The activities undertaken consisted of a period of study of relevant government documents and then four different writing teams wrote outlines of each of the strands (as outlined in the *National Statement and Curriculum Profile for Science*). These teachers then trialled the materials and teaching approaches in their classrooms, discussed and shared their experiences and individually reviewed their own curriculum and teaching methods.

4.2.3.2 Teaching Methods
All staff were experimenting with new teaching methods, at least in some lessons. Students were involved in *hands-on* activities, such as making a video to present information on space research; and, in pairs, drawing an outline around each other's body, then drawing in where they thought body organs were placed.

Students took responsibility for their own learning by designing and planning their own experiments; for example, grade 7 students were observed conducting experiments in groups for which each group had devised their own experiment to test the strength of different types of paper. Students made the following comments about the lesson in their journals:

> *First we made a plan of how to test the strength of toilet paper, tissues and paper towelling. We held the paper in a clamp, tied string to it and used a force measurer [spring balance] to measure the strength.*
>
> *I carried out the experiment of which I devised (with Nathan) myself, to see how strong different paper is. Our idea of testing was a complete failure because we didn't have the equipment we needed.*
>
> *We had a lot of freedom because it was our ideas for the experiment, not no one else's.*
>
> *It was fun to do our own experiments for once, instead of experiments we were told to do.*
>
> *It was interesting to see what other groups had as their plans and it was also interesting carrying out the experiments on our own.*

Students at Cosgrove High School also brainstormed questions on new topics to research and were given the opportunity to give reports on anything of scientific interest. Group work was being used extensively by all science staff at Cosgrove High School. Students chose their own groups and the group assigned specific tasks to each group member. As a result, the atmosphere became far more industrious with more work appeared to be being undertaken.

4.2.4 Pupils in Change
Students could not compare Science with previous years as it was their first year of high school science. However, 87 percent were able to report something of interest

in their journal entries for selected Science lessons. Examples included:

> *It was good because we got to do our own thing - we don't get to do our own thing in other classes.*
>
> *We had to carry out our experiments on the strength of paper. It was fun because you didn't know when the paper would break.*
>
> *When I walked in the class I saw bodies [sic] hanging up everywhere, I thought it was fun.*
>
> *We tested the absorbancy of different papers. I didn't think it would be very interesting, but it's really amazing how much water a small strip can hold.*
>
> *I liked setting up the apparatus and doing the actual experiment as it is interesting.*
>
> *I enjoyed today's experiment as it involved not much theory.*

The Principal commented there was a heightened interest in junior science classes during 1994. Students also appreciated not having regular tests and appeared more relaxed.

4.2.5 Equity Issues

A student issue which was a concern at Cosgrove High School was obtaining equity in science education for girls and boys. Teachers had noticed a recurrent conflict apparent between grade 7 boys' and girls' expectations and responses to science lessons at the school. There were also some gender-specific discrepancies in the students' responses to some lessons, *viz* boys' enthusiasm for a teacher versus girls' lack of enjoyment and interest in the same class. Many of these students supported the plan for single-sex classes as had been introduced into grade 8.

4.2.6 Evaluation of the Innovation

The Key Teacher conducted a review of the new curriculum in October 1994. This was to gather staff responses and to plan for the review of the 1995 grade 8 curriculum which was based on the 1994 grade 7 experiences. There was a recognition that there was a need for the evaluation procedures of the new curriculum in both grades 7 and 8 to be continued in 1995. There was support from staff to maintain change at this stage, although there was a general frustration that more time was not available out of class for teachers to work together.

4.2.7 Conclusion

The innovation within the grade 7 Science program at Cosgrove High School was successful in the initial trial in 1994. There was strong support for its continuation into grade 8 in 1995 and further in subsequent years. The initiative relied on a Key Teacher to drive the innovation in the early period, but as the new approaches were becoming embedded in the teaching of a greater number of science staff, it was likely that this innovation would become an integral part of Cosgrove High School with full support from all staff.

4.3 Elizabeth College: Mathematics

4.3.1 The School

Elizabeth College, situated in central Hobart, provides a range of academic, vocational and broader spectrum courses at the pre-tertiary level. It offers up to 200 subjects depending on student demand. Mathematics is taught at all levels as a distinct subject.

The physical resources consisted of a disparate group of acquired buildings including the original two-storey redbrick school block, a 1950s secondary school of two- and three-storey grey cement blocks, various demountables, a couple of terrace houses, and some off-campus buildings. Purpose-built buildings included a state-of-the-art gymnasium, the 1993 built Learning Resource Centre (LRC), which included the functions of a library, and now the energy-efficient Futures Technology Centre (FTC).

The 1995 student enrolment was 1284, of whom 713 were full-time day students. The remainder were night class students or part-time day students. The largest age group of students (376) was sixteen year olds, though 337 students were aged twenty years and over. Female students outnumbered male students; in 1995 there were 707 females to 577 males.

Overall, Elizabeth College had a broader socio-economic mix and higher ethnic diversity than the other southern colleges. Around two-thirds of students had full or part-time work. As with other senior colleges, the enrolment had become increasingly more heterogeneous, with about ten percent of the daytime enrolment categorised as *special education*.

The staff quota of 58.7 was filled by the principal and 68 teaching staff, librarians, counsellors and a laboratory assistant. The college valued multi-skilled staff, with most staff teaching across several curriculum areas. Elizabeth College had cultivated many links with the community.

4.3.2 The Impetus for Change: Origins, Purposes and People

<u>4.3.2.1 Context</u>

The innovation at Elizabeth College was concerned with the development and implementation of a series of mathematics courses. These were designed to make the mathematics offered to students more relevant and practical for their lives now and in the future.

The innovation was initiated in 1991 in response to changes in the nature of the student population. It occurred concurrently with the introduction of the new criterion based Tasmanian Certificate of Education (TCE). The student population had changed from one oriented towards tertiary education to one in which approximately 70 percent would discontinue education at the end of grade 12.

Historically, students who had only just passed mathematics at secondary level were struggling to succeed at the algebra-oriented pre-tertiary courses and there was little provision to prepare these students for the more rigorous pre-tertiary courses. In the late 1980s there was a large increase in the number of such students entering senior secondary colleges throughout Tasmania. At Elizabeth College, there was also a significant increase in the non-English speaking population and the corresponding need to cater for students whose language skills did not equip them to participate in the traditional program.

4.3.2.2 The Implementation of Educational Change

The change was instigated by a group of teachers representing all secondary colleges in Tasmania, with the guidance of the Principal Curriculum Officer (PCO) for Mathematics. While it was driven from within the secondary colleges, it was supported by the DEA because of the obvious need to adapt to the changes in the student population. Thus, the change was primarily driven, through the changes in the student population which had been brought about by the decision to keep students at school for longer.

The program was particularly suited to Elizabeth College. Within the college, the new courses were developed and implemented by a group of teachers. A key feature contributing to the successful implementation of the innovation was the cooperation and sharing of ideas and resources between the mathematics teachers at the school. The majority of teachers adapted to the new program quickly and easily.

From the outset, the students seemed to be pleased with the introduction of a program which catered for those from non-academic backgrounds. It was accepted, without question, by the school community as an integral part of the overall program.

4.3.2.3 Goals and Content

New mathematics courses were developed at Elizabeth College in order to cater for the change in student population over recent years. Courses were needed which were relevant to students not proceeding to tertiary education. The innovation resulted in the development of four hierarchical courses. *Maths Studies, General Maths, Maths Applied Stage 1* were courses which could be completed in one semester (six months). *Maths Applied Stage 1* could also be taken over two semesters (twelve months). *Maths Applied* was a year-long course.

These new courses ranged from a very general course covering basic skills to one which offered similar content to that of the pre-tertiary courses. *Maths Applied* was similar to a pre-tertiary course, but with a practical applied mathematics content (*eg* finance, navigation, and statistics). The other pre-tertiary courses, not newly developed, *Maths Stage 2* and *Maths Stage 3* were heavily biased towards pure mathematics content (*eg* algebra, differential and integral calculus, trigonometric function study, and graphs of polynomials). The emphasis in the new courses was on real world problems, and students were shown how to use mathematical tools, such as calculus, to solve these problems. Students were encouraged to use concrete materials before concentrating on theory.

One of the problems identified by the teachers was the amount of course content. Many teachers felt it was difficult to complete within the allocated time and that this could detract from students being able to learn a topic thoroughly. Another problem was that the courses were not linked directly to work-related competencies. However, integration of vocational education training was under discussion.

4.3.2.3.1 Materials, Equipment and Setting
The teachers emphasised the importance of a good communal resource centre if a *hands-on* approach was to be implemented successfully. The lack of appropriate resources initially was a problem but a resource centre was established as the courses developed. The Resource Centre included concrete materials such as globes and projections used for spherical geometry and navigation, equipment for probability, statistics and game theory, and a growing library of computer software. Documentation consisted of worksheets designed to cover the syllabus topics.

The new integrated subject building (*ie* the Futures Technology Centre) was being used, and at the beginning of the 1995 school year mathematics classes moved from their previously isolated premises to the new facility. Mathematics classrooms were now conveniently located near computer laboratories which were shared with other subjects.

It was anticipated that the development of the Futures Technology Centre (FTC) would have direct implications for the Mathematics program. One plan was to integrate mathematics more as a tool to be employed in other subject areas. For example, with the proximity of the chemistry laboratories, it would be possible to conduct experiments to collect 'real' data for mathematics tasks. Mathematics teachers would be more accessible to advise students who needed to apply mathematical concepts in other subject areas. Mathematics classes would have easier access to computer facilities, and there were plans to develop parts of the course based on computer packages. It was envisaged also that there could be a move towards more open-learning type situations through the availability of multi-media facilities.

4.3.3 Teachers in Change

4.3.3.1 The Role of Teachers
The teachers played a significant role in adopting, implementing and integrating the newly developed mathematics courses. Their initial inservice training was in the form of seminars for teachers from secondary colleges around Tasmania, and internal staff development arose from this. Little support was required in this process, probably largely due to the fact that the new program lent itself effectively to the type of adult learning typically used within Elizabeth College.

4.3.3.2 Teaching Methods
The teachers reported they had to change their teaching methods in order to cater for students working at their own pace and to facilitate the use of genuine group work within the class. In solving problems there was a lot more discussion involved, which led to a lot more *ownership* by the student.

At the outset, teachers were concerned this would involve them in a great deal more work. However, they later believed that the applied nature of the courses led to them expanding their range of teaching techniques. A positive outcome of this was that it enabled them to build on their expertise in other areas and make more use of personal examples. They described it as being "fun to teach". They attributed this enjoyment at least partly to the fact that the students enjoyed it.

The most positive impact of the Elizabeth College program was that participation in the courses contributed to successful outcomes for students who previously did not succeed in mathematics. Of the six mathematics teachers who were interviewed, all felt happy with the applied nature of the courses they were teaching, believed that the students were learning and usually succeeding at mathematics, and saw the pathway which the courses offered as a suitable route for students to build on from their particular ability levels and progress easily to the next level.

The teachers indicated that it was easier for students to transfer from one mathematics subject to the next, since the short courses of six months encouraged reluctant students to enrol in a mathematics course, then their success gave them confidence to progress to other courses. The teachers commented favourably on the practical approach to mathematics, and believed that the students were much more positive about the subject since the topics could be related to everyday living.

However, the teachers did report that some students found it difficult to cope with being made responsible to get the work done. They found that some students did not like the course because they preferred the security of a more structured class in which the activities were more teacher-directed.

4.3.4 Pupils in Change

Journals and some of the interviews suggested that the majority of students were still negative about mathematics, but favourable about these courses compared to others they had done. They commented favourably on the more relaxed environment, smaller classes and friendlier atmosphere, all of which made it more conducive to asking questions and interacting with the teacher and other students. Two of the students interviewed indicated that they would prefer a more structured environment.

Students in the *Maths Studies* group were generally those who found mathematics very difficult, needed to be *spoon fed* and lacked confidence. Most entered the course with very negative feelings about mathematics. However, the students interviewed indicated they found Elizabeth College mathematics courses valuable because they felt they were learning something and they liked the teaching approach.

Students who enrolled in *General Maths* did so for different reasons. First, there were the students who had mastered basic mathematics but were not capable of entering directly into the academic courses. They enrolled through parental pressure or a genuine sense of the importance of mathematics in their futures. Many felt upon entry into *General Maths* that "this maths can't be real maths because I can do it." Some students indicated it was the first time since primary school they had experienced a real sense of satisfaction for achievement in mathematics. A second group was those students who had the potential to study the academic courses but needed to spend some time in *General Maths* to aid their development. These students found *General Maths* an ideal subject to aid their improvement and there had been some who had continued successfully to other maths units.

Students who enrolled in *Maths Applied Stage 1* fell into three categories. First, there were those who did so with a desire to proceed to *Maths Applied* and eventually pass a pre-tertiary subject, but initially needed a bridging course from their grade 10 Mathematics. Second, there were those students who enjoyed *General Maths* and felt they would like to do mathematics for further enjoyment, with the bonus of a higher award. The third group were those students who had an excellent grasp of basic mathematics, but were unsure as to their ability to study further in maths. This course allowed students in grade 11 to enrol in a mathematics course, hence keeping their options open for further mathematics study.

Students who enrolled in *Maths Applied* usually had a desire to gain a pre-tertiary mathematics subject but recognised that the alternative pure mathematics courses would be inappropriate for them; either because their future chosen careers did not demand a pure mathematics course, or because they did not have the appropriate background and ability.

4.3.5 Equity Issues

The initial impetus for the innovation was to address equity issues, namely to encourage participation by students from non-academic backgrounds and a range of ability levels. More recently, the program was also effective in catering for students from non-English speaking backgrounds. Most of the teachers interviewed felt that the *hands-on* nature of the courses lent themselves particularly to involving girls in them.

4.3.6 Conclusion

The innovation at Elizabeth College in mathematics was aimed at improving the course offerings for the growing number of non-academic students. Teachers did not only change the content of the courses, but also the manner in which the content was delivered. Students were responding in a positive way to these changes.

4.4 Elizabeth College: Technology

4.4.1 The School

Elizabeth College, in central Hobart, provides a range of academic, vocational and broader spectrum courses at the pre-tertiary level. It offers up to 200 subjects depending on student demand.

The college spawned the development of the Elizabeth Computing Centre which became a world-renowned provider of computing services for the state until its demise in the late 1980s as a result of budgetary cutbacks. Indecision on the future location and funding of secondary colleges in the region stifled development at the campus throughout the 1980s and this was only resolved a few years ago.

In 1995, the physical resources consisted of a disparate group of acquired buildings including the original two-storey redbrick school block, a 1950s secondary school of two- and three-storey grey cement blocks, various demountables, a couple of terrace houses, and some off-campus buildings. Purpose-built buildings included a state-of-the-art gymnasium, the 1993 Learning Resource Centre, which included the functions of a library, and the energy-efficient Futures Technology Centre.

The 1995 student enrolment was 1284, of whom 713 were full-time day students. The remainder were night class students or part-time day students. The largest age group of students (376) was sixteen year olds, though 337 students were aged twenty years and over. Female students outnumbered male students; in 1995 there were 707 females to 577 males.

Elizabeth College had a broader socio-economic mix and higher ethnic diversity than the other southern colleges. Around two-thirds of students had full or part-time work. As with other senior colleges, the enrolment had become increasingly more heterogeneous in recent years, with about ten percent of the daytime enrolment categorised as *special education*.

The staff quota of 58.7 was filled by the principal and 68 teaching staff, librarians, counsellors and a laboratory assistant. The college valued multi-skilled staff, with most staff teaching across several curriculum areas.

Elizabeth College had cultivated many links with the community. Some of these are described below.

(1) The Cultural Park of Hobart was to be a park set up on the Elizabeth College campus by a committee of college, community, and DEA representatives and was designed to express the ethnic diversity of the community.

(2) The college engaged in artistic events and projects in the community.

(3) A variety of vocational education programs ran in conjunction with major commercial and governmental employers in the hospitality, retailing and clerical areas.

(4) The Child Care and Child Studies course ran a child care centre and creche on site for the local community. Students operated the centre under supervision,

and charges covered the costs.

(5) Local private schools sent pupils to Elizabeth College for subjects they could not resource.

(6) Classes from feeder primary schools used the Learning Resource Centre and computer facilities. This led to the entire staff of one such school enrolling in a computer class at Elizabeth College.

(7) The night class program of 10-15 subjects offered a service to the community and was largely taken up by mature-age students.

(8) Elizabeth College designed and ran user-pays computer and word processing courses for commercial users such as the state electricity corporation.

(9) Elizabeth College's facilities were used by many community groups; for example, the Tasmanian men's professional basketball team and the Tasmanian Symphony Orchestra.

(10) The journalism class produced a magazine for the North Hobart community.

As indicated earlier, the college student population was now more heterogeneous. Teachers, therefore, could have different levels and even subjects in one class. Students who enrolled for subjects which proved to be too demanding could receive assessment in a *neighbouring* syllabus while remaining in the class. Students were encouraged to take courses which at least provided them with the fundamentals of literacy, of computer skills, with the ability to work with others, to show initiative, and to use enterprise skills. Timetables were altered from year to year to reflect changing needs and priorities. In 1995, after much discussion the timetable was altered to provide increased time for an enrichment program offering short courses, activities and workshops, enterprise subjects, and access to resource centres and teachers for key competencies and skills essential to all students; for example, literacy, numeracy, research and essay writing skills and computer and technology proficiency.

Enterprise subjects placed learning in a real-life context; some of the course hours were spent acquiring the theoretical knowledge, but a large proportion of the time was spent in putting that knowledge towards creating and running a business, either in a group or an individual situation. Enterprise subjects equipped students with most, if not all, of the key work-related competencies.

Some enterprise initiatives at Elizabeth College are listed below.

(1) *Elizabeth Publishing Centre.* Designed and produced various publications including a college and community newspaper and a magazine, and coordinated the work of about 100 students from a variety of classes.

(2) *Graphic Design.* Students worked to real design briefs for real clients, usually within the college.

(3) *Media Production C (Journalism).* One class produced a newspaper for the local

community.

(4) *Information Processing B*. Produced desk-top published work for students, staff and others for no payment.

(5) *College Yearbook A*. Students were responsible for the production, within a budget of $6,000, of the Elizabeth College Yearbook.

(6) *Catering Management C*. Students within Catering C formed two Catering Management Committees responsible for the organisation of Catering students who catered for 15-20 functions per year.

(7) *Tourism C*. Students sought design briefs from industry for the production of literature to support existing tourist enterprises.

(8) *Applied Small Business Management (ASBM) C*. One class developed enterprises of their choice. Most enterprises were marketed to college students or staff.

4.4.2 The Impetus for Change: Origins, Purposes and People

4.4.2.1 Context

The impetus for building both the Learning Resource Centre and the Futures Technology Centre arose from a number of factors; individual, collegial, local and national. Central were:

(i) the need to significantly upgrade facilities at the college and the availability of funding to do so;
(ii) key staff with innovative ideas and the commitment to pursue them; and
(iii) the pressures, both internal and external to the college, to make radical changes to teaching methods, courses and facilities to cater for the rapidly changing needs and priorities of students, educators and governments.

Following the development of the Elizabeth Computing Centre, the college attracted many key staff with a particular expertise in and commitment to technological innovation and to using technology to empower all students. Two senior librarians played a key role in the development of the Learning Resource Centre. Key computer and physics staff were similarly important in the development of the Futures Technology Centre. The Elizabeth College atmosphere was conducive to innovation in the Technology area, with innovators aware of a supportive network both in and outside of the college.

A number of national factors emerged during the late 1980s which provided the impetus for curriculum reorganisation and a thrust to broaden the incorporation of technology into classroom practices. Similarly, several changes were taking place at the state level. At Elizabeth College these national and state changes resulted in:

(i) an increase in class numbers;
(ii) mixed ability classes became the norm rather than the exception;
(iii) non-academic students outnumbered tertiary bound aspirants;
(iv) different subjects, teaching methods and styles were necessary to ensure that students who were alienated by the old subjects and the old chalk-and-talk routines would be motivated to acquire the key competencies;
(v) student choice of college and student choice of subjects and teachers

within that college ensured that the college and the staff presented interesting and relevant courses to ensure the working future of both groups;

(vi) Criterion Based Assessment produced more work for teachers in extensive and time-consuming record keeping;

(vii) work placements required staff and students to be comfortable with current commercial technology and practice;

(viii) work placements required that certain courses were structured for 'Open Learning' techniques, given that college contact time usually could not be timetabled to suit these students' various and limited available times;

(ix) credit transfers for Technical and Further Education (TAFE) students required lesson and assessment restructuring in certain subjects;

(x) extension of students' current computer-based skills as increasingly skilled students emerged from primary and secondary schools; and

(xi) an increase in staff teaching loads, with contact time up from 18 to 20 hours per week in 1994, with an increased variety of subjects to be taught by most teachers.

These changes were set against a prevailing climate of decreased funding, lower staff numbers, and larger class sizes with resultant increased workload expectations and teaching loads for staff. Staff confronted with these additional pressures responded by developing new ways of teaching more students, more flexibly, for less cost and in a shorter time.

<u>4.4.2.2 The Implementation of Educational Change</u>

Individuals in a supportive environment were important. Elizabeth College had had many key staff who had the commitment and capacity to make innovative leaps, and a Principal who was supportive of the principle of technology education for all. Many of the college's innovations were a combination of the right person being in the right place at the right time.

While the conditions for change at Elizabeth College were created by external forces, the content of the change was internally driven. Thus, when money became available for a major upgrade of facilities, Elizabeth College built an innovative Learning Resource Centre and an integrated technology resource centre (the Futures Technology Centre), rather than a library, workshop and home economics block. These innovations were a product of the knowledge, commitment and collaboration of the teaching community at Elizabeth College, and, in particular, some key staff.

<u>4.4.2.3 Goals and Content</u>

The Futures Technology Centre was designed with 'the *National Statements and Curriculum Profiles* as the warrant and initiator of ideas, and with the following goals:

(i) to providecomputer literacy and technological competency for all students;

(ii) to ensure that every student should have access to one or more subjects where technology was used;

(iii) to ensure that technology was taught, experienced, available and used at every level and across all subject areas;

(iv) to provide a range of subject levels in technology to attract students from lowest to highest ability;

(v) to provide the appropriate environment, skills and services, and quantity and quality of hardware and software to facilitate the goals;

(vi) to redress the gender imbalances prevalent in technology subjects;

(vii) to give students access to samples of different areas and styles of learning; and

(viii) to use applied technology to transmit the key competencies to the 70 percent of non-tertiary aspirants.

To achieve these goals Elizabeth College implemented a number of strategies:

(i) to form a Technology committee to ensure all learning areas were represented and that technology acquisition was researched and coordinated with the aim of breaking down duplication and possessiveness about *our* equipment;

(ii) the integration of technology subjects in the handbook as a defined learning area;

(iii) the encouragement of utilisation of technology in Mathematics by siting the Mathematics department in the Futures Technology Centre, and in Science by physically linking the adjacent Science block with the Futures Technology Centre;

(iv) the integration of subjects; for example enterprise courses such as the Elizabeth Publishing Centre which drew students from Journalism, Graphic Design, Public Relations and Photography;

(v) the active trialling of a number of pilot programs while pursuing accreditation; for example, Desk Top Publishing in 1994 and Multi Media in 1995;

(vi) the annual priority selection of an area of technological development; in 1994 it was the Futures Technology Centre;

(vii) the ensuring of continued relevance of teaching by using real-life applications and enterprise applications which cross traditional subject boundaries;

(viii) the encouragement of a philosophy of self-discipline and of equality of college members which underpinned both students and staff taking responsibility for their own learning and development;

(ix) the empowerment of students; for example, English as a Second Language (ESL) students took a 50 hour word processing course to put them ahead of fellow students in general studies in at least one area;

(x) the inclusion of social and cultural components in previously male-dominated technology subject areas to attract female students;

(xi) the ensuring that resource centres (*ie* the Learning Resource Centre and Futures Technology Centre) featured the latest appropriate technology;

(xii) the encouragement of feeder school staff and students to use the Futures Technology Centre and Learning Resource Centre resources to engender future student interest; and

(xiii) to ensure they kept up with and at the cutting edge of industry trends in both computer hardware and software.

The Technology learning area included dozens of courses, grouped in areas and under major subjects. Thus for each C or pre-tertiary C subject requiring a year of study, there would be allied A or B courses covering specialised topics within that area. Major subjects with associated courses are listed below:

(1) *Materials and Design Technology.* Design in Wood C, Design in Metal C,

Automotive Technology C, CADD C, Power Technology C, Design Graphics C, Electronics B and Computer Aided Drawing and Design at both C and the pre-tertiary C levels. There were A units in each subject and Credit Transfer subjects in each area.

(2) *Home Economics*. Food and Lifestyle B, Catering C, Food and Family B, Catering Management C, Textiles and the Family B, Fashion and Design B; and two pre-tertiary subjects, Food Studies C and Housing and Interior Design C.

(3) *Business Studies*. Applied Small Business Management C, Applied Small Business Accounting C, Australian Business Issues B; and the pre-tertiary subjects Accounting C, Economics C, and Legal Studies C.

(4) *Computing*. Applied Computing B with three neighbouring syllabuses; and the two pre-tertiary subjects Information Systems C and Computer Science C.

(5) *Computing for Business*. Key boarding, Word Processing A, Business Computing B, and Business Practice B, plus Information Processing B which divided into two subjects for assessment, Business Information Processing B and Personal Information Processing B which was targetted at ESL students.

The Enrichment Program was an innovation in 1995. It was allocated three 75 minute sessions per week, after all other classes finished in the early afternoon. Students received points for each attendance; one point for playing a sport, two for attending a class, or four for organising or tutoring a group. A total of forty points in the year qualified the student for an extra TCE A Unit. Student enrolment of 772 was far higher than expected. The aims of the Enrichment Program were:

(i) to engage and challenge all students;
(ii) to encourage them to take responsibility for their own learning; and
(iii) to recognise student achievement whether it be in community service, sport, personal development, increased learning skills, or whatever.

Elizabeth College emphasised multimedia. As the college handbook said:

> *... students find multimedia inherently motivating and challenging. Multimedia authoring provides a fertile ground for the development of many key competencies because it involves the integration of knowledge and skills from different sources for an agreed purpose. It draws on the skills of all involved to produce a quality product for a designated audience.*

Many day students already created multimedia presentations as their final projects in Applied Computing B and Information Systems C. It was proposed to offer Media Production C (Digital Video) and Media Production C (Multimedia) by 1996.

4.4.2.3.1 Materials, Equipment and Setting

The obvious changes to resources were the building and equipping of the Learning Resource Centre and the Futures Technology Centre. The Futures Technology Centre building was physically linked with the adjacent buildings containing the cafeteria and the Art, Science, and Ceramics departments, and with the Learning Resource Centre.

The building of the Learning Resource Centre was designed to encourage and prioritise electronic information gathering and processing, and to promote the central sharing and management of resources in the college. The Learning Resource Centre was situated at the centre of the campus. It provided resources and services for staff and students in support of the entire college's teaching and learning programs. The purpose-built complex included a large reading and expansive study area, two seminar rooms, small group work or tutorial areas, a computer room for student use, a teachers' reference area, a fiction reading and magazine room for recreational reading, and an open area for computerised information inquiry. CD ROM players with encyclopaedias, databases and indexes, and terminals for Australian Associated Press (AAP) and Job and Course Explorer access were provided for general student access. Cutting edge subjects were resourced with very little emphasis on book stock, and more on serials. Being close to the State Library meant book stock there could be accessed easily.

The design of the Learning Resource Centre visually defined the shift in importance from books to electronic media; the books were tucked away beyond the CD ROMs, the AAP and Internet terminals, and the OnLine catalogues linking all the public and educational libraries of Tasmania. The student-access computer room was the closest room to the main door. The Learning Resource Centre had extended hours to serve the many part-time and working students, opening daily at 8 am and staying open until 7 pm on two evenings.

The Futures Technology Centre was designed to facilitate cross-overs between subject areas. On Level 1 were electronics and robotics laboratories, computers for design work, the automotive technology workshops, metal work areas, textiles areas, and industrial sewing machines in the woodwork area. Each area was physically, but not visually, separated from the other due to the demands for noise reduction and dust extraction. On Level 2 were two large photographic darkrooms, two film-loading rooms, a computer laboratory networked for desk top publishing and multimedia work, and seminar rooms and staffrooms. On Level 3 were computer laboratories for Information Processing, Computer Science and Business Computing, and seminar and classrooms for these areas and for Mathematics, plus a staffroom shared by Business and Computing staff.

An objective achieved with the building of the Learning Resource Centre was the provision of accessible, free, fast, high-quality word processing facilities with computers and laser and other printers at various centres around the college. An objective achieved with the opening of the Futures Technology Centre was that the majority of computers in the college formed a networked system of machines which were not *owned* by any particular department or subject area. A future goal was that students would be able to save work on any platform and terminal in the college and pick it up on any other.

The centralisation of technology facilities meant that software important to a certain subject area, but not suited to the platform previously available in that area, could now be purchased to be used on the correct platform in the shared building. The college used the latest Genesis multimedia software which could integrate work off all the different platforms and produce marketable quality output. With their new computer equipment, Elizabeth College would be able to distribute programs overseas. The new servers would link all the PCs and Acorns and would increase the college's ability to gather both pictures and text from Internet.

The computer technology was carefully selected to give maximum educational value. At Elizabeth College Acorn computers were chosen for general educational use given that the software was cheaper, more user friendly, good for graphics and less business oriented. PCs (IBM compatibles) were used only where industry standards required that students were familiar with particular software, such as AutoCad.

The provision of computers within the college in 1995 was:

- 47 PCs;
- 20 Acorn 5000s;
- 11 Acorn 3000s; and
- 16 RISC (Reduced Instructions Set Chip) PCs.

These were distributed between the three levels of the Futures Technology Centre, the Learning Resource Centre and English and literacy areas.

At Elizabeth College the Automotive Technology course used seven engines, including one electronically fuel injected (EFI) model, to teach a class of 28 students. All the students could be taught simultaneously. The engines were mounted on free standing mounts which allowed them to be rotated for easy access. The move to the Futures Technology Centre added EFI testing equipment and a paint workshop. Students also brought in their own cars for group project work.

4.4.3 Teachers in Change

<u>4.4.3.1 The Role of Teachers</u>

The Learning Resource Centre policy was to initiate and support technological confidence and usage in both staff and students. All Learning Resource Centre staff had knowledge of teaching information skills, were experienced in desk top publishing, sat in on other professional development courses, knew how to manage the college enrolment system, and knew most generally-used software. They offered exemplary professional development backup, with conference reports, manuals and staff to help with new information skills such as Desk Top Publishing, Internet, Email, multimedia and other computer-based skills. Learning Resource Centre staff were involved in planning courses wherever possible, finding out what their assessment criteria were, how far the library could get involved with content, advising the teachers what was available in that area, and trying, sensitively, to help the teachers with the process of teaching.

The successful commissioning of the Futures Technology Centre was facilitated by appointing a senior teacher to oversee the process of design and physical organisation of the building and the moving-in process. A second such teacher initiated and organised discussion and decision-making groups centred around curriculum planning and possibilities opened up by the new facilities. Part of the preparation for the Futures Technology Centre move was to build up collaborative groups of teachers to plan space and equipment sharing and to develop an atmosphere conducive to future integration and team teaching. This was particularly effective for the Level 2 group who met frequently to plan, to learn and to select new technology, and it created a group who understood the basics of each others' areas and priorities, were motivated, and already had initiated integration and team-teaching on that level. On Level 2 of the Futures Technology Centre, two teachers from the arts area shared a staffroom with the Mathematics teachers. This enabled the sharing of ideas and knowledge. For example, one teacher planned to use the basic Draw program to motivate a low-ability mathematics class to use measurement.

The Enrichment Program enabled the college to timetable specialist teaching; for example, in computer, literacy and numeracy skills which were needed in most subjects or learning areas. This alleviated the pressure on teachers who were not specialist in these areas, and maximised the effectiveness of the specialist teachers.

Much emphasis was placed on staff becoming computer literate, and the Learning Resource Centre contained an area for professional development in computer skills. In this area models of the latest technology with appropriate software was available for staff to use and to familiarise themselves with in an open learning situation where there was support from the skilled library staff. Skilled staff ran introductory demonstrations.

The DEA required that full-time teachers undergo five days of professional development annually. A state initiative contracted the major private supplier of educational computer training to run free courses upgrading all educational business staff in all appropriate areas. However, in other areas, the cost of keeping abreast of industry-standard technology and software via corporate sector courses was too great to send staff out. Much of Elizabeth College's professional development relied on motivated teachers buying their own computers and learning new packages in their own time. The staff specialised and then ran workshops for colleagues on days set aside for professional development.

While all teachers agreed with the ethos underlying the changes, some were disheartened by the compromises which were necessary to build and equip the Futures Technology Centre within a diminished budget. Many raised the issue of time; the budgetary cuts and the 1994 increase in teacher workloads led to great frustration that there was no time to plan jointly new integrated courses, or create new teaching methods which could exploit the advantages offered by the new environment, or to undergo proper professional development to become confident with new equipment and the techniques demanded by that equipment. As one Materials, Design and Technology teacher reported:

> *We need new thinking for integrated courses, to bring in hands-on experts, to write courses with outside experience. We need time and paid professional development. For example, a sail-making course needs sewing, computer, mechanical and teaching skills, and the current Materials, Design and Technology, Textile, and Computing teachers don't have all those. But sail makers don't have teaching or syllabus-writing skills.*

For some teachers, the move to the Futures Technology Centre and the integration of subjects in the Technology learning area implied a paradigm shift; photography moved overnight from a purely wet process to a largely digital imaging process, with the necessity that the teachers suddenly became proficient with computer technology and the specialist software. Similarly, textiles teachers moved from manual to digital methods of design and machining. The buildings and changes were conceived at a time when teacher loads were lighter. However, current teaching loads limited time for getting necessary professional development.

Given the newness of the move to the Futures Technology Centre, it was to be expected that some discomfort would be expressed. The building was handed over three months late, the week before the start of the school year, and without some of the promised facilities and equipment. Some courses were marking time, waiting for vital equipment. It was a particularly stressful time for these teachers. The staff who organised the move believed that teachers would become more comfortable with the changes within a couple of months.

4.4.3.2 Teaching Methods

By virtue of their position, teaching students on the brink of leaving school for further education, the workplace or unemployment, senior secondary teachers were most aware that their students faced an unknown and ever-changing future. All the interviewed teachers had long believed in the conceptual change to student empowerment and teacher as facilitator, and were keen to implement strategies which would improve the range and accessibility of learning to all students.

Elizabeth College was trying to integrate different technology subjects to give a complete curriculum direction which crossed some of the boundaries it hadn't been possible to cross before. Learning was to be project or task driven. The Futures Technology Centre enabled new courses to be implemented using team teaching, collaborative working, and an enterprise approach, given that all teachers and facilities were now in the same space.

The response to the shift to collaborative methods and team teaching was positive, with teachers appreciative of the supportive atmosphere that both engendered. The change to collaborative approaches had been starting to happen informally over the last few years and was ongoing. Team teaching implied double or triple size classes and could be difficult to timetable in older colleges. The Futures Technology Centre facilitated this with interconnecting rooms, glazed walls giving complete vision of each room from the next, computer terminals on continuous benching around the walls, and spacious central desk areas. The visibility of classes and the *open door* policy of the Futures Technology Centre were catalysts for change as they allowed teachers to see how other teachers taught.

The Enrichment Program was structured to increase key competencies; for example, students set their own goals in each activity, organised their time over the year, and appraised their own performance, particularly in terms of the key competencies achieved. Students were encouraged to initiate their own enrichment program activities and to act as tutors and organisers, and many were doing so.

Throughout 1995 the college intended to initiate several specialist Resource Centres in the Futures Technology Centre, which could also operate as drop-in centres with resource teachers at class-free times; for example, in Desk Top Publishing.

Members of the Computer Expert Users group were using the terminals to become familiar with cutting-edge software in multimedia, animation, digital imaging, and so on. As they became proficient, they would act as tutors to other interested students, earning Enrichment Program points in the process. As the Computer Science teacher pointed out, no teacher at the cutting edge of computer software could hope to have comprehensive knowledge of all the packages they may have been asked to transmit to students. Fostering student expertise in individual packages and in tutoring other students enabled all to benefit.

A teacher in Electronics set up a teaching system which both empowered a group of students not previously renowned for their diligence and discipline, and enabled him to successfully teach classes of mixed ability and at different stages of learning the subject. They were virtually self running, with the teacher a very relaxed and much-appreciated facilitator. He started with a minimum of chalk and talk to outline an area. The goals were clearly defined in terms of the criteria to be met over the duration of the course, the work was completed via largely practical design briefs, which built on the knowledge gained in the briefs already completed. The students paced themselves, working individually, but in small self-selected groups, which usually contained students at all stages of learning. There was an atmosphere of quiet, interested and mutually supportive chat as everyone got on with the task at hand. The teacher only gave out additional information if the student was not capable of finding the answer in the magazines filed in the lab, or in the Learning Resource Centre or via the computer terminals. The design briefs were filed in an open cabinet, and all but some of the very expensive materials were freely accessed by the students as they needed them. The students were responsible for keeping the tool and the material cabinets tidy.

As they finished a design brief they presented the work for assessment. When the teacher accepted it, the student marked off that project and those criterion in the record book and selected their next project from those remaining. The record book was left open and very accessible on the front desk. Each student could see at a glance what projects and criteria they had met, and which remained outstanding for the entire course. The students were completing not only their electronics course but were, by the very nature of the teaching methods employed, acquiring many of the key competencies.

In 1994 another teacher had 80 photography students in three groups of very mixed ability and experience, starting at any time of the year, and using a tiny darkroom containing four elderly enlargers. He created what was virtually an 'Open Learning' course, based on themes such as *composition, tone,* or *the portrait*. He gave a brief lecture introducing each topic, handed out photocopied background information and illustrations, and the project design brief, and set a loose deadline. He held a one-hour seminar about once a week. Otherwise he used his contact time to demonstrate basic techniques to small groups of students, and was available over the teaching periods for students to request individually assistance. The students booked time in the darkroom across the college opening hours.

Other teachers created projects which students could self assess. As Applied Computing classes became so large two out of three students had to share a terminal, one teacher reorganised his teaching. By splitting the students into small groups working on multimedia projects and using a design-brief approach, he fulfilled syllabus demands, encouraged acquisition of many key competencies, motivated the students, and made more effective use of both computers and his teaching time. The work was student-centred; students provided the context and the teacher the expertise. The course was predominantly *hands-on*, with only five to ten percent of the class session as *chalk-and-talk*.

Information Systems was a combination of 50 percent theory and 50 percent practical work, but the delivery method of the theory component had changed; on the computer network there was an icon *Library* and a folder under each teacher's name in which were work samples, exercises and solutions for the students to access. One teacher collected work by asking students to put their assignments on a disc he passed around. With the whole of the Futures Technology Centre networked, this teacher would ask students to send him the work electronically. There was a similar system for computer studies. The computing staff had invested a lot of their own time in setting up the systems, but expected that it would save time in the long run.

4.4.4 Pupils in Change

The current generation of Tasmanian public school students had been educated in a system which emphasised life skills, promoted assertiveness and high self esteem, and encouraged students to take responsibility for their learning. Most responded positively to the open, adult atmosphere of Elizabeth College and the requirement that they be independent learners.

In the broadest sense, all students were targetted to use the Futures Technology Centre and the Learning Resource Centre, and were brought into the spaces by the centralisation of computer facilities and the expectation that all became computer literate. The Learning Resource Centre offered open access to computers and the laser printer and was fully used by students.

Within the Futures Technology Centre, the visibility and accessibility of exciting new facilities and approachable staff opened students to new possibilities and encouraged them to experiment and expand into new areas. The Enrichment Program offered more options for experimentation.

Students on the whole were moving through a range of new experiences, being taught new subjects by different teachers every year. The studetns spent, on average, two years at Elizabeth College. It was rare that they were in a position to distinguish between normal differences and structural change.

After just two weeks in the new building and the new academic year, the enthusiasm and sharing and generating of ideas amongst the Level 2 students was obvious; the journalism students had already initiated a new magazine production and were working with the graphics students next door. Comments from the Graphic Design students included the following.

> *The windows between the classrooms help us interact; we see them writing about the magazine on their whiteboard. They've just decided on a new name, and we know that before they tell us.*
>
> *I've worked in design offices, and this gives the feeling of a working environment.*
>
> *People from different subjects are coming in and out all the time, and the teachers interact with each other in the computer rooms and the*

design rooms.

They always did [interact], but here they're next door so it's easier.

The whole new building makes you want to do more; it's more professional. Last year the computers weren't near the graphics room, so we didn't have much to do with them. I'm a bit wary of them and want to overcome that, and that will be easy with them in the room next door.

There's lots of natural light and space and headroom in the Futures Technology Centre. The newness of the building gives a new aspect to work.

People are quite attracted by this big new building.

Comment from a student who moved to Elizabeth College from Year 10 in Victoria:

I chose Elizabeth College because it looked better in the information brochure. It's really relaxed here, the teachers are relaxed. We don't have separate senior colleges in Victoria. It's good to have everything you need; it's inspiring, it gives you confidence. The computers are good, I want to use them for graphics, and they've got everything here. The Learning Resource Centre is good; some libraries are really boring, but this one's really casual in there, and definitely different. The layout is really good. Teachers give you things to do and you organise your own time to do it.

Comments from Photography students included the following.

The [new] facilities for photography drew me here this year. I know a couple of people who came here because of them.

Photography is all about computers now so I may do a computer course this year as well.

4.4.5 Equity Issues

The design of the Futures Technology Centre was intended to further break down cultural barriers which still limited many students to narrow choices and stereotypical roles. Students in traditional technology areas were particularly targetted; for example, the placing of industrial sewing machines with the metal working equipment was an innovation intended to break the gender stereotyping of both the textiles and metal work areas. Teachers at Elizabeth College were committed to redressing the gender imbalances seen in some areas.

In 1994 in the Technology areas the ratio of males to females in the traditional Materials, Design and Technology subjects was 6:1. Gender stereotyping persisted even within the classes; in the CADD C class all the females were designing houses whereas the majority of the males were working on sophisticated engineering projects and scientific inventions. Similarly in Electronics, the male:female ratio was 11:1. Conversely, in the traditional Home Economics area, females outnumbered males 2:1. Only in the Catering C class was there parity.

In the non-traditional computer-based Technology area there was overall gender parity. However, within this, males dominated in Computer Science by 6:1. In 1995, enrolments in Computer Science doubled, and half the enrolments were female. Whether this was due to the new building, or to other gender equity programs succeeding, was unclear. In the business accounting areathere was a male:female ratio of 1:1 while in the secretarial skills area there was a ratio of 2:1 females to males.

Elizabeth College recognised the importance of role models. There was a female teacher as role model on each floor of the Futures Technology Centre; mature-age female students were encouraged to enrol in the traditionally-male area of Design in Wood by teaching in a four-hour block and their presence was seen as encouraging younger females to enrol; and a female ex-student who had become a motor mechanic and Tasmanian Apprentice of the Year was invited in as a role model on various occasions.

Elizabeth College teachers ran courses for girls from feeder schools, including the girls' high school, in Physics, Science and Motor Mechanics. There was no need for these courses in the science area as ten of the top twelve students in Chemistry, for example, at Elizabeth College were girls.

Due to Elizabeth College's aged, lift-free, multi-story buildings, students with mobility problems were not catered for. However, the planned provision of literacy, numeracy, and computer literacy resource centres in the Futures Technology Centre were to ensure that students with learning special needs were targetted.

English as a Second Language (ESL) taught word processing skills to empower ESL students in their general subjects. Additionally, new pictorial signage for buildings was being implemented.

Elizabeth College had moved away from *streaming*; students at all levels studied together and were then assessed at different levels. The spread of A, B and C courses catered for students of all ability levels.

4.4.6 Conclusion

Elizabeth College aimed at a closer convergence of general and vocational education, at making students multi-skilled, creative and adaptable, and ensuring that students had access to a variety of vocational and academic pathways. There was a major commitment to experiential learning, both in enterprise subjects, and in integrated and appropriately structured work experience programs. This paralleled the shift from teacher-directed education to the teacher as facilitator of student-led learning. There was a perceived need for new types of room 'spaces' to enable the new ways of learning; spaces which provided open access to appropriate technology and information, and which could be used by facilitating teachers in new ways.

The Futures Technology Centre was one of the most advanced technology education facilities in Australia and provided learning opportunities for students of all abilities. It was the outcome of key staff members' commitment and drive to change technology education, and the timely need for extensive upgrading of the physical facilities of the college in this area. The building had many innovative, artistic and technological features including sophisticated energy management systems and links to international computer networks.

The Centre's design included flexible spaces for new technologies, serving the demands of education and industry into the twenty-first century. The integration of these spaces provided opportunities for stimulating small business operations from initial creative concepts through the design and production phases. It also provided pathways for students to experience high technology applications in the areas of robotics, print, fibres, publishing, electronics and computer communications. The Centre also offered professional development opportunities for teachers in associated schools and was available for outside groups conducting workshops and conferences.

Through the Futures Technology Centre, Elizabeth College offered an exciting and challenging vision of the future where students could enhance skills suitable to the worlds of work, leisure and general pursuits relevant to a complex and changing society.

4.5 Exeter Primary School: Science

4.5.1 The School

Exeter Primary School is situated 24 kilometres north of Launceston. The school had an enrolment of approximately 650 students from a variety of socio-economic backgrounds in 1994. Seasonal work and changing economic conditions affect population movement in this area resulting in quite marked changes in enrolment figures in any one year. The school serves the township of Exeter and the surrounding rural area with over 90 percent of the student population bussed in from the surrounding countryside each day. There were 28 teaching staff with 10 support staff in 1994.

Previously the school was an Area School with secondary classes until a separate high school was built across the road from the Primary School which opened in 1985. Recently, Exeter Primary School underwent building redevelopment resulting in attractive, pleasant, purpose designed facilities for primary level education. The school developed strong relationships with the parents and local community.

4.5.2 The Impetus for Change: Origins, Purposes and People

<u>4.5.2.1 Context</u>

During 1992/93, school staff identified science education as a priority area for development. The staff perceived a need to raise the profile of science as they felt there was a deficiency in students' learning in this area and they perceived science as an area that had not been reviewed recently. Additionally, the emergence of the *National Statement and Curriculum Profile for Science*, in conjunction with science being listed as a DEA system-level priority for 1993/94, led teachers to nominate science as a priority area for 1993 at Exeter Primary School. Coincidentally, and shortly after the school embarked on the innovation, a scheme entitled *Key Teachers in Key Schools - Science Program* was commenced by the DEA's Principal Curriculum Officer for Science. Exeter Primary School was approached and joined the DEA'sprogram.

<u>4.5.2.2 The Implementation of Educational Change</u>

Initially the innovation was internally driven by a perceived need for improved teaching of science amongst staff at Exeter Primary School. Subsequently, external assistance was received for the innovation from the DEA.

An Advanced Skills Teacher (AST2) from outside the school was given the tasks of overseeing the delivery of a Science curriculum, providing professional leadership and achieving a high profile for science in the school. Her expertise was in professional development, rather than science teaching. However, she expressed interest in taking on the role of Science Resource Teacher, in a traditionally male area, and was willing to learn about content, methods and materials for teaching primary science along with other staff. As she stated:

> *I hadn't actually been a Science teacher as such before - I had just been a good classroom teacher and I thought that Science just needs a good classroom teacher.*

The Science Resource Teacher approached teachers in the school to take part in the Science program and under her leadership a group of six Key Teachers formed the

Science Committee. The Science Resource Teacher commented on how the Science Committee was formed:

> *I chose the people personally. I had time to get to know everybody and I tried to choose people right across the school - from kinder to grade 6, and I tried to choose people who had just an interest in this particular area.*

The Science Resource Teacher was instrumental in the innovation at Exeter Primary School. It was a case of sharing knowledge of science teaching by the Science Resource Teacher and the Key Teachers with other staff to increase their confidence in order for the plan to move forward and spread through the whole school. As the Science Resource Teacher's role diminished, the Key Teachers involved in the program, and other staff members, were required to take on more of the responsibility for the innovation. Other teachers in the school were attempting to become familiar with the ideas inherent in the innovation. More professional development was deemed necessary, however, for this to occur effectively.

The DEA no longer supported the program, therefore the school was fully responsible for the innovation. Commitment and support, including budgetary support from senior school staff and support from the parent community, were important features of the implementation of the innovation.

<u>4.5.2.3 Goals and Content</u>

The innovation at Exeter Primary School had three main features:

(i) the appointment of a senior teacher (AST2) to the position of Science Resource Teacher;

(ii) the nomination of teachers interested in science who would be Key Teachers in the development of a Science curriculum for the school in line with the ideas of the *National Statement and Curriculum Profile for Science*; and

(iii) the creation of a special science facility, namely a Science Room, for the school.

A goal of the DEA Key Teacher program was to work with volunteer or nominated teachers in designated schools with the aims of assisting them:

(i) to be comfortable in sharing their science teaching practices and approaches with other teachers in the school (Exeter Primary School), and other schools in the district; and

(ii) to enable them to further their own understanding of science teaching and learning.

The brief from the school Principal for the Science Resource Teacher was "to come up with some kind of curriculum framework to lead the staff in developing a particular Exeter curriculum framework" in science. Alongside a Key Teacher professional development program, the Science Resource Teacher worked on setting up the Science Room in the school with the aim of interesting children in science and generating enthusiasm for science in the total school community.

The Science Committee acquired new skills to develop a Science curriculum and materials (including the Science Curriculum Broadsheet) to be used by the whole school. The Science Room became the focus for this activity. At regular staff meetings time was devoted to keeping all staff informed of developments in this area. This raised the profile of science in the school and the development of curriculum became a shared responsibility between the Science Resource Teacher and the other Key Teachers.

The curriculum planning broadsheet for Science designed by Exeter Primary School as part of the innovation, with input from other schools involved in the *Key Teachers in Key Schools - Science Program,* was commended by the DEA and provided to all schools in the state as a possible model for them.

4.5.2.3.1 Materials, Equipment and Setting

The specialist Science Room was set up in 1993, but reverted to a normal classroom in 1994 due to major building redevelopment within the school. During this time, the onus of responsibility for science teaching reverted to individual class teachers. However, the Science Room was reestablished in 1995.

The Science Room operated on a booking system with staff able to book blocks of time, usually of one hour's duration. Clearly labelled equipment boxes, for example boxes for pulleys, magnets, mirrors, and so on, were easily accessible. A book display contained relevant books for both teacher and student use. Learning Centres were set up around the room and display shelves housed such things as biological specimens and examples of students' work. The room had a sink, a water trough and a trolley equipped with tools for construction activities. The central area of the room allowed for working space together with tables and chairs for desk work.

Each classroom in the school received a Science Kit in 1995. These kits were developed by the Science Resource Teacher with input from Science teachers at the nearby high school. The Science Kit contained magnifying lenses, a microscope, magnets, batteries, a battery holder and globes, tweezers, eye droppers, funnels, test tubes and holder, measuring beakers and a stop watch. This classroom based Science Kit was to ensure that science was not confined to the Science Room. Additional equipment was available from the Science Room for classroom based science work.

One grade 6 teacher said that the new approach created "a real buzz throughout the whole school".

4.5.3 Teachers in Change

<u>4.5.3.1 The Role of Teachers</u>

The Science Resource Teacher was responsible for:

(i) delivering the Science curriculum for K-6;
(ii) providing leadership in the organisation of resources;
(iii) developing a professional development program for the staff; and
(iv) achieving a high profile for science in the whole school community.

To assist her she had support from the Principal Curriculum Officer for Science at the DEA. The Science Resource Teacher and Principal Curriculum Officer for Science were in contact about once a month during 1993. However, the Principal Curriculum Officer for Science was not available in 1994 or 1995 due to promotion.

The teachers on the Science Committee (including the Science Resource Teacher) took on new roles within the school as well as their traditional teaching roles. Initially they undertook a series of five professional development workshops organised by the Science Resource Teacher, with the support of the Principal Curriculum Officer for Science, in order to develop a curriculum broadsheet and links maps for the new Science program. Four of these workshops took place in 1993 and involved the Science Committee from Exeter Primary School and the Principal Curriculum Officer for Science. The final workshop held in October 1994 involved the whole school staff so that the Science Committee could share their ideas and the newly developed program with the rest of the staff. The Science Resource Teacher stated:

> *Next year [1995] I will be running little sessions every now and again. For instance, I might get someone who is really good at doing visualising lessons to run a visualisation session at the staff meeting or someone to do design briefs. Some people just about go spare having to do these. But if someone can tell us how to go about it then it is going to arm people with more strategies and I guess that is what they need - more strategies. People feel frightened because they are not quite sure what to do and where to go.*

She later added:

> *I really felt it would be crucial that I had highly interested people, an amount of expertise, and a balance across the school so that all those things are reflected in the materials we developed; and as well all along the way, we reported back to the staff what we were doing and we did surveys and gathered information from them so the rest of the staff were in on it all along the way.*

In addition to effort being made to share the outcomes of the workshops with other staff members through several short staff meetings, a display board in the school staffroom encouraged Key Teachers to share ideas they had tried following the workshops. Therefore, through the work of the Science Committee, the whole school became committed to the Science program. Additionally, Exeter Primary School made an effort to keep the parent community informed of the developments in science from the beginning of the innovation. Parents were enthusiatic about the Science initiative, which was a reflection of the enthusiasm of their children for the Science program.

The Science Resource Teacher's role would gradually diminish as the innovation became internalised and embedded within the school. However, there would be a need for a person to be responsible for resources and this role could be filled by a member of the Science Committee. Key Teachers would continue to have an important role to play in professional development and especially in the dissemination and presentation to staff of new Science units.

<u>4.5.3.2 Teaching Methods</u>

At Exeter Primary School, the development of the Science program and support materials, and adoption of associated teaching methods, was grounded in the ideas in the nationally developed and Tasmanian Science curriculum documents. The

Science Resource Teacher commented:

> *And so really I have got the teachers to the stage where they think of the Science curriculum in those four strands [ie Earth and Beyond, Energy and Change, Life and Living, and Natural and Processed Materials] and I have encouraged them to think of Working Scientifically as the way we teach the strands.*

She also commented on the various approaches people could use.

> *They might brainstorm. They might do a concept map. They might do a visualisation. They might do a drama. They might do a design brief. We encourage them to decide their intention; decide their key idea and then decide how they are going to introduce it.*

The Science program at Exeter Primary School had a strong *hands-on* emphasis. Design and construction were part of the challenge of the subject. As an aid to this, the Science Room included a *tinkering* table equipped with a basic tool kit where students were able to dismantle household items such as toasters, a TV and electric irons to see how things worked. This area was very popular. Additionally, an observed grade 6 activity involved children learning about gear systems on bicycles, involving knowledge of ratios. The central space in the Science Room allowed children to have several bicycles inside for observation and practical exercises.

Students at Exeter Primary School helped generate ideas about which science topic they wished to pursue. The result was that students possessed a sense of ownership and power over their own learning and outcomes in the science topics. The teacher was a facilitator for their students' learning.

The new Science program was specifically designed to be inclusive of other subject areas; for example, Literacy, Numeracy and Technology. Science was recognised by the teachers as being a subject area with links to many other subject areas which could be explored in the classroom. The Science Resource Teacher commented:

> *We tried to show everyone that the starting point in science can be anywhere. You might be working in Earth and Beyond but your activities go off into the other areas - off into Energy and Change; off into Materials, off into Studies of Society and Environment.*

The primary level of school was particularly suited to this sort of exploration. Examples of cross-curricula work at Exeter Primary School included the following.

(1) A Key Teacher did some drama work, involving scientists presenting arguments for allowing a development on an ecologically sensitive island, with a grade 2/3. This had its origins in the science topic they were studying.

(2) Grade 6 students used the computer to type up their science reports.

(3) A grade 1 class studying snails made observations, built models and drew pictures.

(4) A grade 2/3 class studying ants used the information obtained in Science as a basis for writing poems about ants.

4.5.4 Pupils in Change

The following responses from students regarding the Science Room were typical of the school as a whole. They enjoyed having a special room and time for Science; it helped concentration as it had a quiet atmosphere.

> *... it's more like a High School when you have a Science room and a Science teacher.* (Grade 6)
>
> *... being in another room can help you concentrate on one subject.* (Grade 5)
>
> *You can make more mess in the Science Room when you work on things.* (Grade 4/5)
>
> *Going to the Science Room makes you feel special.* (Grade 4)
>
> *There is more equipment available as well as better resources.* (Grade 4)

The advent of the Science Room created an enthusiasm for science throughout the school. The school participated in a statewide Science Talent Search in 1993 and the Science Resource Teacher organised grades 5 and 6 teachers to hold tutorials on specific areas of science to help children to devise and develop ideas for the competition. Exeter Primary School students were very successful with a number of awards being won, indicating the students' interest and achievement.

4.5.5 Equity Issues

Teachers made a deliberate effort to involve girls and boys equally in learning science, especially when conducting brainstorming sessions and organising groups for collaborative learning. They found that boys and girls were equally interested in learning science.

Differences in ability levels of students was not an issue at Exeter Primary School since the *hands-on* nature of the Science curriculum catered for all students. The lower ability students experienced success through the practical work and children worked in mixed ability groups.

4.5.6 Conclusion

Staff at Exeter Primary School were aware of a deficiency in the teaching of science at their school, and so instituted a program, run by the Science Resource Teacher, to address the problem. They gained support in this innovation from Science curriculum officers at the DEA. The program involved writing the Science Curriculum Broadsheet and setting up a Science Room for classes. Ongoing professional development of teachers at the school was an integral part of the program's development.

4.6 Lauderdale Primary School: Technology

4.6.1 The School

Lauderdale Primary is located in a semi-rural commuter seaside suburb of Hobart. The school was opened in 1965 and there have only been three Principals; in position for six years, ten years and, fifteen years, respectively. In 1994, at the start of this project, the school buildings were overdue for a major redevelopment. There were 35 teaching staff, including the Principal and two Assistant Principals, three administrative and office staff, and seven teacher aides, two of whom were assigned permanently to the two-classroom kindergarten unit.

Student enrolment in 1994 was just under 700 students. Class sizes ranged from 25 to 31 students. The feeder areas had undergone a rapid expansion and change from sparsely populated rural land and small seaside holiday villages, to a permanent, predominantly commuter population. Well-built houses on one or five acre lots typified the new developments.

Thus, Lauderdale was a young community with little infrastructure, and the school was a focus for community activity. In 1995 one class was working with the local council to observe, maintain and make suggestions about a section of the foreshore. The school encouraged parental participation; and the parent body made outstanding contributions to the school in the provision of both financial resources and input of time. Parents offered their skills and experiences in diverse activities such as 'Antarctic expeditioners', special education teachers, builders, marine biologists, cooks and carers. They raised money for new playground equipment, computers and CD ROMs. The school kept parents informed with a weekly newsletter.

The mission statement for Lauderdale Primary School was:

> *To provide a range of opportunities and experiences in a stimulating environment which nurtures a love of learning in students and develops active, independent learners and problem solvers.*

4.6.2 The Impetus for Change: Origins, Purposes and People

4.6.2.1 Context

The innovation at Lauderdale Primary School focussed on introducing children to computers at the kindergarten level and by grade 6 having them achieve a high level of computer literacy. Thus, the innovation was aimed at only one component of the Technology area; Computing.

The vision and the supportive and confident leadership of the Principal guided the school. He saw part of his role as to challenge, ask questions, and raise issues, to bring in expertise to support work in new areas, and to create an environment in which staff and students could take risks without feeling they were going to be criticised.

The Principal's vision of a tomorrow we could not predict, and an awareness of the need to exchange information and ideas locally and globally, necessitated that students be given a flexible, confident and problem solving approach to the technology of the future. His vision included Internet access in every classroom:

> *If kids can communicate earlier then there is a chance of peace and international friendship.*

In 1991 the Motec initiative (a mobile technology unit, now discontinued) came to Lauderdale Primary School. The Primary Assistant Principal had completed recently his MEd thesis on technology and invented the Technology Challenge, which had since become an annual all-school venture at Lauderdale Primary School. He also participated in preliminary meetings about technology guidelines for both *Our Children: the Future* and the *National Statement and Curriculum Profile for Technology*, and he and the principal were well informed as to the future direction of technology education.

Individual teachers were asking increasingly for facilities for Email for students to contact schools abroad, and stating a need for better self-publishing facilities for the students than the single BBC computer shared between two classes and the solitary school printer. Since 1991, Lauderdale Primary School had organised its Technology curriculum on the principles of *design, make, and appraise.* The principal said:

> *Computer technology is an integral part of the learning process. Its use extends across all learning areas; it is not a subject in itself except in the initial learning stage.*

4.6.2.2 The Implementation of Educational Change

At the level at which Lauderdale Primary School had emphasised technology, we were not looking at radical change so much as at a logical outcome of the Principal's vision of:

> *a school which knows it is preparing students for the twenty-first century, students who are flexible in their thinking, competent in each of the curriculum fields, are independent learners, communicate effectively and enjoy walking into class each day.*

The change therefore was largely internally driven and was initiated by the broad vision and leadership of the Principal. The principal saw his primary role as leadership, and had written a thesis and various papers on the concept that outstanding educational leaders have a vision for their schools.

The Principal had a strong and clear vision for the school and was a leader who gained maximum support from his staff by giving them encouragement, support, respect, and a free rein to try things out. The Principal had a vision of a mutually supportive family atmosphere for Lauderdale Primary School within which the students were given ownership of the means of becoming flexible thinkers and well-prepared members of a community in an unpredictable future. Staff, students and parents were seen as a team working together to achieve this aim.

The change was enabled by the Primary Assistant Principal's experience and enthusiasm for technology in education, and his self-confidence in moving into uncharted territory. External impetus existed in the discussions about technology at both state and national level, but the timing and the overall quality of the change was certainly a product of internal motivation.

The change was adopted readily by students who enthusiastically turned to computers for story writing, drawing, publishing, multimedia, and communication with their peers abroad, and for the 'games' which enhanced areas such as literacy, numeracy, general knowledge, and motor skills.

Teachers varied in their support for of the change; there was a range from teachers who were 100 percent enthusiastic and were initiating the use of computers in every conceivable way in the classroom and in setting work; to those who recognised their value but were not 100 percent confident, and who developed that confidence after seeing what the initiators were doing and then followed on; to those who were rather hoping that computers would stay in the word-processing area and not demand too many changes on their part. However, the groups did not appear to be static; there seemed to be a level of confidence at which a person moved from being a follower to being an initiator and an independent learner. In 1994, at least two of the staff moved on to being initiators themselves.

The school community was clearly behind the change, funding the provision of computers to an exceptional degree, and responding very supportively and positively to their childrens' work via learning journals.

4.6.2.3 Goals and Content

The innovation at Lauderdale Primary School focussed on introducing students to computers across the curriculum from kindergarten to grade 6. Lauderdale Primary School organised its Technology curriculum on the principles of the *design, make and appraise* model outlined in the *National Statement and Curriculum Profile for Technology*. In the two-page 1987 statement of his vision for Lauderdale Primary School, the Principal envisaged it as a place

> *... in which teachers acknowledge the increasing importance of technology as a learning aid, a means of global communication and a tool to access information [and] ... in which teachers explore with enthusiasm theories of learning and refine their approaches to teaching during the implementation of new curriculum field guides and frameworks for planning.*

The goals of the innovation were:

(i) to empower students to be confident and competent using computer hardware and software, including word processing, Email, CD ROMs, desk top publishing, and multimedia;
(ii) to challenge students to be particularly creative in areas of designing, making and appraising;
(iii) to focus on the students' skills to scan, access and appraise information;
(iv) to enable staff to recognise and to use the enormous teaching resource which Internet provided;
(v) to skill staff to a level at which they could confidently use and teach technology in the classroom; and
(vi) to skill staff to be competent to run the computers and the network.

The school set, and met, a priority that sufficient computers be available for students to learn as a class, and to be able to practise their skills at other times. The minimum they set was two computers and a printer in each classroom, plus a networked laboratory of 32 computers. The laboratory had open access before and after school and at recess and lunchtime.

The next goal was to network the classroom and library computers. As stated by the Principal:

> *So many students are now corresponding internationally and access is the problem. Therefore the network is vital.*

A goal for the near future was to have a computer on each teacher's desk so that by inputting administrative information even the most diffident would become comfortable with the technology.

4.6.2.3.1 Materials, Equipment and Setting
Lauderdale Primary School had upgraded its computer resources over the last few years from a base of a BBC computer for each classroom and several printers. In 1990/91 the school bought ten more printers. In 1993, the Parents and Friends Association purchased 32 second hand BBC computers which were networked in the computer laboratory, and 12 new Acorn 3000s for the classrooms. Therefore, each of the 23 classes in 1994 had a BBC, an Acorn 3000 and a printer. Additionally, Lauderdale Primary School was determined to have Internet access, thus the DEA provided them with a recycled multiplexer and a dedicated line.

The Library had four IBM compatible computers with CD ROMs. One was used mainly for issuing and the librarian's work, the others were as accessible to the students as the books on the shelves. Grade 1s routinely accessed the catalogue, selected a title, memorised the location and shelf number and found and issued themselves with a book via the barcode system. By grade 2 they were also accessing the CD ROMs for information on projects.

4.6.3 Teachers in Change

4.6.3.1 Role of Teachers
Teachers at Lauderdale Primary School had various different roles in relation to the innovation. The Primary Assistant Principal was responsible for technology and tutored staff and students. The Primary Assistant Principal had a hands-on pragmatism, getting networks and computer laboratories set up. He did not consider himself an expert, but as someone who encouraged others to do what he did rather than "blinding them with science". The Primary Assistant Principal selected new and stimulating technology tools and kits and put them in the staffroom for all to look at and try. His own enthusiasm and willingness to explain and discuss inspired the others. The Primary Assistant Principal also took classes for special technology lessons when teachers requested them or were otherwise engaged. He was usually on hand near the computer laboratory, strategically placed next door to his office, if a teacher needed assistance or the system 'crashed'.

Technology was being taught, used, learned and discovered at every level at Lauderdale Primary School despite many of the teachers being initially uncomfortable with many of the technologies. The senior staff had a high priority to enable the predominantly female staff to become comfortable with technology, and encouraged and appreciated all staff to progress in this area.

Improved staff skill levels were being met by providing in-school professional development and supporting external professional development for the teachers. Staff were encouraged to become computer literate by taking desk top publishing classes at Elizabeth College. Although this was done in their own time in the evenings, the courses were paid for by the school and the staff were accredited with a small proportion towards their five-day annual professional development requirement. Some teachers were tackling technology *full on*, thriving at the chance to expand their skills. Others were seeing it as intellectually appropriate, but personally *scary*. The willingness to *have a go* characterised the school and appeared to be due to the very supportive environment which had been built up. The senior staff made a superb team, and the teachers generally appeared to be highly effective, committed, well qualified and experienced.

Lauderdale Primary School was working on sharing the increased staff workload and limiting teacher stress with a number of initiatives. In 1994 post-class time was assigned for teachers of each grade level to meet for discussion and mutual support. This group coordinated curriculum and planning decisions and could also act as a support group. Grade 6 teachers collaborated closely in preparing complex units such as media analysis and production. The initiative proved so successful in generating new teaching ideas and methods, and alleviating stress, that in 1995 the timetable was rearranged so each grade level team met for a 1.5 to 2 hour weekly session whilst their classes were taken by specialist teachers. The Principal had noticed at the start of 1995 that teachers who had prepared in tandem teams, pairs or grade level groups were very positive and effective right from the start, whereas those who by chance were working alone were feeling isolated.

Three educational priorities were set for each year and were pursued by 'A' teams of senior staff and representatives of each grade level. In 1995 these were *Science and Technology*, *Gender*, and *Integration*. The Science and Technology team would work on implementing *National Statements and Curriculum Profiles* recommendations.

The librarian was integral to the changes. The role of the librarian was:

(i) to provide students with access to skills in information retrieval to enable them to live in the modern world; and

(ii) to have terminals throughout the school for children to access the various programs; CD ROMs, library program, Internet, *etc*.

Teachers were moved up and down the school frequently, but usually stayed with one year level for up to three years. This, many of the teachers said, kept them fresh while allowing them to build on knowledge gained over each year. The school had no power to select staff, but, as the Principal said, "teachers could probably choose not to come if they don't like the style." The Principal also said Lauderdale Primary School had

> *a terrific staff team, with a terrific sense of relationship, and a fair degree of purpose.*

Teachers had a high workload, and appeared to have taken on the *National*

Statements and Curriculum Profiles, technology and computer usage at a faster rate than other schools.

4.6.3.2 Teaching Methods

The senior staff saw change as internally motivated, and based on the premise that education had moved from being very teacher-directed to being student-focussed, with teachers continually assessing the current level of each student's knowledge and using that as the starting point of the teaching. Teaching therefore took into account the diversity of students and the various levels at which they were operating, rather than being monolithic and teacher-centred.

The reduction in teaching staff had accelerated alternative methods of teaching including:

(i) cross-age tutoring;
(ii) team teaching;
(iii) design briefs;
(iv) open learning projects;
(v) parent involvement in the learning process through learning journals and clear and supportive communications;
(vi) technology usage to extend student learning, as in CD ROMs and networked educational software; and
(vii) the Technology Challenge which involved the whole school in an inspirational and fun focus on a new learning area.

The diversity of teaching styles was respected and celebrated. One grade 6 classroom was papered and hung with information, posters, design briefs, and ever-changing displays of the students' current work, to the point that light could barely enter the windows. The students here were enthusiastic, loud, caring, expressed their ideas and feelings confidently, and treated the teacher as an honoured friend. Next door a double grade 3 class had a calm, gentle atmosphere, students chattered quietly as they got on with their work in groups at circular tables. One grade 5 operated in a creative ferment, half built structures, video equipment, weather maps, design briefs, and work in progress cramming the floor space and walls, students often worked at fever pitch moving all over the room and out into the school environs. In another grade 5 class, the students sat at ordered desks in neat rows responding quietly and confidently to a verbal test.

Many teachers at all levels used rotating work groups for much of their work. The session's or day's tasks and learning objectives were clearly outlined on a whiteboard, and the students moved from task to task. This enabled limited resources, such as the two classroom computers, the Lego Technic sets, or the technology kits, to be used more effectively. Several students commented in their journals similarly to a student who said:

> *I think that it is good to be in small groups so that you learn more like in today's lesson.*

Design briefs and project-based work, applying the *design, make, and appraise* model, were used by some teachers throughout their work. Design briefs involved the students in reflective processes; whether they were being asked to write a story or design a room, they had to consider the purpose of the work and the materials available, and design and make and continually appraise the match between their product and the required outcome. Project-based work, whether by individuals or groups, enabled children to be taught and to learn at their own pace, with the teacher able to work with small groups facilitating the learning.

A grade 5 teacher set most work in the form of design briefs; for example in an extended unit on human shelter he set many briefs, one of which was the following:

> *Past Shelters: Research and choose a shelter from the past. Prepare notes and graphics and a model. Show what the shelter provided and what kept it going. What lifestyle did the group have? What time was the shelter made? Where? Was it part of a larger group; village, town or city?*

Many of the classes used Email for students to correspond internationally. Internet put the students in touch with the *outside* world. Teachers used themes which were developed through all the learning areas, and Email was used to develop literacy, communication and research skills; keyboarding and hence fine motor skills; and an expanding awareness of the vast world beyond southern Tasmania. Teachers asked their students to gather information about how and where their Email friends lived, leading the students to an awareness of the similarities and the differences in the social life, the school day and the geography of children with whom they identified as friends, yet who lived in a very different part of the world.

Methods of communication between the students ranged from teachers communicating with each other, to children handwriting their letters and the teachers checking their spelling before the students typed them into the computers, to students running real time conversations without a teacher present. (In the latter case, the teacher safeguarded himself by ensuring all messages went via his password, and he could check that the students were abiding by the Internet rules.) A grade 1 class corresponded with a base leader in Antarctica. Many grade 6s rushed to be in school before classes started to continue their real time conversations with a class in Austin, Texas; the students typed straight into the computer their greetings and questions and answers. A few of the teachers also were communicating with their counterparts in other countries and sharing ideas and information which were then used in their teaching.

Each student had a weekly session in the computer lab. 1994 was the first, and successful, time that kindergarten students had a weekly 20 minute session, each pair of kindergarten students was aided by a grade 3 tutor. Preparatory to grade 6 students had a 40 minute session each week. Simple games helped kindergarten students gain dexterity with the controls which moved the pointer around the screen and which completed one task and moved on to the next challenge. They also used number recognition and alphabet recognition programs. In the following grades they used games which were designed to increase various competencies, such as literacy and numeracy, and to challenge and extend their knowledge in the various learning areas. In grade 4 they were taught keyboarding.

The classroom computers used more sophisticated software than those in the laboratory, and children were using graphics and desktop publishing programs on these from about grade 1 onwards. The choice of software was up to the individual teacher. Some were confident with sophisticated programs and could therefore introduce them to the students. Many grade 3 students were very confident with desktop publishing. One grade 6 class produced excellent multi-media work.

Students were introduced to searching databases by the use of the CD ROMs in the library, and could be seen as early as preparatory class playing with the terminals controlling the encyclopedias, and in grade 1 confidently using the Bookmark system to select and find books.

Cross-age tutoring had many beneficial effects. In the cramped computer laboratory where each kindergarten child needed physical assistance to get into the menus and a constant and individual guide as to how to proceed, the tutor acted as an involved motivator and helper to the younger child. Without the tutors, teachers would not have been able to keep up the momentum necessary to enthuse the students. Tutors became aware of their own skills and learnt to verbalise the processes, get satisfaction, and increase self esteem. Cross-age tutoring also was used for reading practice and for mathematics tutoring between grades 3 and 6. In some cases it was the younger child who was helping the older child. Pairs were carefully selected. The tutor rehearsed their skills and the tutee got individual attention over a prolonged period. Comments by students on cross-age tutoring in the computer laboratory included:

> *We have two kinders to each grade 3. We go into the kindergarten program and help them to get into the menu and program. We choose the program with the kinder kid, the program they want to work with. Sometimes you choose for them if the pair don't agree.*
>
> *It's hard to keep control of the two people on different games. And if one of them is ahead of the other, it's hard.*
>
> *It teaches us to be patient.*

In the computer laboratory in free time older children spontaneously tutored their younger neighbours.

The network had menus for each grade level and, under each teacher's name, specialist curriculum software, Email and the word-processing software. No *games* could be used on school computers, but the children considered the educational software to be games, as fun, and rushed to get on the computers in each session. Teachers used software appropriate to their curriculum areas and year groups; for example Pendown 2 and Magpie, a multimedia program. Some software was filed under the teacher's name on the network for students to access formally or informally in the computer lab; other software was available from the library for use on the classroom computers. Keyboarding was formally taught from grade 4. Computer usage was often used as a reward for diligent students.

Students at Lauderdale Primary School were encouraged to be responsible for their own learning, and made the following comments about this.

> *It was interesting because I was able to choose what I wanted and I didn't have to use something I didn't like.*

> *Planning the card was [interesting] because I had to work out what I was doing and how I would do it.*

An emphasis on 'real world' problems was apparent at the school. One grade 6 student noted in their journal:

> *I think it was good because I learnt how to make Christmas cards on the computer and [that will] help me in the future.*

Technology at Lauderdale Primary School was cross-curricular with students from grades K-6 involved in designing, making and appraising. Their technology projects integrated other learning areas. Design briefs were frequently based on literature; labelling and written appraisal increased literacy; measurement and graphing for numeracy; materials and process awareness for science; presentation for art; design and presentation increasing computer skills. At all levels the students were integrating mental processes and concepts with materials and process knowledge.

Technology as a motivator for cross-curricula learning was demonstrated in one grade 2 class with a theme of snails. The class was asked to gather snails in their gardens and bring them to school with some of the vegetation on which they were found. About 100 snails arrived. The entire project was characterised by great excitement and the desire to share with everyone in the room the delights and the discoveries each child was making The class was asked to sit in a circle and warmed up by asking if anyone knew the word for snails on a restaurant menu. A couple of students knew escargot from LOTE. One girl, who showed a particular delight in snails, was asked to choose one and the students carefully passed it around. Each student studied it and thought of a word which described that snail. They were concentrating very hard and came up with wonderful words; for example, protective, slimy, delicate, spiral (Observation and Language). The teacher wrote the words on the whiteboard (Spelling). The students were asked to divide themselves into groups of five. The teacher expressed her worry about some groups; she asked them, "why were there more boys in some groups and more girls in others?" She sent those in well-balanced groups to tables to start work, and waited for the other groups to re-select themselves. As they did, she sent them to start work.

The students used individual magnifying glasses to study a snail. There were many sizes, colours and shapes of snail, including some sea snails. They sketched the snail. The drawings were very accurate and specific (Observation and Drawing). Finally they were asked to draw an outline of the snail in their spelling books and to write in the words that described their snails (Diagram, Observation, Writing and Spelling). Over the week of the project, the students went on to design and conduct experiments to find which foods their snails preferred, and what surfaces the snails preferred to move on. They predicted outcomes, designed experiments, brought in materials, set up the experiments, observed, collected and organised the data, graphed, wrote and drew the results, drew conclusions, discussed and appraised their work, and displayed excitement, delight, motivation, confidence and individuality in all their tasks (Science, Maths, Technology).

This teacher made a habit of integrating all the learning areas. She had taught both kindergarten and preparatory classes in the past few years and began by reading the children a book then basing a lot of activities on that; for example, *Teddy Bears Go*

Shopping led on to mapping skills and language activities for preparatory level; while, for older children, *One Dragon's Dream* and *Counting on Frank* were fairly open and allowed lots of exploration, and could be linked with the use of calculators. She designed and desk top published stimulating worksheets and helped the kids publish their work using the computer, and presented it, often in the form of short prose poems displayed with a drawing, on an attractively coloured-in worksheet.

The division between Technology and Science was not clear at the practical level in primary education. *Hands-on* science used technology; a technology brief requiring students to create a vehicle with gears driving the wheels would open the student to learning about the transmission of power and the effects of changing the size relationship between drive and take-up wheels. Even being asked to design and test a paper plane brought with it much scientific knowledge, in a highly enjoyable way.

In the computer area, students were engaged with mathematics from kindergarten, using the *Early Number* program to learn to recognise numbers, and then using drill and practice software from that point. Many of the adventure challenges were designed to enhance numeracy.

Database on the classroom computers was used to run surveys, to analyse and graph data and to write reports, combining Mathematics, Science and Technology, and, depending on the subject of the survey, other learning areas as well. *Spreadsheet*, another program on the classroom computers, was used in Mathematics from about grade 5. A grade 6 teacher was about to get the students to use computer software for Control Technology.

In 1995 the Primary Assistant Principal commenced running specialist information skills sessions for grades 5 and 6, showing students how to access a number of sources, to look at the appropriateness of the sources and at the balance or point of view of their coverage. The course covered all the sources available in Lauderdale Primary School's library, and included books, CD ROMs, Internet (using Gopher, Telnet, Archie, and Veronica), the state's libraries, and using file transfer procedures to download relevant information. Students were encouraged to develop the skills to independently access these services for school project work. The Primary Assistant Principal planned to run an information skills course for the teachers as many had pointed out their own lack of skills in these areas.

The annual Technology Challenge empowered students and staffs in a motivating, fun manner using the *design, make, and appraise* model. The challenge set a common goal for the entire school and students, staff and parents all become involved. This created a supportive environment for all to take risks and learn from each other. The 1994 challenge was to build the fastest land-yacht with a maximum sail area of one square metre. There were various levels in the competition, for example, starting from scratch, modifying an already wheeled vehicle, or using Lego.

4.6.4 Pupils in Change

In the primary school context, students had no real perception of change in a historical context. All of the content and pedagogy was new. It was difficult for a child to differentiate between teachers' diverse styles and innovative teaching methods. But the enthusiasm with which students talked of their computer time and with which they remembered the Technology Challenge proved that they were tremendously popular innovations, and the clarity of their conclusions, their computer skills, and the inventiveness of their designs indicated their educational value.

Comments on the Technology Challenge by grade 3 students included:

> *To enter the competition, you had to have a picture, labelled, of the design. You could use any materials.*
>
> *We made a little car with a sail and had to make it go. We used a clipboard as a fan.*
>
> *One made of straws flipped over; it was too light.*
>
> *Some of us were working through lunch and at home too. We were very keen. We only had half an hour in class each time. It took about three weeks to plan and make it.*
>
> *One really big design had huge wheels, but it fell apart!*
>
> *The design that won, Tamara's, wasn't put together very well, just two margarine lids with cardboard in between, it was a very simple design. It would only have taken her about an hour to make, but it covered the course in 21 secs.*
>
> *Mine took 48 secs. I learnt to try and make them simpler.*
>
> *The ones that took a lot of time to make, or the bigger they were, the longer they took to complete the course!*
>
> *Last year we had to make a boat from milk cartons and see how much weight it could carry. One could carry a person, but they cheated by using lots of cartons.*

Grade 3 students commented on the computer laboratory and classroom computers as follows:

> *The latest thing is we're doing computer pictures to print out. It's not hard for us; we're experts! The ones with computers at home are more afraid to take risks; they're afraid of crashing their parents' computers! These computers are totally different to the ones at home (PCs).*
>
> *We're not allowed to play (computer) games at school.*
>
> *We get free time on the computers if we finish our work early ... some people always get that!*
>
> *We go into the lab out of school time. [How much? Two boys:] All the time! We'd be there twenty four hours a day, seven days a week. [Or, two girls:] About 45 minutes extra a week, on top of class time.*

They all reckoned educational games are fun, yet saw what they were learning:

Pool Table uses angles and gets balls in holes.

Dragon's World isn't very educational.

Yes it is, at some levels!

Comments on classroom computers also involved negative reactions:

We mainly do story writing on the Acorn 3000s.

You can't print them.

It's easy! Control F8!

Loading the printer driver takes ages.

These Acorn 3000s always give errors.

Students willingly engaged in cross-age tutoring, both formally set up in weekly computer classes (grades K-3) and in reading and maths activities (grades 3-6), and voluntarily in extra-curricular activities.

Comments from students' journals on student-centred learning included:

It was fun designing and setting up, you had to use your imagination. (Grade 6)

The interesting thing was that my [pop-up Christmas] card turned out really well because I used my imagination. (Grade 6)

I think the most interesting thing was tyring to think what I was going to draw and which way to cut it out. (Grade 6).

4.6.5 Equity Issues

In some classes informal use of the computers had to be rostered to ensure that less extroverted, and particularly female, students got equal access. Teachers setting up technology briefs encouraged small group work and designed tasks to give girls equality. Some of the teachers were careful to assign girls to more technical challenges and to give added support and explanation.

For example, a grade 6 teacher set up a multi-task technology project. She assigned a group of girls to the Lego Technik challenge which involved building a vehicle or a merry-go-round and using gears to power it. The teacher told the girls that she herself was unsure about how gears worked, so she asked the Principal for assistance. He came and gave a very gentle and clear exposition which empowered both teacher and students. The teacher thought that her willingness to show her ignorance and to ask for help offered a positive role model to the students. Some of these students' comments in their journals were:

We feel good because we knew something [our teacher] didn't know.

Something interesting was that so many things are powered by cogs because I didn't know that when I started.

The open learning capabilities of computers at Lauderdale Primary School allowed students to proceed at their own pace. The computer laboratory was open outside class hours. Menus were set up for grade levels, but students could access software at other grade levels. Generally they were asked not to go into higher grade level software to protect them from failure, but they were not prevented from doing so if they wished. Competent students could use higher levels to challenge themselves, students feeling unsure of themselves could return to lower levels to rehearse their skills and build confidence.

4.6.6 Conclusion

Lauderdale Primary School had a commitment to positively prepare students for an unpredictable future, by giving them the skills and confidence to be independent problem solvers in times of changing technology and goals; and beyond that a belief that only by empowering students, and hence adults, could world peace be attained. The school had an ethos of opening out students and never underestimating them, of respecting differences, supporting and encouraging growth, creating the whole school as a family of respected learners, challenging mindsets, and encouraging and supporting everyone, staff or student, to have a go; that is, to go beyond their perceived boundaries. Everything was integrated towards empowering the students and staff. Obstacles were seen as challenges, and staff took on the role of facilitator, rather than arbiter and closed authority figure.

4.7 Launceston College: Science

4.7.1 The School

Launceston College is situated close to the city of Launceston on the site of the original Launceston High School. Extensive redevelopment of the site has occurred since the college was formed. Launceston College has developed from its origins as a traditional matriculation (university feeder) college to meet the needs of the wider community which it now serves.

Students enrolled at Launceston College come from a wide variety of socio-economic backgrounds with around 40 percent of students receiving Austudy. Though parental involvement is always greatly reduced at senior secondary level, the support is nevertheless evident when it is acknowledged that 60 percent of students rely on parents for full support. One quarter of the student population comes from rural areas as geographically widespread as Flinders and King Islands and St Mary's.

The college provided courses for a small number of disabled students. Aside from these special needs students, a wide range of student ability was evident, from exceptionally gifted and talented students through to those who had struggled to complete grade 10 courses at secondary schools.

The college had an enrolment of approximately 1500 students and had 130 teaching staff. At Launceston College, Science was taught at all levels as a distinct subject. C courses catered for pre-tertiary students, while B and A courses catered for non-tertiary bound students.

4.7.2 The Impetus for Change: Origins, Purposes and People

4.7.2.1 Context

During 1994, the focus at Launceston College was to make science more accessible and appropriate to grade 11 students by offering more suitable courses. The impetus for these curriculum changes stemmed from a greatly increased student enrolment in the past five to six years brought about by the removal of Commonwealth unemployment benefits for 16-18 year olds. This led to a larger number of lower ability students seeking to study at the college which traditionally was perceived as an *academic* institution.

In May 1993, a *Map of Launceston College Curriculum Provision* for each different DEA Framework (subject) area was set out for five student categories:

(i) Gifted and Talented;
(ii) Pre-tertiary;
(iii) Grade 11 and 12 Leavers;
(iv) Less-Skilled; and
(v) Special Needs.

Following analysis of this map for deficits in offerings to students, it was found there was a large imbalance in science subjects (in comparison with other areas) in the academic (pre-tertiary) subjects when compared to those for the non-academic (non-tertiary bound) students. Many science subjects at the college were not available to all students except those studying pre-tertiary units (*eg* Physics and Chemistry).

Following the subject mapping exercise, a survey of all students in grades 11 and 12 was conducted in 1994 to determine:

(i) the main reasons students were studying science;
(ii) the main reasons students were not studying science;
(iii) the attitudes of students to the range of science subjects offered; and
(iv) additional science subjects students were interested in studying.

New science offerings (outside of *mainstream* science subjects) were constrained by a number of factors, including:

(i) the difficulty of getting any new syllabus accredited;
(ii) the need for class sizes to be viable; and
(iii) for the new units to be timetabled.

To deal with the issue of science subject offerings, it was identified by the college as a priority area of the curriculum.

4.7.2.2 The Implementation of Educational Change

The innovation at Launceston College was internally driven by staff who perceived a lack of science subject offerings for non-tertiary bound students. No assistance for the innovation was provided by external sources. One Key Teacher, with the support of the science staff, coordinated the innovation and course developments.

4.7.2.3 Goals and Content

The college-based research was carried out by a committee set up to investigate this issue, and a number of initiatives were recommended to be taken during 1994 and 1995. These were:

(i) the introduction of an all-girls *Physical Science* class;
(ii) analysis of current and possible future offerings for non-academic students, including line release for a teacher to develop a *Natural Science* course for these students; and
(iii) funding for professional development of science staff to expand their pedagogical practices.

The teachers at Launceston College looked at how best they could offer science subjects and attract certain students who would not normally be joining their science classes. Considerable time was spent looking at the possibilities of particular non-mainstream subject areas that included a whole range of areas that the students had suggested, such as astronomy, horticulture, marine biology, and so on. A number of these had been tried already, but in some cases the facilities available limited the offerings, so the staff opted instead for a revamped *Natural Science* course where elements of all of these other courses could be included. It was considered there was a little bit of something for everybody that way.

Launceston College adapted existing Tasmanian Certificate of Education (TCE) syllabuses and modified both content and the teachers' pedagogical approaches to better meet the needs, interests and abilities of the non-academic students. In-house seminars determined a number of suitable courses in 1994. Subjects selected for inclusion in the 1995 curriculum offerings were *Physics B*, *Chemistry B*, *Natural Science B*, and a non-pre-tertiary *Agricultural Science* course.

The *Agricultural Science* course would not be offered at the pre-tertiary level so that students who were interested or had a background in agriculture could do the subject at an interest level and in an applied sense. Since many of these students came from rural communities it was considered they ought to have little difficulty with the course.

To attract female students to study science, an all-girls *Physical Science* C syllabus class was established during 1994. An *Industry/Technology Science* C syllabus course had also been introduced to attract trades students. It was hoped all of these units would be seen as more appropriate for students who had not been catered for with previous offerings.

A further key innovation was the emergence of an amalgamated Science Department comprising all science teachers rather than the traditional compartmentalised areas of Physics, Chemistry, Biology, *etc*.

4.7.2.3.1 Materials, Equipment and Setting
Launceston College declared 1994 to be the *Year of Science*. A budget allocation of several thousand dollars as well as the time allocation to the AST3 of Science was resourced to assist with a review of science within the broad framework of school improvement.

4.7.3 Teachers in Change

4.7.3.1 The Role of Teachers
A Key Teacher (the AST3 of Science) provided the leadership necessary to bring the large group of science teachers together. Under this leadership, the science teachers evolved into a cohesive Science department that viewed science in a generic sense across the curriculum, rather than as separate areas of Physics, Chemistry, Biology, *etc*.

This very large lobby group generated considerable influence across curriculum committees within Launceston College, so that the new course proposals discussed in its report received strong support and subsequently were approved. It was likely also that this new group would seek professional development options that would be very feasible given the size and experience of the science staff.

4.7.3.2 Teaching Methods
Launceston College was supporting this course restructuring by allowing line release of teachers for the restructuring of the *Natural Science* course which could be adapted and used by other teachers. This course had been specifically designed around context based learning experiences for students, which used the local environment as its key resource.

4.7.4 Pupils in Change
Student feedback on the new courses was positive. The all-girls class in *Physical Science* C syllabus was successful in its trial, as comments from a number of students revealed:

> *... use of real examples that we could relate with and that related to things in everyday life.*
>
> *In the all-girls class you could say anything and not worry about the boys hassling us.*

Again, the new subject offering was seen to be a good option:

> *It helps to keep Physics C (pre-tertiary) option open to me.*
>
> *My attitude to Science has improved.*
>
> *Motion and Chemistry were the best parts for me, especially Chemistry.*

Equity Issues

Launceston College funded four science teachers to attend a *Girls' in Science* seminar and to report back to all science staff on interesting and relevant findings. There was a perception by teachers that the atmosphere in the newly established classes had changed (improved) although the trial was still relatively new. According to the AST3, the feedback at this stage indicated that the girls were receiving a number of positive benefits through being together as an all-girls class with a female teacher. The enrolment in future years would reveal the true extent of success as publicity and advertising along with anecdotal data spread through the student population.

4.7.5 Conclusion

The developments at Launceston College provided students with curriculum offerings from which they were able to select science units which provided material of interest and at a level suitable to their abilities. This innovation resulted in a greater number of students studying science at Launceston College and the students reported they had greater interest in the material and it had more relevance to the outside world.

4.8 Lilydale District High School: Science

4.8.1 The School

Lilydale District High School is a K-10 school situated approximately 30 kilometres from Launceston. It is sited on a five hectare block within the small rural township of Lilydale. The school caters for children from the township and for children from the surrounding district who are bussed in to the school each day. It had an enrolment of approximately 430 students and a staff of 31 teachers in 1994.

Originally the Lilydale school was one of a cluster of small rural schools serving the farming communities of the Lilydale district. During the 1950s school rationalisation occurred with the result being progressive closure of very small schools. The Lilydale school became the focus of school education for the district and the school was renamed the Lilydale Area School catering for students from kindergarten to grade 10. Agricultural education was included in the curriculum and, as with all Area Schools, a school farm was an important feature of the educational program. A strengthening of secondary education programs in rural schools commenced during the late 1960s. This resulted in the upgrading of many Area Schools to the status of District High School. The Lilydale school was one such school and today it provides a full range of opportunities at both primary and secondary levels.

The school started to increase substantially in size during 1986-7 primarily due to increased enrolments in kindergarten. This growth was maintained in subsequent kindergarten intakes. The enrolment *increase* entered grades 7 and 8 in 1994 and placed pressure on resources and accommodation. A building program was underway.

The school was essentially divided into three main organisational groups: grades K-4, 5-7 and 8-10. This arrangement was recent with the creation of a middle school (grades 5-7) occurring in 1994. This division of class groups could have been adjusted in 1995 with the possible inclusion of grade 8 into the middle school group. Each organisational group was served by a senior teacher.

4.8.2 The Impetus for Change: Origins, Purposes and People

<u>4.8.2.1 Context</u>

The Assistant Principal was keen to develop the idea of the middle school after attendance at a conference relating to middle school organisation. Discussion with other staff members provided the impetus to implement a middle school approach at Lilydale District High School.

The Senior School Key Science Teacher (the head of Science) was instrumental in exploring and adopting new and dynamic approaches to teaching science (*eg* CoRT thinking) through his own reading of the current literature and professional development. He passed his ideas on to other interested members of staff to be used in their teaching of science and he was the proponent for restructuring the middle school Science program.

<u>4.8.2.2 The Implementation of Educational Change</u>

The initial K-8 innovation within the school was internally driven by the Senior School Key Science Teacher. The subsequent innovations were instigated separately.

The middle school innovation was driven internally by the Assistant Principal and a senior teacher, who had attended a conference on middle schooling, and thought it a worthwhile proposition for Lilydale District High School. After discussion with staff, parents and administration the middle school idea was adopted and implemented. The senior school innovations were again internally driven by the Senior School Key Science Teacher. (This begged the question of what would happen at Lilydale District High School when this teacher left (he was retiring in 1995).)

4.8.2.3 Goals and Content

The Senior School Key Science Teacher was first appointed to the school in 1988 and it was his vision to create a K-10 Science program. The aims of this program were that:

- (i) teachers would become more confident teaching science;
- (ii) teachers would have a better understanding of *sciencing* (*ie* what science is all about and how science is fundamental to other areas of knowledge); and
- (iii) teachers would have knowledge of a wider range of approaches to teaching science.

In consultation with other staff, he produced a document entitled *A Guide to Teaching and Learning Science from Kindergarten to Year 8* (1990). This document only related to science teaching up to grade 8 as the Senior School Key Science Teacher was himself responsible for teaching science at grade 9 and 10 levels. To attempt to implement this program, three teachers who were most interested in science were incorporated into the organisational structure of science teaching within the school. These teachers taught grades K-2, 3-4 and 5-6, respectively.

The middle school organisational arrangement was a recent development. While *middle schools* were not of themselves new and innovatory, the resultant Science program at this level could have been classed as such. It included the components listed below.

(1) *Collegial planning* across the classes which made up the middle school. Sectional meetings were held weekly to fine tune planning, discuss past and present teaching events and plan for future programs.

(2) *Centrality of science content* in the middle school program. Units of work covering the middle school were often planned around a theme or issue which was very often Science or Technology related; for example, machines.

(3) *Key Teacher.* As with the senior school, there was a Key Science Teacher for the middle school. Planning meetings provided the Middle School Key Science Teacher with a regular forum to pass on knowledge and information regarding science issues and resources. Such input was regarded as enormously beneficial and a key element to the success of the Science program at this level.

(4) *Flexibility and diversity in delivery.* With the reduced number of organisational subgroups (five classes) which made up the middle school, it was possible to set aside time slots for options, tutorials and extension groups. Throughout 1994, all middle school students completed a science option, some were part of

an extended science group, and all completed a CoRT *thinking* tutorial.

(5) *Home group science class*. Science was taken by the home group teacher on a regular twice weekly basis instead of being taken by a specialist science teacher. Integration and compliance with agreed middle school studies was thus assured.

The restructuring of science occurred within the middle school through flexible use of the timetable and personnel.

4.8.2.3.1 Materials, Equipment and Setting
Although the school was undergoing redevelopment as a whole, and the science area was undergoing some minor alterations, this was not pertinent to the innovations. In fact, the science facilities were inadequate for the teaching of senior science as these facilities were built for a small number of senior students in the 1950s. However, these facilities were a good resource for the teaching of primary science, particularly as a science aide was available.

4.8.3 Teachers in Change

4.8.3.1 The Role of Teachers
The three teachers involved in the K-8 program were provided with information from the Senior School Key Science Teacher about new approaches to science which he had researched. Subsequently, they were given opportunities to attend science professional development courses. There were no opportunities for the inservice of science teachers within the school.

One teacher was interested in and enjoyed the new approaches and opportunities and used them to some degree in her teaching. Another teacher used science in her grades 3 and 4 classes, but it was difficult to determine whether or not this was as a result of the input from the Senior School Key Science Teacher. The other teacher was on leave at the time of the study.

The middle school teachers, in conjunction with the Senior School Key Science Teacher, were involved in the restructuring process in the middle school. They collaboratively planned the timetable and, as a consequence, were comfortable with it. Meetings occurred where a theme was targetted for teaching science in the middle school and approaches to teaching were brainstormed. This was seen to have a positive effect on those teachers who were previously not comfortable or confident in teaching science.

The sense of *ownership* of the middle school Science program resulted in teachers being well motivated and enthusiastic regarding their teaching. The teaching methods adopted in the middle school engendered an atmosphere of confidence, investigation, individuality, self-discipline and encouragement amongst the teachers.

4.8.3.2 Teaching Methods
The Senior School Key Science Teacher was the only teacher of science in the senior school. He had developed a broad and dynamic philosophy of education which he incorporated into his teaching, and which the middle school science teachers had adopted to some extent. It included the following components.

(1) *Science is investigatory.* To be effective, investigators needed to have a base store of facts and information.

(2) *Thinking and questioning skills are crucial.* Edward de Bono's teaching strategies (*ie* CoRT thinking) were used with this in mind.

(3) *The Solo Taxonomy* (Biggs & Collis,1982; Biggs & Collis, 1991; Collis & Biggs, 1991) was one process which allowed students and teachers to evaluate the level of thinking taking place. Elements of the Solo Taxonomy were used actively with the students during class teaching and as an assessment tool.

(4) *Preferred modes of learning* by children were acknowledged by the teacher and the teaching strategies used by him accommodated the various learning modes.

(5) *Language development* was a key component of science lessons.

Students in both the middle and senior schools, as a result of the approaches to teaching, were developing attributes of self-discipline, control over their learning, confidence in their approach to science, and knowledge of the holistic nature of science and the fundamentals of working scientifically.

4.8.4 Pupils in Change

Although the students were involved in the change process, they were not necessarily fully aware of the changes in approaches to teaching. Additionally, they did not necessarily understand the basis of these approaches to teaching. The most positive comments came from students in the middle school program, but it must also be said that positive comments were a norm for the school as a whole.

Middle school students reported that they:

> *... are doing interesting things.*
>
> *... liked it [Science and school] better.*
>
> *[were actually] ... doing science now.*

Students saw repetition of science activities as a problem in earlier years of schooling with students being able to nominate an experiment which they had repeated at different grade levels over two or more years. The coordinated middle school Science program helped to eliminate critical comments of this kind.

4.8.5 Equity Issues

The middle school program included extension science units for students identified as having a *science bent*. These students were not necessarily those with the greatest aptitude. There was an awareness of gender issues regarding science, but they were not addressed specifically.

4.8.6 Conclusion

Overall, Lilydale District High School was trying different, interesting ideas in science teaching. The science innovation was actually the way science was taught in the various school organisational divisions, particularly in the senior and middle school levels. It is possible that in time some tensions might emerge between the ideal of a cohesive, whole school program and the obvious benefits of autonomy in smaller organisational units. Other problems could emerge also, but the benefit of the present innovation was undoubted.

4.9 Penguin High School: Technology

4.9.1 The School

There were 351 students enrolled at Penguin High School in 1994. These students came from a variety of social backgrounds and were drawn from a wide area. While many students came from farming families, there were also some students who travelled from the urban centres of Ulverstone or Burnie to attend the school.

Thirty-six staff were employed at Penguin High School in 1994; of which 23 were teaching staff. There were five members of staff directly involved in the delivery of technology education programs. Penguin High School had experienced little staff movement since 1977, with some staff being at the school for up to 18 years. The Food and Textiles teacher and the teacher in charge of Materials, Design and Technology had been at the school since it opened in 1977. There had been only two Principals of the school, with the Assistant Principal in an acting position until the current Principal was appointed. The current Principal had been at the school for three years.

The staff at Penguin High School were recognised as leaders in technology education. One current and one past member of staff were holding very significant positions in technology education in Tasmania. The Food and Textiles teacher held the position of Moderation Adviser and a past Materials, Design and Technology teacher was the National Project Officer for the Technology Education Federation of Australia (TEFA), and was also National Vice President of the Australian Council for Education through Technology (ACET). Some of the staff at the school had varied work backgrounds. Both of the Materials, Design and Technology teachers in 1994 were Fitter and Turners and had worked in that area before training as teachers and a Maths/Science teacher was an engineer before becoming a teacher.

In the mid 1970s when Penguin High School was built, the open-plan design for high schools was popular in Tasmania. Since the school was built no changes had been made to the exterior of the building, but some changes were made to the internal design and teaching area arrangement, some as part of the technology education innovation.

A Community Association existed at the school. This was similar to Parents and Friends Associations that existed in other schools. Membership of the Community Association was open to residents of Penguin and surrounding areas, and to staff and students of the school. There was also a School Council which served the three schools (two primary, one secondary) in the area. This arrangement was unique to Penguin. The School Council included the three school Principals, elected staff members from each school, elected community representatives from each school, and elected student representatives from Penguin High School.

The study program at Penguin High School worked on a five day program (day one through day five). For days one to four students had regular timetabled lessons. On day five there was a different teaching program called CARE (which is the acronym for Children Accepting Responsibility for their Education). The day five program catered for events, such as sporting carnivals which integrated normal school activities. It also provided time for students who had been absent to catch up and allowed students and staff to pursue areas of interest not otherwise offered and gave students an opportunity to have extra time or extra tuition in subject areas.

4.9.2 The Impetus for Change: Origins, Purposes and People

4.9.2.1 Context

The focus of change at Penguin High School was in the area of technology education. A $58,000 grant received in 1992 enabled changes to be made to the Materials, Design and Technology workshop and work areas to make a more pleasant and functional design centre and associated work areas.

Individual teachers were the instigators of change at Penguin High School. The initial changes were made by a previous Key Teacher at the school who had well-developed ideas on what technology education should be and how it should be structured. The new ideas and initiatives that he developed, based on some time he spent in the United Kingdom in 1990/91, and as a participant in the development of the *National Statement and Curriculum Profile for Technology*, transformed the teaching of technology at Penguin High School. Later teachers of technology education with similar enthusiasm and initiative continued to develop the teaching area and the teaching methods. The work of these teachers was supported and encouraged by the successive school Principals and other senior staff.

4.9.2.2 The Implementation of Educational Change

The changes at Penguin High School, originally, were internally driven by a Key Teacher, with financial support from the Commonwealth. This Key Teacher had left the school but the changes he put in place were still evident and on-going. The innovation became institutionalised within the Food and Textiles and Materials, Design and Technology areas and helped reshape the approach in the area of Information Technology and Keyboarding.

4.9.2.3 Goals and Content

In 1992 Commonwealth funds were allocated to Penguin High School for the refurbishment of its technology education facilities. At the time there was target upgrading of technology education facilities for one school in each education district. Another high school was awarded the major funding grant for Penguin High School's education district. However, the District Superintendent identified Penguin High School as a leader in Technology and allocated them $58,000 for alterations to better accommodate the technology education programs and teaching methods they were using.

Penguin High School had been a leader in technology education for many years. The goals and aims of the technology education offered by teachers differed in some ways but in other ways they were similar. In the Materials, Design and Technology program plan for 1994-1996 the Teacher in Charge stated the purpose of the subject as follows:

(i) to provide quality individual and group programs for students;
(ii) to develop student expertise by working in a variety of materials and media;
(iii) to develop students' skills in designing, making and appraising; and
(iv) to provide students with a satisfying and challenging courses which will develop self esteem and independent thinking.

The 1993 program for Materials, Design and Technology addressed similar issues:

(i) to provide quality individual programs for students;
(ii) to promote technology across the curriculum; and
(iii) to develop an understanding of and competence with technology.

The 1994 program for Food and Textiles had similar goals. The purpose of this course was:

(i) to develop basic food and textile skills and knowledge including an understanding of materials used and nutrition;
(ii) to allow students the opportunity to *design, make and appraise* and develop the use of materials, information and systems;
(iii) to develop specific skills in areas of interest and need;
(iv) to develop the opportunity for collaboration between Technology areas and Art, using a thematic approach; and
(v) to develop self esteem by the completion of practical work.

4.9.2.3.1 Materials, Equipment and Setting

The use of technology and technology education programs and facilities were well developed at Penguin High School. It was a lighthouse school for computer usage and it continued to emphasise the use of computers across the curriculum and in all aspects of school administration. A $58,000 grant from the Commonwealth, received in 1992, enabled changes to be made to the Materials, Design and Technology workshop and work areas to make a more functional, pleasant work environment. $38,000 was used to complete the changes to the Technology Learning Centre; the remaining $20,000 was used to procure new equipment for the area.

The block partitions between the wood and metal areas were removed and the area became a large open workshop, and served as the construction centre. The two areas in the construction centre were then referred to as the *clean* and *dirty* work areas. The *clean* work area was used for such materials as wood, plastic and leather. The *dirty* work area was used for activities such as welding, gluing and painting. A large window was installed between the workshop and design centre and a new window was installed in the Control Technology Centre. These windows provided a visual linkage of the areas enabling better supervision of the entire area; they enabled students to see what other students were doing, giving them a more holistic view of Materials, Design and Technology, and, at a more practical level, they allowed the transfer of light.

At the completion of these changes, three new work areas had been created; they were the Construction Centre, Design Centre and Control Technology Centre. The creation of the Control Technology Centre provided an ideal area for students to use multi-media computing equipment, explore robotics, investigate electronics and develop models and prototypes. As well as the changes to the workshop area, there were also some aesthetic changes. These involved painting walls, colour coordinating the furniture, the use of low screens to create work spaces, the provision of a wet area, and the installation of vertical venetian blinds to control light.

4.9.3 Teachers in Change

4.9.3.1 The Role of Teachers

The teachers at Penguin High School involved in technology education came from Materials, Design and Technology, Food and Textiles, Information Technology and Business Studies (Keyboarding). The architecture of the new and redeveloped buildings at Penguin High School facilitated the integration of the various domains of technology. The teachers involved in technology education at the school met once a fortnight to discuss ideas, look at new information and to discuss issues relating to technology teaching.

The role of the teacher in this student-centred learning environment was quite different to the typical instructor role. In this situation the teachers prepared a selection of design briefs for studetns to use. At the beginning of lessons, some initial guidance may have been given to the entire class, but generally, the students were able to continue independently with their work. The teachers then circulated in the work areas supervising and assisting students on an indiviual needs basis. Team teaching was often employed in this situation. The see-through partitioning of the newly developed Materials, Design and Technology area had the benefit of allowing a teacher or team of teachers to work with a number of students involved in different activities, which required different materials, at the same time.

This open learning approach appeared to be unique to Penguin High School at the time of the study. This had the potential to create problems for new technology staff at the school. The Teacher in Charge of Technology had gone through a process of gradual change into this method, whereas new teachers had this method as the *norm*. The beginning teacher at the school in 1994 had some tertiary training in this method, while the new technology teacher appointed to the school in 1995 had come from the *old school* where there had been separate manual arts teaching. He underwent some fairly radical changes within a very short time. He made use of professional development opportunities and as a result enjoyed the change of teaching patterns and fitted in well to the team teaching arrangement.

Penguin High School serviced a small and close knit community and as such encouraged an open door policy betwen all members of the school community. The Materials, Design and Technology teachers encouraged parents to come into the area and work with their children. When the Materials, Design and Technology areas was undergoing refurbishment, parents and members of the community were encouraged to come and have a look at various stages. When the refurbishments were completed the school held a parent and child evening so parents had some first hand experience of the changes made and how their children were now learning. Parents and children were given a design brief setting the problem and the restrictions within which it had to be completed. Parents then had to design their product, make and appraise it. This evening proved to be very popular and was very successful.

4.9.3.2 Teaching Methods

Lesson plans using design briefs were based on the *design, make and appraise* procedure. The use of the design briefs were most evident in the Materials, Design and Technology and Food and Textiles classes. It was obvious when watching students working through the *design, make and appraise* process, or working together gathering information and sharing ideas, that the goals (as outlined in Section 4.9.2.3) the teachers had for their students and their subject were being reached.

In a move away from the *old style* manual arts where there was often prescribed learning, completion of set tasks and construction of class projects, Penguin High School implemented a student-centred learning program involving the use of design briefs. Students and teachers negotiated to meet course requirements. Students were able to choose what interested them and what they would like or needed to do and they worked through these tasks at their own pace. In this open learning system, students not only developed the skills and knowledge required to use hand tools and power equipment for work with a wide variety of materials, but they also learned how to manage time, how to work independently and how to negotiate designs and create solutions to problems. No longer was the focus solely on the finished product, in this new approach each stage of the design process was valued.

From its early years Penguin High School had placed a strong emphasis on the cross-curricula use of computing technologies for the processing, storage and retrieval of information by students and staff. It had aimed to achieve full integration of both the use of computing facilities and information technologies, and it was specifically set as a goal for Materials, Design and Technology, and Food and Textiles (see Section 4.9.2.3).

The two technology teachers who had been at Penguin High School for over fifteen years were continually upgrading their teaching methods, trialling new ideas and were enthusiastic about the subjects they taught. Some of these initiatives were not obvious and often went unnoticed. One such initiative was the use of a variety of materials in technology. In the Textiles classroom there were recycling bins containing donated material. The grade 8 Textiles class used only donated materials and the design briefs they used reflected this. This approach was welcomed by parents as it reduced the expense of the Textiles course, which typically had been an expensive subject. Recycling also happened in Materials, Design and Technology where recycling bins were made available and design briefs could state that recycled material should be used. This also gave students the opportunity to learn about cost saving measures and environmental issues.

4.9.4 Pupils in Change

Students at Penguin High School generally enjoyed their technology subject. Responses from interviews with students during Materials, Design and Technology classes were very positive. As technology education and the use of design briefs had replaced manual arts over fifteen years ago most students were not really aware of the difference in approach. Those who were familiar with manual arts had either been to another high school or had friends at other high schools where it was still being taught. When asked which they preferred all commented that the Materials, Design and Technology at Penguin High School was better. They reported that students at other schools were making set class projects, while they, at Penguin High School, had choices and were able to negotiate with the teachers what would be required; there was more emphasis on the process at Penguin High School rather than the finished product; andtudents at Penguin High School knew they had more use of power tools and electrical equipment than students at other schools.

More opportunities, the choice to do different things and the freedom to work at their own pace as well as the use of excellent facilities made the students Penguin High School very positive about the Materials, Design and Technology courses offered at the school. The students liked working to design briefs because they knew exactly what they were supposed to be doing and what the work boundaries were. Quotes from student journals supporting these points follow.

> *[What was interesting in today's lesson was] ... stuffing up my material because now I know what not to do.* (Grade 7, Textiles)

> *Cooking and gathering ingredients, because it can be done without help.* (Grade 7, Food)

4.9.5 Conclusion

The innovations in Technology at Penguin High School occurred over the period of 18 years since the school was built. Adoption of the *design, make and appraise* model occurred well before it was advocated nationally. Upgrades of the facilities for Technology Education at Penguin High School were in-line with this teaching approach.

4.10 Reece High School: Technology

4.10.1 The School

Reece High School is located in Devonport, a city of 20,000 people. Set in extensive grounds, the original buildings were established in 1956. The buildings varied in age, were in close proximity of each other and, because of the sloping site, were multi-levelled (with wheelchair access provision). Recent upgrading included redesign and refurbishment of the Science and the Design and Technology areas.

Although situated in a suburban environment, in 1994 the school drew on both urban and rural communities for its students, with significant numbers coming from the latter. There were 680 students at Reece High School in 1994. Approximately five percent of the students were Aboriginal. The School Charter stated that:

> *In contrast with many schools in other parts of Australia this school does not have large numbers of students from a variety of ethnic backgrounds, [and that] The proportion of students from low socio-economic areas is relatively high.*

In line with the recent State Education Policy of Inclusion, a small but increasing number of students who were physically or mentally disadvantaged were enrolled at the school. Seventy-three percent of students continued to further education in 1993.

The staffing of Reece High School comprised 48 teachers, three administrative staff, three (full-time equivalent) aides including 0.5 dedicated to Science and Technology. A broad age and experience range was represented and many staff had dedicated much of their career to the school. The school's Management Policy was cognisant of the issues arising from the State's Transfer Policy innovation which would greatly increase staff turnover.

The school was developing and enacting a revised management and organisation structure which was sensitive to local, state and national factors. The developments were seen as being evolving in nature and were thus responsive to change. Broader management and leadership roles and participation for all staff were envisaged and four key areas were identified:

- (i) student support;
- (ii) staff support and development;
- (iii) administration; and
- (iv) curriculum redevelopment.

The proposals included a Learning Area Leader (at Advanced Skills Teacher level) who would be

> *... responsible for developing a collegial approach to the implementation of all programs in that area.*

The Learning Area Leaders were coordinated by an Assistant Principal.

The school's curriculum was developed by the staff (in liaison with the local community) against the backdrop of the recently developed *National Statements and Curriculum Profiles* and the DEA's *K-12 Framework*. One former emphasis for the school was the preparation of its students, through specialised subjects and courses, for a relatively stable range of employment positions and apprenticeships. In recognition of, *inter alia*, the decline in these secure career opportunities for school leavers, Reece High School promoted academic excellence in the context of fulfilling the potential of each individual to be a successful member of the community. The School Charter reported:

> *[The school] believes that the provision of a broad range of skills is the most appropriate for adult society and hence offers a comprehensive curriculum ...*

The school had community links of various kinds:

(i) the Parents and Friends Association encouraged full participation in, and support for, the school's activities;
(ii) the Aboriginal Parents Support Group has a broad role in helping Aboriginal students to succeed at Reece High School (the group had funded the purchase of a laptop computer for student and staff use); and
(iii) associations with local business and industry.

On entering the school in grade 7, students pursued a broad-based course covering a wide variety of subjects. Although an Options System operated from grade 7 to grade 8 (students added five Options to five compulsory subjects) this encouraged students to pursue subjects of personal interest and was not viewed as significantly impacting upon particular career paths. Selection from each Key Learning Area was encouraged and did not preclude different selections for grades 9 and 10 when new Options Systems occurred (three options in addition to a common core). Breadth of education was encouraged throughout the students' high school career and this was not seen as being contradictory to more specialised study at college in grades 11 and 12.

4.10.2 The Impetus for Change: Origins, Purposes and People

4.10.2.1 Context

The principal focus of technological innovation at Reece High School was the application of computer facilities and proximal staffing to the school curriculum in respect of one particular laboratory of machines. Two additional foci were apparent. First, the redevelopment of the organisation, staffing and equipping of the Technology Learning Area; and second, the recognition of the relevance and status of technology as reflected in the school's evolving Management Structure. Curriculum redevelopment within the school focussed on the grades 7/8 curriculum within the guidelines of the eight Key Learning Areas, which were endorsed by the *National Statements and Curriculum Profiles*.

In the early 1980s, as a response to the perceived importance attached by society to computing, innovative activity commenced with key members of staff establishing the role of stand-alone computers. Information Technology took the form of a program based course. Access to computers was limited to only some (for example, higher ability maths) students. Since these early days the school had continuously upgraded and improved its equipment and associated professional development of staff.

Through to 1987/88 Information Technology programming, graphics programming, word processing, spreadsheet and database were the principal activities on the stand-alone computers. Some additional sound work and computerised control were also developed. 1987 saw the establishment of an Econet network throughout the school with all software being cross-curricular. This development came about in partnership with the State Computer Centre which at the time had a curriculum development and support role (its current equivalent offering solely administrative support to much more school-centred management systems).

Over this period three problems became apparent to users of the systems. First, many machines on the network were in need of upgrading. Second, too much use of stand-alone computers was being given to students as a form of reward for such achievements as early completion of work, or for improved effort in their studies. Third, the presence of a computer in a classroom meant the teacher was now preparing an additional program of study (for students using the machine) as well as for the main lesson. The provision of an integrated suite of computers then seemed a possible logical solution to all of these problems.

Having experienced stand-alones as well as a school-wide network with single or small numbers of machines in isolated locations, Reece High School moved to establish, in 1992, the current Acorn computer laboratory adjacent to the library.

There have been significant shifts in funding arrangements over the years and interviewed staff acknowledged that Reece High School's ability to stay ahead of other schools was linked to its preparedness at each step of development. State-level reorganisation and policy changes, at various times, had meant differing financial considerations and changed support systems. These factors had included:

(i) a shift from a curriculum to an administrative role at State level support;
(ii) the introduction of schools' self-management;
(iii) having *in-house* expertise along with good support from particular hardware suppliers; and
(iv) the funding, from Priority Projects funds, of one staff member's salary to coordinate and develop this area.

4.10.2.2 The Implementation of Educational Change

It is important to note two roles played within Reece High School's technological innovation. First, the person who was appointed as full-time computer resource teacher (now in his third year in this capacity) had in fact been the main force for innovation throughout the last thirteen years. His vision and commitment were crucial to developments. Over the years he was a motivator, a staff trainer, a lobbyist and a technical troubleshooter. This person had had no specialised training in the Information Technology field but, largely through tackling problems as and when they arose, had become highly knowledgeable and was undoubtedly an invaluable asset to the school.

The second significant role was a precondition of the innovation taking root; namely, the agreement and support of the school's senior management, especially the Principal. This had been the case at Reece High School from the early days of innovation to the present, despite a change of Principal. The school acknowledged the combined visionary roles of staff and senior management in developing their computing curriculum.

The recent establishment of the Technology Team (*ie* teachers associated with this field), whose work built upon that of an earlier Technology Committee, provided a strong platform for technological activity at Reece High School. The broad range and depth of experience exhibited by this group of teachers was well matched to the challenges which current technology education demanded. The context of change in this curriculum field had several dimensions:

(i) societal conceptions of technology were often confused;
(ii) parental expectations differed widely, from *training for jobs* and *making products* to understanding the full benefits for personal development which technology education could bring;
(iii) traditionally, subjects in this area were deemed particularly appropriate for students of lower ability, whereas technology education was now recognised as having a role to play in the education of the whole person regardless of age or ability; and
(iv) the very nature of technology itself was one of continuous change.

The change had been well accepted and internalised by all in, and most beyond, the school. All teachers worked with computers in their programs and it was felt that students accepted new aspects of the technology as they did any other new phenomenon; that is, with interest and curiosity but without any great fuss or rejection. Parents were extremely positive in their acceptance of the changes.

Apart from the overt curriculum content delivered through teaching programs it was important to acknowledge the hidden curriculum which operated. It was as though there was a *culture of development and innovation* which all were, knowingly or otherwise, a part of. Staff and students in a school which had institutionalised technological innovation seemed to practise technological innovation with more ease than their counterparts elsewhere.

The clear demonstration of the integrated and cross-curricular use of the computer laboratory by a wide range of the staff was an indication, not of an overnight transformation of staff attitudes nor of innovation through a highly funded hardware injection program, but rather, the result of years of evolving school-based development and the dedication of several individuals within the school.

The role of the key individual in the technological innovation at Reece High School, of course, begged an important observation. Was the school overly dependant upon such a person? The answer is not totally clear. However, it is possible to argue that when a technological innovation is well advanced and there is a broad base of staff with developed knowledge of the field then it will continue to flourish. However, it is important to note this key role and in this innovation to reflect upon the degree of significance that one person has to a total school.

4.10.2.3 Goals and Content

When observing Technology in any educational environment it was helpful to remember that this newly-titled curriculum learning area could have manifested itself in several forms. There could have been differences of definition among policy documents. There were inevitable variations in interpretations, understandings and applications by those who practised in and beyond the field. These variations were neither unreasonable nor surprising given the complexity of the field, its relative newness to education and, most problematic, its constantly changing nature.

Understanding the subtleties and interactions between different manifestations was necessary when analysing technology in school settings.

Three useful descriptors to bear in mind when describing innovation in technology were:

(1) *Technology as Hardware*. The common public image was the *hi-tech* world of electronic innovation. A deeper, historical, understanding embraces all human-made tools and their consequent products.

(2) *Technology as Knowledge*. The theoretical and academic basis for the whole learning area. Although the concept of technological knowledge was debated strongly, the current educational climate would have rejected simplistic associations such as *the application of science* and would have sought to embrace concepts of:
   (i) cultural development;
   (ii) personal expression through design;
   (iii) problem solving skills; and
   (iv) provision for human needs.

(3) *Technology as Process*. The interaction of mental, motor and expressive activity while working in two- and three-dimensional media is a complex one. Technology in education traditionally had been judged by the product alone, whereas the process, which was often undervalued, was the source of much powerful learning.

While the School's Charter cited, as part of its comprehensive curriculum, "...skills of information processing and computing", it was clear that computing effectively *permeated the curriculum* to the extent that the school no longer needed to state, as a goal, the establishment of cross-curricular, or integrated, computing. The fact that Reece High School was at times modest in its self-image of computing was merely a reflection of the many years of effort and development which gave a strong foundation of experience which was not held by many other schools.

The developing role and commitment of the team of teachers delivering the Technology curriculum at Reece High School was both innovative and demanding. The complexities of working within the multi-dimensional context outlined previously were being approached professionally and with determination.

The developments included:
   (i) the appointment of the Technology Team Leader;
   (ii) the building of a coherent team philosophy;
   (iii) the exploration of new pedagogical strategies and staff skills transfer;
   (iv) the incorporation of school based professional developments (*eg* Cooperative Learning, Literacy programs, Competencies) into the team's own specialised programs;
   (v) the completion of an integrated suite of workshops and studios for the delivery of design-based technology courses; and
   (vi) the refurbishment and upgrading of the Commerce laboratory along with its greatly increased usage by students.

Although in an early stage of its development, the Technology Team was operating on a new threshold of technology curriculum innovation at Reece High School. The potential of their efforts was substantial and the outcomes, both short and long term, promised to be rewarding for both individuals and the school.

It was noteworthy that the Management Structure reflected the *National Statements and Curriculum Profiles'* Key Learning Areas. The embodiment of this model in the leadership and management organisation was significant for the status and development of technology education at Reece High School. Technology could not have played its true part in the curriculum nor could it have been changing and innovative if it was marginalised within a school's management structure.

4.10.2.3.1 Materials, Equipment and Setting

The machines in the Acorn computer laboratory were networked on Ethernet, and this was viewed as desirable on the grounds of speed and reliability. Logic suggested that if all students were to have access to computers then a laboratory might provide the most equitable solution. It was coincidental that a centrally placed room was available and, interestingly, that its position was viewed as advantageous by virtue of its *neutrality* in terms of curriculum. It was here in this space that whole classes, with their teacher, visited and had access to centralised equipment along with an available member of staff in a support role.

A booking system operated for the laboratory whose popularity was such that a survey of staff indicated that approximately half of the school's teachers had, at some time, experienced difficulties in gaining access because of usage.

Recent developments with the Computer Laboratory incorporated:

(i) the availability, full-time, of a member of staff who was able to support colleagues working in the laboratory at all levels; lesson delivery, software research, professional development, technical troubleshooting;

(ii) connection to Internet and consequent developments; initially Email (with students' own accounts) and subsequently Telnet, World Wide Web, and Gopher; and

(iii) access to the statewide library catalogue was standard and links with AARNET were available, but cost factors were a concern with the latter.

In keeping with the continuous program of change and development at Reece High School, the old network was replaced completely and a second laboratory of Acorn computers was about to come on line. The field of computing was viewed by the school as a constantly evolving one and thus those responsible for this curriculum innovation vigourously pursued the latest in educationally valid developments.

Reece High School fought hard to get their Internet connection, and have been using the facility for three years whilst many were just starting. There was little co-development across the country and being a school Internet site was fairly unusual. A consequence of this was that most of the Email correspondence by the students at Reece High School had been with students in the United States of America.

Elsewhere in the school the Commerce Laboratory was well established with 20 PCs. There were also stand-alone computers available in general classrooms and for specialised work; for example, Control Technology in Materials, Design and

Technology (in cooperation with Science).

The school's Development Plan identified Technology as a Priority Area and of this innovation it stated:

> *Classes have been booked into the laboratory for 635 lessons during the year from subject areas of English, Social Science, Science, Home Economics, Information Technology, Health, Mathematics, Design Graphics, Business Studies, Languages and Art. It has also been used extensively by individual students and teachers.*

A usage rate of 635 lessons per year means the computer laboratory was in operation approximately one half of the year.

4.10.3 Teachers in Change

4.10.3.1 The Role of Teachers

In common with all Learning Area Leaders, the Technology team leader had responsibility for:

- (i) the professional development of the team;
- (ii) implementation of national, state, and school priorities;
- (iii) budgets;
- (iv) pedagogical improvement; and
- (v) inclusion (of Special Education and Gifted and Talented Students).

Particular to the Technology Learning Area were two further responsibilities:

- (i) cross-curricular Technology; and
- (ii) management of the specialised equipment and learning spaces used for the delivery of technology education.

The preparation and acceptance of teachers for cross-curricular work with computers had evolved over a period of years. Professional development sessions had been largely *in-house* with a small amount of training coming from external courses or hardware suppliers. For reasons of confidence, perceived appropriateness of the medium, or personal or professional interests, the development program had been a progressive one to meet each teacher's needs at the most suitable time.

While computing across the curriculum at Reece High School engaged the whole staff to varying degrees, there were several avenues for involvement. Most staff were active at the class level through their teaching work, however many also were involved in other ways. Some operated in the hardware and technical operations field, offering support and guidance with equipment. Others made contributions in the curriculum development and planning area or with management aspects of computing. Yet others were involved in pedagogical and process developments.

4.10.3.2 Teaching Methods

Developments in teaching methods included:

- (i) diversification embracing software which offered interactive skilling and testing of students (*eg* grade 7 Social Science Mapping and Geography);
- (ii) Computer Aided Design as an adjunct to more traditional Technical Drawing lessons; and

(iii) peer-teaching.

The innovation at Reece High School was aimed at integrating the use of computers across the curriculum. In terms of the three descriptors of technology outlined earlier (refer to Section 4.10.2.3), Reece High School integrated all three in the context of computing across the curriculum. In the field of Mathematics, a full range of software was used and was readily accepted by the students. This was true too for Science and there was some integration between these fields; for example, in the application of mathematics graphs and statistics packages to science research and case study activities. Word processing was very strongly present and was integrated across most of the curriculum.

Subject-specific software was used by Science, Mathematics and Technology teachers, however both students and teachers were able to transfer skills between applications. Students carried their knowledge and abilities between classes while many teachers worked in both fields of Mathematics and Science.

The versatility and commitment of teachers using specialised technological applications such as in drama (*eg* programmable console and shadow theatre), in Science and Technology (*eg* Control Technology) and the publication of the school magazine using desktop publishing further demonstrated the diversity of technological activity in the school.

4.10.4 Pupils in Change

The teachers' perceptions were that the students were very comfortable with the changes, and they noted the importance of the students "not being frightened" by the technology. Computing at Reece High School was a part of the curriculum rather than an adjunct to it. If any *novelty factor* was perceived it had certainly disappeared by grade 8 when the technology was simply a part of school life. Staff did believe that students were not particularly conscious of the changes and cited the occurence of peer-teaching as significant in the development of continuous acceptance of innovation.

4.10.5 Conclusion

Reece High School was nominated as a school which had demonstrated innovation In Technology. A superficial view might have suggested that the technological hardware alone was the innovation. It was, after all, easy to count computers and describe their presence as educationally significant. However, such an approach would be simplistic. What was demonstrated at this school was:

- (i) commitment to technology in education from an individual through to a system level;
- (ii) manifestations of technology in specialist as well as general forms, for example, subject based and cross-curricular;
- (iii) learning experiences which embodied all the aspects of technology for students (*ie* as hardware, as knowledge, as process); and
- (iv) an evolving curriculum which provided the necessary freedom for continuously changing and dynamic fields such as Technology to flourish.

Technological innovation at Reece High School turned out to be much more than the sum of the components listed (each of which was significant in itself). As befitted the continuously evolving nature of technology, it was the now mature process or culture of innovation which had been the key to its successful integration across the whole curriculum. Much hard work over a period of many years had borne the fruit of establishing Reece High School as a leader in technology innovation.

Staff at Reece High School were self-effacing in seeing Technology at their school as in any particular way innovative. Whilst they did acknowledge that, in respect of other schools, they had been leaders in developing a particular dimension of technology, they did not see the current position as innovative per se. This was because, in the most general sense, the innovation was made many years ago. Since that time, however, its impetus had been maintained and its focus refined.

4.11 Smithton High School: Mathematics

4.11.1 The School

Smithton High School is located in a rural district in an isolated area in the North-West of Tasmania. It differed from most high schools in the state in that it offered a grade 7 to grade 12 program. Due to the small numbers in grades 11 and 12, compared to the senior secondary colleges in the urban areas, it was only possible to offer a limited range of subjects at this level. The original school buildings were old, but recent extensions included a computer laboratory. The school facilities were used extensively by the community, particularly for sporting activities. The school had a student population of 500 and a staff of 38 persons in 1994, including six mathematics teachers. Students were drawn from the local farming communities and in some cases travelled significant distances to get to school.

4.11.2 The Impetus for Change: Origins, Purposes and People

4.11.2.1 Context

The innovation at Smithton High School attempted to develop a range of student abilities and learning outcomes outlined in the *National Statement and Curriculum Profile for Mathematics* and the Tasmanian *K-8 Mathematics Guidelines*. The main impetus for the innovation was that the students were unable to understand why they were being taught particular algorithms, and they were unable to relate these algorithms to new contexts. Furthermore, the algorithms being taught only suited some students. Thus, it was decided to present learning experiences in a manner which raised student interest and gave them all a chance of success.

This was a direct reflection of the Mathematical Inquiry strand of the *National Statement and Curriculum Profile for Mathematics*, which "...addresses communication skills, ways of thinking and habits of thought which are explicitly, if not exclusively, mathematical" (p37) and has a particular emphasis on encouraging students to develop their own heuristic strategies and their own preferred learning styles for solving problems. A constructivist learning philosophy underpinned the program.

4.11.2.2 The Implementation of Educational Change

At Smithton High School, the innovation was started by a Key Teacher whose focus was a shift away from teacher-centred to student-centred, constructivist learning. His philosophy of teaching and dedication to student interests drove the program at Smithton High School. The Key Teacher had support for the program from the teacher in charge of Mathematics, and six other teachers were involved in the development and/or trialling of the program materials. The Mathematics program at Smithton High School was internally driven.

4.11.2.3 Goals and Content

The program at Smithton High School was based on important concepts and its focus was to present learning experiences in problem solving contexts. There was also a great deal of emphasis on equipping the students with problem solving strategies and giving them the confidence to develop their own solutions to problems. It was a student-centred program aimed at developing a learning environment where students were free to express their ideas and articulate their understanding of the learning activities. The main objective was to provide the students with an environment where they could develop preferred learning styles.

So far, the program had only been targetted at grades 7 and 8 students.

The program followed a five-stage model of change:

(i) gathering information (in this case from the nationally developed and Tasmanian curriculum documents, and other sources);
(ii) understanding what the innovation was about;
(iii) developing strategies for classroom management;
(iv) examining the consequences (*ie* the impact of the innovation on the students); and
(v) collaboration between colleagues.

After five years, Smithton High School was at the fifth phase of this model.

In response to the new program, assessment in grades 7 and 8 had become more continuous, and was based more on observation than previously. This coincided with the statewide introduction of criterion-based assessment.

4.11.2.3.1 Materials, Equipment and Setting

The program was documented in two booklets, a teacher's guide and a student workbook, for each of grades 7 and 8. This documentation was designed to be flexible so that teachers could add and delete materials to suit their situations. The teacher's guide provided suggestions for teaching ideas, strategies and resources to cover the program content. The student workbook presented activities in problem solving contexts and suggested a range of strategies which could be used to complete each activity.

4.11.3 Teachers in Change

4.11.3.1 The Role of Teachers

At Smithton High School, some of the maths teachers were more actively involved than others in the innovation. Those who were actively involved completed in Term 1 of 1995 a series of collaborative processes aimed at skilling these teachers in implementing the newly developed programs for grades 7 and 8. The school developed this infrastructure to support the program in the absence of the Key Teacher (who was transferring to another school at the end of Term 1, 1995). The various collaborative processes which were trialled included:

(i) regular time given in subject staff meetings for analysis of the content and intent of the learning activities of the program;
(ii) examination and discussion of the work of specific students; and
(iii) use of other staff to supervise classes so that the teachers concerned could all be present in the one room in order to observe and discuss a variety of preferred learning styles.

The teachers interviewed were positive about the outcomes of the program, but divided in their opinions about whether or not it would last when the Key Teacher left the school. There had been some inservicing, with two algebra workshops having been conducted, but this fifth stage of the program was to establish an avenue for the Key Teacher to pass on his philosophies and encourage more interchange of ideas. This phase was considered by the teachers to be essential if the program was to survive in the long term.

Teacher management and collaboration were thought to be crucial factors. There was already some collaboration, but there needed to be more sharing, exchanging and interchanging of ideas amongst the teachers to build up a more common framework which clearly identified the key areas that were crucial to achieving the aims of the program. This framework, however, had to be flexible enough to allow for teacher differences and teacher mobility.

The program at Smithton High School provided the materials and the teaching ideas, but ultimately, it was the individual teacher's responsibility to implement them in whatever way was most appropriate for the individual. All teachers adopted the changes to different degrees. The extent to which the teachers adopted the innovation varied according to their perceptions of the need to change. Some teachers commented that following the program had made the teaching of mathematics easier because it catered for a variety of student ability levels, facilitated classroom organisation, reduced unnecessary repetitiveness and provided a good balance of practical and written work. The resulting classroom atmospheres were varied, but were notable in that productive mathematical working environments occurred in all cases.

Teachers at Smithton High School were keen to involve parents in the program. Parents participated in a series of *coffee shop* meetings (*ie* workshops) run by the teachers involved in the innovation to introduce them to the constructivist philosophies of the innovation. The parents valued the workshops which helped them to understand the way in which their children were being taught maths (which was perceived to be very different to the way they were taught).

4.11.3.2 Teaching Methods

Teachers at Smithton High School attempted to introduce more *hands-on* activities into their Mathematics classes. Grade 7 students commented in their journals:

> *We learnt about comparing fractions by using the length of two people's stride. It's a different way to learning fractions and it makes it easier.*
>
> *It was good that we went outside to try the problem out. It helped me understand what we were doing.*

Students at Smithton High School were given responsibility for their own learning. Students were encouraged to develop their own learning styles and to learn at their own pace. The emphasis was on quality not quantity of learning. A critical component of the innovation was a lesson structure which comprised three distinct phases as follows.

(1) **Teacher explanation of the lesson's activity.** Students were asked to participate by confirming explanation, drawing diagrams on the board, *etc.*

(2) **Student time.** Teacher interaction was low-key, mainly helping students to extend or clarify their thinking. Students were encouraged to consult each other, discuss and check their ideas first before seeking more help from the teacher.

(3) **Drawing together of ideas.** Students presented their solutions, defended these

to challengers, discussed areas of difficulty or good ideas, *etc*. Student input was very important at this stage.

In an interview, two students commented on the new method of teaching maths by the Key Teacher in response to the question, "So what is it that makes it so different about the teacher's methods?":

> *Mr [Key Teacher] makes you understand. Other teachers told you the answer and Mr [Key Teacher] asks you the answer and doesn't tell you. Mr [Key Teacher] makes you think and lets you work it out yourself.*

They compared it to their other maths teacher, saying:

> *... she just does her steps different - more board work, less discussions, tells you the work and you do it, [you] work from textbooks.*

4.11.4 Pupils in Change

Teachers involved in the program reported marked differences between students who did and did not participate in the new teaching program, with the former being more persistent and confident to try new ideas. Some concern was expressed about the students' poor performances in some areas of the statewide standardised 14N test of basic numeracy skills for fourteen-year-olds, although it was pointed out that this tested only one aspect of students' mathematical thinking skills.

Through their journal entries, and particularly through interviews, students commented on one major difference between their learning experiences in the new program and in their previous Mathematics classes. This is that there was more responsibility placed on them to do the thinking, and that the teacher asked questions rather than telling them what to do. They believed this would be beneficial to them in their future studies of mathematics. There was no evidence that the program was more suited to some students than to others. In fact, this would have been contrary to the aim of the project, which was to meet the preferred learning styles of <u>all</u> students.

Some relevant quotes from students' journals about the student-centred learning and practical nature of the lessons were:

> *In one problem, you could write it out as words or write it in the fraction way. How cool!* (Grade 7, Fractions)
>
> *We didn't have to ask our teacher for help, we just looked on the strips to help us.* (Grade 7, Fractions)
>
> *[Today's lesson was interesting because] we changed norrnal problems into practical problems (walking).* (Grade 7, Fractions & Algebra)
>
> *I liked sharing out the pizzas. It was fun.* (Grade 7, Fractions)
>
> *When we were acting the problem out. It makes it more interesting*

when we do this. (Grade 7, Fractions & Algebra)

I thought that it was good that we could get ouside and out of the horrible classroom for a while. (Grade 7, Fractions & Algebra)

We were using algebra and fractions without really knowing it. (Grade 7, Fractions & Algebra)

The handshakes problem was interesting because it was different. (Grade 8, Problem Solving)

4.11.5 Equity Issues

By its very nature of encouraging preferred learning styles, the Smithton High School program was designed to encourage maximum participation in mathematics by minority groups including girls, those of different abililty levels, and those with special needs. There was evidence that all groups were participating in the program at their own levels.

4.11.6 Conclusion

The innovation at Smithton High School was largely driven by the vision of the Key Teacher. Apart from the innovatory approach adopted to mathematics teaching and learning, based on constructivist philosophy, the change resulted in the innovatory practice of communicating the innovation to the parent population via *coffee shop* meetings (*ie* workshops). The innovators at Smithton High School realised that change in curriculum practice, where students were given the opportunity to learn at their own pace and in their own style, needed to be supported by the parent body of the school.

5. Themes

5.1 The Impetus for Change: Origins, Purposes and People

5.1.1 Context

The case studies exhibited a range of starting points for the innovations described. These included the following.

(1) Staff concerned with:
  (a) pedagogy;
  (b) curriculum (including Key Competencies);
  (c) their professional development; and
  (d) staff-student relationships.

(2) Schools concerned with:
  (a) teacher professional development;
  (b) curriculum (including Key Competencies);
  (c) their organisational structure;
  (d) school to work transition; and
  (e) community relationships (including parental support).

(3) State and federal government departments (*ie* DEA and DEET) concerned with:
  (a) a framework for curriculum (including Key Competencies);
  (b) professional development;
  (c) pedagogy; and
  (d) school to work transition.

Table 4.1: Innovation starting points of case study schools.

Innovation Starting Points	SCHOOLS	CPS	CHS	EC (M)	EC (T)	EPS	LC	LDHS	LPS	PHS	RHS	SHS
Staff	Pedagogy	X	X			X		X		X		X
	Curriculum	X	X	X	X	X	X	X	X	X	X	X
	Professional Development	X				X					X	
	Student-Teacher Relationships						X					X
Schools	Professional Development		X						X			
	Curriculum		X	X		X	X	X		X		
	Organisational Structure				X		X	X		X	X	
	School to Work Transition			X	X		X					
	Community Relationships				X				X			
Government	Curriculum	X		X		X		X		X		
	Professional Development	X				X						
	Pedagogy	X								X		
	School to Work Transition			X			X					

Table 4.1 shows which innovation starting points were important for each of the case study schools.

The innovations which took place in the case study schools and colleges occurred in the context of a non-static, dynamic system; that is, a system which was already changing. Some of the changes occurring within the system at the time of the case studies included the following.

(1) Implementation of recommendations from CRESAP. CRESAP was a Victorian management consultancy firm employed by the Tasmanian Government to produce a report on the function of the DEA. The report recommended significant restructuring of the DEA and Tasmanian government schools, including staff and resource reductions.

(2) Introduction of the Tasmanian Certificate of Education (TCE) and its associated criterion-based assessment.

(3) Efforts to devolve more managerial responsibility to the schools (*ie* self-managed schools), as in most states.

(4) Implementation of policies such as social justice (known as *inclusion*) which resulted in the integration of students with special needs in normal classrooms.

(5) Productivity agreements negotiated with teacher unions as part of National Award wage cases, which implied two major goals of efficiency and effectiveness for teachers and employers.

(6) Identification of the importance of Key Competencies by the Finn (1991), Mayer (1992) and Carmichael (1992) reports.

(7) The provision of nationally recognised vocational credentials through a range of flexible postcompulsory education and training pathways.

(8) An increase in the quality of provision and relevance of postcompulsory education and training.

With the increasing number of changes which occurred within the education system and comprised such significant matters, change could be seen as providing a *turbulent* environment; that is, the amount of change in all areas of a teacher's work life was significant. In addition, previously familiar systemic features were also altered significantly. The case studies showed schools, colleges and teachers were facing this situation in a positive manner, accepting it as a challenge to reconsider all aspects of their operations.

5.1.1.1 Implementation of the National Statements and Curriculum Profiles

The *National Statements and Curriculum Profiles*, a federal initiative, were given broad agreement by the states. Each state had the opportunity to work out its own curriculum frameworks based on these documents. Concurrent with the changes mentioned above were curriculum, pedagogical and assessment developments through trialling of the *National Statements and Curriculum Profiles* in schools across

Australia. For instance, Tasmania was jointly responsible for developing the *National Statement and Curriculum Profile for Technology* on behalf of the Australian Education Council.

In Tasmania, as in other states, the implementation of the *National Statements and Curriculum Profiles* was conducted within the state curriculum frameworks, such as the *Science Frameworks* and *K-8 Mathematics Guidelines*. At the school level, each had the opportunity to work out its own curricula based on both the nationally developed and state curriculum frameworks. This *opportunity within frameworks* approach was adopted as it was recognised that a centre-periphery model of curriculum or pedagogical change had major difficulty in being adopted as developed at the centre. In addition, the nationally developed curriculum could not be prescribed to the states, it could only be outlined as a framework.

The case studies demonstrated the practicality of this approach as many of the schools and colleges adapted the frameworks to suit their own local circumstances and situation.

5.1.2 The Implementation of Educational Change

Educational change can be thought of as occurring along a continuum; to move from a decision to embrace change, through to working it out in operation and practice, through to internalisation and institutionalisation, denotes a continuum of change. The schools and colleges in our case studies were at varying points along this continuum. In addition, due to the *turbulence* mentioned in section 5.1.1, this continuum was constantly shifting with no fixed points for reference. This issue was recognised with support being provided at the macro level more systematically by the DEA and at the micro level by Advanced Skills Teachers and senior school staff.

5.1.2.1 Internal Motivation for Change

The motivation for change as evidenced in the case studies showed them to be predominantly internally driven (*eg* LDHS, SHS and LPS). However, some of the cases illustrated an external environment working in conjunction with and supporting the internally driven innovation (*eg* EPS, CPS and CHS). Notwithstanding the *system* in place, it was up to the individual to decide change was needed. Once this decision was made the individual could act to effect change. The majority of the case studies demonstrated the importance of the individual (the Key Teacher) as the basis for change in each case. Apart from teacher willingness to change, support was needed from the administration and from the system. The decision to change needed to be nurtured in order for it to be effectively put into action. Thus, change could not occur without the right person in the right place at the right time, and with the right support. Additionally, the system needed to be able to recognise when to provide appropriate support.

Other case studies reflected a larger external input, mainly in the area of physical facilities provision, which provided necessary support for other changes within the school, particularly in the areas of pedagogy and curriculum provision (*eg* EC and RHS).

5.1.3 Goals and Content

The goals and content of the case study innovations varied, depending upon the innovation. In broad terms the innovations were concerned with change at (i) the *micro-level*; and/or (ii) the *macro-level*. For example, at the micro-level, Lilydale District High School was concerned with pedagogy, Cosgrove High School was concerned with curriculum, and Smithton High School was concerned with student-teacher relationships; at the macro-level, Elizabeth College was concerned with employment opportunities for students. Several of the case studies combined the micro- and macro-level of interest; for example, in the development of a more appropriate curriculum to facilitate employment opportunities. This was evident at Launceston College.

The goals and content of the innovations could be mapped along two distinct axes:

(i) a temporal axis which incorporates short, medium and long term change goals (*eg* the five-stage model for change outlined at SHS); and

(ii) a goal focus axis which extends from individual student or teacher through to the wider community (*eg* at EPS, changes in any one teacher's approaches to teaching science were to be communicated to other members of staff at EPS and to teachers at other schools).

The separation of timeframe and goals along these two axes allows us to consider initiatives by the case study schools and colleges in terms of the complexity within which they were operating. Consideration of these dimensions allows us to describe the four interrelated factors (pedagogy, curriculum, student-teacher relationships and professional development) within a time framework where emphasis upon one of the factors has direct consequences for the other factors.

5.1.3.1 Materials, Equipment and Setting

Significant changes in materials, equipment and setting occurred in the Technology case study schools and college and to a lesser degree in the Science and Maths case study schools. These had been provided in varying amounts by the DEA (*eg* EC and RHS), the individual school or college (*eg* EPS), and parents (*eg* LPS).

The architecture of the new and redeveloped buildings in several of the case study schools had facilitated the integration of Technology across the curriculum, not only by providing adjacent classrooms and workshops but also by providing *see-through* partitioning so the various activities could be seen as linked. It had the additional benefit of allowing a teacher or team of teachers to work with a number of students involved in different activities, which required different materials, at the same time. In this way, students were able to develop a holistic view of the activities.

Science and Mathematics had not required the same capital and recurrent fund injections as had Technology. These subjects, however, had become more practical (*ie hands-on*) and it was likely this would have resulted in a need for more materials and equipment in the near future. This was already evident in some case study schools and colleges (*eg* CHS and EC).

5.2 Teachers in Change

5.2.1 The Role of Teachers

The case studies demonstrated a significant shift, often aided by appropriate professional development, in the role of the teacher and highlighted the following points.

(1) The teachers involved in the innovations were *reflective* on:

(i) their own practice (*eg* the senior school science teacher at LDHS);
(ii) appropriate curriculum (*eg* science teachers at LC);
(iii) models of learning (*eg* the Key Teacher in mathematics at SHS); and
(iv) the role of the school or college in the community (*eg* technology teachers at EC).

As a consequence, the following *practical* outcomes could be seen:
(i) implementation of a repertoire of teaching strategies;
(ii) curriculum redevelopment and broadening;
(iii) adoption of constructivist (*ie* knowledge is not transmitted in a fixed and final form from one person to another, but is actively created by the learner) views on student learning;
(iv) greater collegiality between teachers in all aspects of pedagogy, curriculum and professional development;
(v) involvement of parents in the school; and
(vi) a clear, practical articulation of school activities with vocational pathways.

(2) The teachers were more willing to *have a go*, (*ie* take a risk). This was expressed in the nature of their relationship with:
(i) curriculum material;
(ii) teaching strategies;
(iii) colleagues;
(iv) school administration; and
(v) the wider community.

(3) The teachers conceptualised their role more as a facilitator of active learning rather than as a possessor of content which needed to be transmitted to passive learners.

5.2.2 Teaching Methods

The case studies showed a shift in pedagogy from a teacher-centred, didactic approach to a more student-centred approach of self-initiated learning. The teacher, in broad terms, had become a facilitator of students' learning and the students, concomitantly, had become more responsible for their own learning. This shift in emphasis concurred with the teaching approaches outlined in the *National Statements and Curriculum Profiles* (see Section 2.2).

Changes in teaching approaches included:
(i) a more *hands-on* approach (*eg* a *tinkering* table for science students at EPS);
(ii) use of the *design, make and appraise* model, including design briefs (*eg* at LPS, PHS and EC);
(iii) greater student responsibility for their own learning, including self-paced learning (*eg* at PHS and SHS);
(iv) peer-tutoring (*eg* at LPS and EC);
(v) group work (*eg* at EC and CHS);
(vi) greater emphasis on 'real world' problems (*eg* at CPS and SHS);
(vii) attempts to link subject with others; that is, emphasis on cross-curricula work (*eg* at EC and RHS); and
(viii) a learning focus on process rather than product (*eg* at PHS).

5.3 Pupils in Change

Several points regarding students' views of the innovations could be ascertained from the case studies. These included:

(i) students were not necessarily able to perceive the changes which had occurred and were occurring;

(ii) most students were positive about the shift to more student-centred learning;

(iii) a positive response by the students to the more relevant and practical (*ie hands-on*) nature of the curricula; and

(iv) in the colleges where a more differentiated student population recently had emerged, changes had been made to accommodate the needs of non-academic students and these students were positive about the new courses developed for them.

For many students, curriculum, pedagogy and the nature of their relationship with the teacher were not things which for them had had a significant shift in one year. Many could not compare the present teaching approaches with others. The changes to teaching occurring within the case study schools and colleges by the Key Teachers were evolutionary rather than revolutionary. That is, the Key Teachers had already begun the process of changing approaches as they had reflected on their practice and its appropriateness for the changing circumstances.

5.4 Equity Issues

The case studies showed concern for a number of equity issues. For example, concern with gender equity was seen at Launceston College, Cosgrove High School and Penguin High School where positive steps had been taken to involve both sexes in curriculum areas not traditionally studied by them.

Equity in terms of ability levels had been addressed in all case study schools and colleges. In the colleges, non-tertiary bound students had been provided with a more diverse, appropriate and vocationally oriented curriculum. In the compulsory sector schools, the move to mixed ability classes, student-centred learning and many instances of student self-paced learning facilitated equity. In addition to core units, extension and support neighbouring units were evident in many schools.

6. Conclusion

All of the case studies showed schools and colleges that were making significant changes in one or more aspects of their pedagogy, curriculum, organisational structure, or links with the community in Science, Mathematics and Technology education.

For the schools and colleges the changes they were making, by and large, were internally driven. They were changes that had come about because the school community had recognised a need within the student population which the teachers and the school had acted to address. Essential in this process had been the activity of agents we have referred to as Key Teachers; that is, an individual who recognised the need for change and set out to achieve this.

In several of the case studies the role of external factors in providing a context for the change or adding emphasis to the need for change also could be seen.

The case studies demonstrated the importance of having all *stakeholders* aligned in their understanding of and commitment to the innovation. For example, the class teacher needed to have the support of the school administration, who needed to have the support of the wider system and so on.

Many of the initiatives could be traced in broad terms to the challenges given to the education community by the federal Minister for Education in the late 1980s. At this time, he invited state and territory authorities to "strengthen our schools." Consequently, documents and reports relating to the *National Statements and Curriculum Profiles* and the promotion of Key Competencies for school-work transitions were disseminated. These initiatives could be seen as providing important contextual factors in the present innovations.

The case studies all demonstrated that successful change could not be mandated by an external authority. The essential element of time for the innovation to be developed, implemented and institutionalised was reinforced in all of the case studies. In the longer term, therefore, the question of how to insitutionalise change was of major concern. The case studies indicated that the collegial aspect of teachers' professionalism was particularly relevant here.

The case studies all demonstrated a change in the nature of student-teacher relationships and in the focus of teaching and learning. At all levels of education, the relationship between student and teacher did not have the authoritarian overtones which might have been evident in the recent past.

Similarly, the teaching strategies evidenced in the case study schools and colleges showed a clear shift from teacher-centred to student-centred learning. The teachers in the case studies saw their role as a facilitator of learning rather than as a content expert who would dispense information in pre-packaged form to the passive learners. The case studies, therefore, all showed more active, *hands-on* approaches to student learning.

The importance of an individual teacher and their desire for change as a critical factor in the success of these innovations was demonstrated in the case studies. It was at this level that the impetus for change began and was nurtured. The setting for successful innovation, however, was not one where individual teachers continued to work in isolation and independently of colleagues. There was a high degree of collegial interaction on all matters relating to the innovations. In addition, the nature of the professional relationship between the teachers involved in the innovation was designed to transform the present educational situation.

A factor which was evident at both the individual and teacher team levels was the willingness to *take risks*. For the teachers involved this ranged from being willing to push their idea for the innovation within the school community, to open up their classroom and their teaching strategies to examination by colleagues, to enter into dialogue with their students' parents and the wider community regarding the innovation, and to work with system level officers.

The factors referred to above (*ie* teacher volition, collegiality, and risk taking) could be seen in combination in the area of professional development. With the innovation came a willingness to change all aspects of pedagogy, curricula, organisation and school-community relationships. This required professional development in all areas. The case studies showed that this professional development was often site-specific. That is, it involved Key Teachers and others participating in the innovation, but was supported by participation in external workshops, seminars and conferences. These all had the goal of extending the professional networks of the teachers.

The implementation of innovations as significant as those discussed in this report have major implications for learners. Students' perceptions of the innovations were collected via student journals and interviews. The data showed the students had positive reactions to the more *hands-on* and learner-centred approaches of the curriculum, they supported the changes in teaching strategy and they preferred the changed nature of the relationship with their teachers.

The case studies demonstrated what may be termed a craft-level approach to the innovation. This was supported very quickly by relevant Principal Curriculum Officers and other DEA curriculum support personnel so that a positive linking of practice and relevant theory was enacted. With the benefit of hindsight, much of what was described in the case studies was seen in the current literature on change and innovation as the desirable way to proceed.

A statement which summarises many of the points mentioned above was described by a Research Assistant who used the metaphor of *the wave* to explain innovation and change. She wrote:

> *Innovation and change may be perceived as a wave. It can be a long roller which one prepares students to ride, and those who ride it best right now may be those who are trained to handle exactly that one type of wave to its greatest potential. But it could change shape or be a dumper, in which case the students need skills in recognition and prediction and decision making as to whether to go for it, stay with it, back off it, or dive under it. It may roll into unknown waters, in which case the student will require both knowledge and a flexibility to apply that knowledge to new situations. Many teachers are not*

swimmers, or have no confidence in fast moving big seas. Some perceive the wave as a potential tidal wave and fear their inability to cope and to prepare their students to even survive or float, let alone to surf with it. School managers can perceive the waves as threatening to crash down and demolish their organisational structures. Yet others see the wave as offering an inspirational and energetic ride to both new and old places and experiences, and strive to make all their students confident and eager to ride the wave.

7. Appendices

7.1 Interview Schedules

The interview schedules supplied to the Research Assistants are given here. A slighltly different schedule was used for each Key Learning Area of Science, Mathematics and Technology. These interview schedules were only guidelines. Research Assistants were free to adapt these as they saw fit dependent upon the context of the interview and the innovation.

7.1.1 For Staff Involved in Curriculum Administration of Mathematics

These interviews will be conducted by the Research Assistants in the case study schools. The school staff who will be interviewed may include one or several of the following: Principal; AST3; AST2; AST1. Any of these staff, or a combination of them, may be responsible for reworking, writing or implementing the curriculum innovations. For example, an AST3 may be responsible for overall curriculum administration in the school, but an AST1 may be responsible for rewriting the mathematics curriculum at the grade 7 level.

The Research Assistant allocated to a school will need to ascertain for themselves who and how many people they will need to interview to gain the relevant data.

All of the interview questions solely concern the curriculum innovation which is occurring within the school.

1. Can you describe the present mathematics syllabus(es) in this school? In particular, can you highlight the strengths and weaknesses of the present mathematics syllabus(es) in this school?

2. What improvements have been made to the mathematics syllabus(es) in the last two years?

3. Who has instigated these improvements?

4. Why were these improvements made?

5. What do you see as the purpose of these syllabus improvements?

6. (a) What provisions, if any, have been made for making mathematics more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

7. What variations, if any, have been made to the way mathematics is assessed?

8. (a) Are other curriculum areas involved in the teaching of mathematics?
   (b) If so, how are they integrated/linked?

9. What plans do you have to improve the mathematics syllabus(es) in the future?

7.1.2 For Teachers of Mathematics

The Research Assistants attached to each case study school will conduct these interviews. The aim of the interviews is to allow teachers to tell *their story* about the innovation. Teachers who are involved in the teaching of the curriculum innovations should be interviewed. It may be convenient if they are interviewed as a group, at least once a week. If a group session cannot be conducted then individual interviews will need to be arranged. Feedback on earlier investigations can be given at this time to check on its veracity. All of the following questions relate to the curriculum innovation being investigated.

1. Can you describe the present mathematics syllabus(es) that you teach? In particular, can you highlight the strengths and weaknesses of the present mathematics syllabus(es) that you teach?

2. What improvements have been made to the mathematics syllabus(es) in the last two years?

3. Who has instigated these improvements?

4. What do you see as the purpose of these mathematics syllabus improvements?

5. How do you feel about teaching the current mathematics syllabus(es)?

6. Have you noticed any differences in the responses of the students to the mathematics syllabus improvements and their implementation?

7. (a) What provisions, if any, have been made for making mathematics more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

8. How, if at all, have your teaching strategies varied in accordance with the mathematics syllabus improvements? Can you please describe a typical lesson?

9. What variations have you made to the assessment strategies you use? Can you give an example?

10. (a) Are other curriculum areas involved in the teaching of mathematics?
    (b) If so, how are they integrated/linked?

11. What new resources have the mathematics syllabus improvements resulted in you using?

12. What innovative support mechanisms have you used to deliver the mathematics syllabus improvements?

13. How relevant do you feel the mathematics syllabus(es) is to students':
    (a) experience
    (b) future?

7.1.3 For Mathematics Students

The Research Assistants attached to each case study school will conduct these informal interviews. Students who are in the classes where the curriculum innovations are being implemented should be interviewed. However, the interviews should not *get in the way* of ongoing school work. If possible, they should be interviewed in small groups of four or five. They should be chosen randomly from the class. Not all students in the class should be interviewed. All of the following questions relate to the curriculum innovation being investigated.

1. Can you tell me briefly about the mathematics you are doing this year?

2. Have you noticed any variation/improvement in the way mathematics is taught this year?

3. How relevant do you feel mathematics is to your own:
   (a) experience
   (b) future?

4. Do you feel the mathematics you are doing is suitable for all students at this level? Why, or why not?

5. How, if at all, is mathematics related to other subjects that you study?

6. Have you noticed gaps in your knowledge of mathematics? If so, what were they?

7. Have you repeated any work in mathematics this year which you already knew? If so, what was it?

7.1.4 For Staff Involved in Curriculum Administration of Science

These interviews will be conducted by the Research Assistants in the case study schools. The school staff who will be interviewed may include one or several of the following: Principal; AST3; AST2; AST1. Any of these staff, or a combination of them, may be responsible for reworking, writing or implementing the curriculum innovations. For example, an AST3 may be responsible for overall curriculum administration in the school, but an AST1 may be responsible for rewriting the science curriculum at the grade 7 level.

The Research Assistant allocated to a school will need to ascertain for themselves who and how many people they will need to interview to gain the relevant data. All of the interview questions solely concern the curriculum innovation which is occurring within the school.

1. Can you describe the present science syllabus(es) in this school? In particular, can you highlight the strengths and weaknesses of the present science syllabus(es) in this school?

2. What improvements have been made to the science syllabus(es) in the last two years?

3. Who has instigated these improvements?

4. Why were these improvements made?

5. What do you see as the purpose of these syllabus improvements?

6. (a) What provisions, if any, have been made for making science more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

7. What variations, if any, have been made to the way science is assessed?

8. (a) Are other curriculum areas involved in the teaching of science?
   (b) If so, how are they integrated/linked?

9. What plans do you have to improve the science syllabus(es) in the future?

7.1.5 For Teachers of Science

The Research Assistants attached to each case study school will conduct these interviews. The aim of the interviews is to allow teachers to tell *their story* about the innovation. Teachers who are involved in the teaching of the curriculum innovations should be interviewed. It may be convenient if they are interviewed as a group, at least once a week. If a group session cannot be conducted then individual interviews will need to be arranged. Feedback on earlier investigations can be given at this time to check on its veracity. All of the following questions relate to the curriculum innovation being investigated.

1. Can you describe the present science syllabus(es) that you teach? In particular, can you highlight the strengths and weaknesses of the present science syllabus(es) that you teach?

2. What improvements have been made to the science syllabus(es) in the last two years?

3. Who has instigated these improvements?

4. What do you see as the purpose of these science syllabus improvements?

5. How do you feel about teaching the current science syllabus(es)?

6. Have you noticed any differences in the responses of the students to the science syllabus improvements and their implementation?

7. (a) What provisions, if any, have been made for making science more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

8. How, if at all, have your teaching strategies varied in accordance with the science syllabus improvements? Can you please describe a typical lesson?

9. What variations have you made to the assessment strategies you use? Can you give an example?

10. (a) Are other curriculum areas involved in the teaching of science?
    (b) If so, how are they integrated/linked?

11. What new resources have the science syllabus improvements resulted in you using?

12. What innovative support mechanisms have you used to deliver the science syllabus improvements?

13. How relevant do you feel the science syllabus(es) is to students':
    (a) experience
    (b) future?

7.1.6 For Science Students

The Research Assistants attached to each case study school will conduct these informal interviews. Students who are in the classes where the curriculum innovations are being implemented should be interviewed. However, the interviews should not *get in the way* of ongoing school work. If possible, they should be interviewed in small groups of four or five. They should be chosen randomly from the class. Not all students in the class should be interviewed. All of the following questions relate to the curriculum innovation being investigated.

1. Can you tell me briefly about the science you are doing this year?

2. Have you noticed any variation/improvement in the way science is taught this year?

3. How relevant do you feel science is to your own:
   (a) experience
   (b) future?

4. Do you feel the science you are doing is suitable for all students at this level? Why, or why not?

5. How, if at all, is science related to other subjects that you study?

6. Have you noticed gaps in your knowledge of science? If so, what were they?

7. Have you repeated any work in science this year which you already knew? If so, what was it?

7.1.7 For Staff Involved in Curriculum Administration of Technology

These interviews will be conducted by the research assistants in the case study schools. The school staff who will be interviewed may include one or several of the following: Principal; AST3; AST2; AST1. Any of these staff, or a combination of them, may be responsible for reworking, writing or implementing the curriculum innovations. For example, an AST3 may be responsible for overall curriculum administration in the school, but an AST1 may be responsible for rewriting the technology curriculum at the grade 7 level.

The research assistant allocated to a school will need to ascertain for themselves who and how many people they will need to interview to gain the relevant data. All of the interview questions solely concern the curriculum innovation which is occurring within the school.

1. What are the strengths of the present technology syllabus(es) in this school?

2. What are the weaknesses of the present technology syllabus(es) in this school?

3. What improvements have been made to the technology syllabus(es) in the last two years?

4. Who has instigated these improvements?

5. Why were these improvements made?

6. What do you see as the purpose of these syllabus improvements?

7. (a) What provisions, if any, have been made for making technology more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

8. What variations, if any, have been made to the way technology is assessed?

9. (a) Are other curriculum areas involved in the teaching of technology?
   (b) If so, how are they integrated/linked?

10. What plans do you have to improve the technology syllabus(es) in the future?

7.1.8 For Teachers of Technology

The Research Assistants attached to each case study school will conduct these interviews. Teachers who are involved in the teaching of the curriculum innovations should be interviewed. It is felt that they should be interviewed as a group, at least once a week, and feedback on earlier investigations should be given at this time. All of the following questions relate to the curriculum innovation being investigated.

1. What are the strengths of the present technology syllabus(es) that you teach?

2. What are the weaknesses of the present technology syllabus(es) that you teach?

3. What improvements have been made to the technology syllabus(es) in the last two years?

4. Who has instigated these improvements?

5. What do you see as the purpose of these technology syllabus improvements?

6. How do you feel about teaching the current technology syllabus(es)?

7. Have you noticed any differences in the responses of the students to the technology syllabus improvements and their implementation?

8. (a) What provisions, if any, have been made for making technology more accessible to a broader range of students (*eg* based on ability, age, gender)?
   (b) Has this been effective so far?

9. How, if at all, have your teaching strategies varied in accordance with the technology syllabus changes?

10. What variations have you made to the assessment strategies you use?

11. (a) Are other curriculum areas involved in the teaching of technology?
    (b) If so, how are they integrated/linked?

12. What new resources have the technology syllabus improvements resulted in you using?

13. What innovative support mechanisms have you used to deliver the technology syllabus improvements?

14. How relevant do you feel the technology syllabus(es) is to students':
    (a) experience
    (b) future?

7.1.9 For Technology Students

The Research Assistants attached to each case study school will conduct these interviews. Students who are in the classes where the curriculum innovations are being implemented should be interviewed. It is felt that they should be interviewed in small groups of four or five. They should be chosen randomly from the class. Not all students in the class should be interviewed. All of the following questions relate to the curriculum innovation being investigated.

1. Have you noticed any variation/improvement in the way technology is taught this year?

2. How relevant do you feel technology is to your own:
   (a) experience
   (b) future?

3. Do you feel technology is suitable for all students at this level? Why or why not?

4. How, if at all, is technology related to other subjects that you study?

5. Have you noticed gaps in your knowledge of technology? If so, what were they?

6. Have you repeated any work in technology this year which you already knew? If so, what was it?

7.2 Documents for Analysis

The following list of documents was given to the Research Assistants and Academics as a guide to what data would be useful to collect for later analysis.

The following documents are required to be collected for analysis in order to help understand curriculum innovations in SMT in the case study schools. The first three documents are held within the Faculty of Education, and, as such, do not need to be collected from the schools. The remaining documents should be collected. However, it is realised that some of these documents may be non-existent (*eg* teacher lesson plans), and thus, unable to be collected. It is hoped that documents not mentioned on this list, but which may be important to the study, will also be collected. The Research Assistant allocated to each school will be best suited to ascertain whether any additional documents need to be collected.

1. DEA curriculum and assessment guidelines.
2. Schools Board syllabus documents.
3. National Statements and Curriculum Profiles.
4. School written/annotated syllabus documents.
5. Teacher programmes (for the term/year).
6. Teacher unit plans.
7. Teacher lesson plans.
8. Assessment guidelines (teacher and school) and items.
9. Student journals.
10. Copies of student work and assessment items.
11. Teacher produced resources (*eg* worksheets) and external resources (*eg* text references).
12. School written cross-curricula or extra-curricula documents; for example, special needs, language, industry liaison.
13. Minutes of meetings relevant to the curriculum innovation.

7.3 Student Journals

The following student journals, with slight variations for each subject area, were given to the Research Assistants as an aid to data collection. These were used at all schools and colleges except Reece High School. Several Research Assistants varied the format of the journals to suit the students and the context of the innovation at their school. These variations did not change the general focus of the student journals.

7.3.1 Mathematics

Please fill in the following information:

NAME: ....

SCHOOL: ....

GRADE: ....

TEACHER: ....

SUBJECT: ....

LEVEL: ....

You are asked to fill in one of each of the following pages at the end of each mathematics lesson. Please take the time to think about your answers. There are no right or wrong answers, we are interested in your opinions. You will not be marked on this work.

The journals will be collected, when finished, by the Research Assistant visiting your school.

Thank you for your help.

PERIOD: ________ DATE: ________

1. What things did you learn or do today in mathematics? (*eg* adding fractions worksheet; built solids using triangles, squares and hexagons)

----

2. What things were interesting in today's mathematics lesson? Why?

----

3. What are the links between what you learned today in mathematics and other subjects you have studied? (*eg* measurements in recipes for cooking; shapes in art; relationship between musical notes)

----

4. How could you use at home or out of school what you learned today in your mathematics lesson? (*eg* baking a cake; checking your change from the shop; working out the top four sporting teams)

----

5. Please add anything else about today's mathematics lesson you would like to tell us.

7.3.2 Science

Please fill in the following information:

NAME: ....

SCHOOL: ....

GRADE: ....

TEACHER: ....

SUBJECT: ....

LEVEL: ....

You are asked to fill in one of each of the following pages at the end of each science lesson. Please take the time to think about your answers. There are no right or wrong answers, we are interested in your opinions. You will **not** be marked on this work.

The journals will be collected, when finished, by the Research Assistant visiting your school.

Thank you for your help.

PERIOD: ________ DATE: ________

1. What things did you learn or do today in science? (*eg* study and build a volcano; investigate the workings of an ant colony)

---

2. What things were interesting in today's science lesson? Why?

---

3. What are the links between what you learned today in science and other subjects you have studied? (*eg* designing a bridge in technology; colours in art; energy in physical education)

---

4. How could you use at home or out of school what you learned today in your science lesson? (*eg* understanding the weather report; growing plants in the garden; understanding why cakes rise when baked)

---

5. Please add anything else about today's science lesson you would like to tell us.

7.3.3 Technology

Please fill in the following information:

NAME: ....

SCHOOL: ....

GRADE: ....

TEACHER: ....

SUBJECT: ....

LEVEL: ....

You are asked to fill in one of each of the following pages at the end of each technology lesson. Please take the time to think about your answers. There are no right or wrong answers, we are interested in your opinions. You will not be marked on this work.

The journals will be collected, when finished, by the research assistant visiting your school.

Thank you for your help.

PERIOD: ________ DATE: ________

1. What things did you learn or do today in technology? (*eg* design a dress; draw a house floor plan using computer graphics; plan a meal)

----

2. What things were interesting in today's technology lesson? Why?

----

3. What are the links between what you learned today and other subjects you have studied? (*eg* textile designs based on art; scale drawings and measurement from maths)

----

4. How could you use at home or out of school what you learned today in your technology lesson? (*eg* baking a cake, making a model aeroplane)

----

5. Please add anything else about today's technology lesson you would like to tell us.

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