Investigation of Design Technology Issues in the Primary Classroom

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Abstract

Design technology is a poorly understood aspect of educational practice, particularly as it applies in the primary school classroom. In a number of countries around the world the implementation of design technology has met with difficulties as it applies to educational practice. In Australia, this curriculum area is a relatively recent addition to classroom programs of study, and it is crucial that a sound understanding of the subject and its specific characteristics is developed to assist in its effective implementation.

In this research a case study of a single primary school classroom was undertaken with a view to identifying issues that may have impeded or facilitated the effective implementation of design technology in such a context. The classroom experiences of the teacher and her students were examined in detail to ascertain any insights into design technology curriculum implementation and practice, particularly as it applies to the primary school environment.

The research identified nine key assertions relating to the practices of this teacher and her students. These assertions were developed and refined throughout the data collection to explain the observed classroom activity. Linkages between previous research and these assertions were utilised to develop a discussion that broadly identifies key issues that may impact on the effective implementation of design technology, as well as addressing broader conceptual issues associated with the subject area. The concept of a contingent approach to design is proposed as a means to explain classroom behaviour by students, and is allied to the concept of a ‘field of possibility’ and the interpretation of artefacts through a narrative approach. These key concepts combine to develop a structure through which classroom activity may be interpreted by teachers in a manner grounded in student behaviour. A model for interpreting technology activity in the classroom is also developed.

The research, therefore, develops present understanding through the observations of actual classroom activity. Furthermore, it presents new ways of conceptualising design technology that may assist in the progression of the curriculum area by academic and classroom professionals in a manner that is grounded in the reality of the classroom experience.
Key words

Alternative assessment
Classroom
Curriculum implementation
Design and technology
Outcomes-based education
Primary education
Contents

Chapter 1
Introduction
1.0 Overview 1
1.1 Significance 2
1.2 Purpose 3
1.3 Outline of format 4

Chapter 2
Literature Review
2.0 Introduction 5
2.1 Technology 6
2.1.1 A brief history of technology in the curriculum 8
2.1.2 Queensland background 10
2.1.3 Language problems 11
2.1.4 The dimensions of technology 13
2.1.5 The human element 14
2.1.6 The liberal tradition 16
2.1.7 Why technology is not science 18
2.1.8 Why technology is not craft/manual arts 20
2.1.9 The influence of science and manual arts 21
2.1.10 The design process 24
2.1.11 Context 32
2.1.12 Summary – Technology 35
2.2 Assessment 35
2.2.1 What is assessment 36
2.2.2 Why assess 37
2.2.3 Alternative assessments 39
2.2.4 Implications of alternative assessments 42
2.2.4.1 The human elements in assessment 42
2.2.4.2 Use of criteria 47
2.2.4.3 Outcomes-based frameworks 47
2.2.4.4 Curriculum and instruction 53
2.2.4.5 Context 54
2.2.4.6 Difficulties with alternative assessments 55
2.2.4.7 Reliability and validity 57
2.2.5 The Queensland context 59
2.2.6 Summary – Assessment 62
2.3 Summary of Chapter 63
2.4 Aim of Research 66

Chapter 3
Design and Methods 67
3.0 Introduction 67
3.1 Design 67
3.2 Implementation Cycle 70
3.3 Participants ................................................................................. 70
3.4 Data Sources ........................................................................... 71
3.5 Analysis .................................................................................... 73
   3.5.1 Credibility ........................................................................ 77
   3.5.2 Transferability ................................................................. 79
   3.5.3 Dependability .................................................................... 79
   3.5.4 Confirmability ................................................................. 80
3.6 Ethical Issues ........................................................................... 82
3.7 Chronology of Events ............................................................. 84
3.8 Summary of Chapter ............................................................... 84

Chapter 4
Initial Investigations .................................................................... 85
4.0 Introduction ........................................................................... 85
4.1 Initial Planning and Context .................................................. 85
4.2 Summary of Chapter ............................................................... 92

Chapter 5
Findings ....................................................................................... 95
5.0 Introduction ........................................................................... 95
5.1 Assertion #1 ........................................................................... 96
   5.1.1 Summary ......................................................................... 107
5.2 Assertion #2 ........................................................................... 108
   5.2.1 Summary ......................................................................... 117
5.3 Assertion #3 ........................................................................... 117
   5.3.1 Summary ......................................................................... 121
5.4 Assertion #4 ........................................................................... 121
   5.4.1 Summary ......................................................................... 129
5.5 Assertion #5 ........................................................................... 129
   5.5.1 Summary ......................................................................... 138
5.6 Assertion #6 ........................................................................... 139
   5.6.1 Summary ......................................................................... 142
5.7 Assertion #7 ........................................................................... 143
   5.7.1 Summary ......................................................................... 156
5.8 Assertion #8 ........................................................................... 157
   5.8.1 Summary ......................................................................... 172
5.9 Assertion #9 ........................................................................... 173
   5.9.1 Summary ......................................................................... 176
5.10 Summary of Chapter ............................................................. 176

Chapter 6
Discussion of Findings ................................................................. 179
6.0 Introduction ........................................................................... 179
6.1 Design and Practice in Technology Classrooms ..................... 179
   6.1.1 Contingent design .......................................................... 179
   6.1.2 Design approaches ......................................................... 189
   6.1.3 The physical environment of the classroom ...................... 189
6.1.4 Fields of possibility ......................................................... 193
6.1.5 Summary ........................................................................ 197
6.2 Assessment ........................................................................ 197
   6.2.1 Artefacts as part of a narrative ...................................... 197
   6.2.2 Understandings of assessment ...................................... 204
   6.2.3 Summary ........................................................................ 208
6.3 Curriculum ........................................................................... 208
   6.3.1 Planning methodologies ............................................... 208
   6.3.2 Development of understanding of technology .............. 211
   6.3.3 Difficulties with the syllabus ........................................ 212
   6.3.4 Summary ........................................................................ 215
6.4 A Model for Interpreting Technology Activity .................... 216
   6.4.1 Description of the model .............................................. 216
6.5 Summary of Chapter .......................................................... 219

Chapter 7

Summary .................................................................................... 221

7.0 Summary of Research Project .............................................. 221
7.1 Summary of Findings ......................................................... 223
7.2 Further Research ............................................................... 225

Appendices

Appendix 1: Data sources, codes and general interaction
             with research site .............................................................. 229
Appendix 2: Overview of cooperatively planned technology unit .. 230
Appendix 3: Teacher planning and documentation –
             year six cooperative planning ....................................... 232
Appendix 4: Technology unit planning ....................................... 237
Appendix 5: Year six & four unit planning ................................. 239

References ................................................................................ 241
Figures

Figure 2.1: Example of simple linear model (adapted from Assessment of Performance Unit, 1994)……………………………………25
Figure 2.2: Ways elements of a technology process may interact (adapted from Queensland School Curriculum Council, 1999)………………27
Figure 2.3: The interaction of mind and hand (adapted from Assessment of Performance Unit, 1994)……………………………………28
Figure 2.4: An interacting design loop (adapted from Kimbell, 1997)…29
Figure 5.1 Boat design by Kimberley (drawn design)......................104
Figure 5.2 Boat built by Kimberley (Photograph of final artefact)……104
Figure 5.3 Car design by Matthew.............................................106
Figure 5.4 Car built by Matthew (photograph of final object).........106
Figure 5.5. Car design by Ian.....................................................116
Figure 5.6 Actual artefact made by Ian (photograph of final object)…116
Figure 6.1 A model of classroom technology...............................217

Tables

Table 2-1 Comparison of Traditional Versus Alternative Assessments....43
Table 4.1 Activities to be Undertaken by Students.........................93
Statement of Authorship

The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

_________________
Robert S. Davis

_________________
Date
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Previously published material

The following papers have been produced from research undertaken as part of this thesis:


Chapter I

Introduction

1.0 Overview

In the State of Queensland, Australia, there are approximately 20,000 government employed primary school teachers. Over the next three years (from 2004) they will be required to effectively implement a curriculum area that many of them have had little or no experience with, and to do so in an already crowded school curriculum. They will need to be able to interpret syllabus documents, make effective assessment of student activity and learning, report in a meaningful manner to parents, and deliver interesting and educationally challenging programs for their students. This subject, or Key Learning Area (KLA), is called “Technology” (in this State at least), and it appears that these undertakings will be no easy task for many teachers.

The terminology that teachers will encounter is very poorly defined. For instance, just exactly what is technology? Many teachers, it is reported in the literature, would respond with the explanation that it involves computers, and yet the “technology” syllabus addresses technology in its broader sense of human made artefacts and activity (Curriculum Strategy Branch, 2003). It is this latter aspect often referred to as design and technology or design technology which is the focus of this thesis. There must have been few teachers in history whose first problem when developing new curricula was to work out exactly what the KLA was that they were going to teach. Such fundamental problems recur in any examination of technology as an educational endeavour. Who will teach the subject (a particular problem in Years 8 to 10; in this State the responsibility of high schools)? How should it be taught? Is it worth teaching? Such are the difficulties that will be encountered by the teachers in this state over the next few years.
More subtle factors are also inherent in the KLA. The KLA is difficult to categorise in terms readily understood by teachers. Is it a manual KLA or an academic one, or perhaps an artistic one? Where does it therefore fit into the traditional hierarchies that are always present in the school environment, and where will it be timetabled? The history of the KLA in overseas jurisdictions as well as in Australia needs to be examined to determine the origins of the syllabus to assist in the development of an identity of a somewhat amorphous syllabus area. From such a basis it is then possible to look at the classroom, and how technology may fit into the primary school curriculum.

Although the research in this thesis occurred in Queensland, Australia where technology curricula are only now being introduced, many of the issues appear to be universal. Research from around the world demonstrates that the understanding of technology as an educational endeavour is still being tackled, as demonstrated by the work of, for example, Rogers and Wallace (2000) in Australia and the UK, Plucker (2002) and Crismond (2001) in the USA, Moreland and Jones (2000) and France and Davies (2001) in New Zealand, Hill and Anning (2001) in Canada and the UK, Doornekamp (2001) in The Netherlands, and Tairab (2001) in Brunei Darussalam.

1.1 Significance

A central issue that needs to be explored is, therefore, the classroom and school based experiences of teachers and students who have attempted to enact the syllabus, and the difficulties they have encountered in realising a classroom program. Such an investigation would form the basis for guidance regarding appropriate approaches to development of in-service and pre-service educational programs. To develop such programs, it is important to understand how teachers interpret the syllabus and how students behave while undertaking technology. Through such understandings,
meaningful advice that is grounded in the reality of classroom activity may be given to teachers.

The development of understanding of technology will provide guidance for the implementation of appropriate assessment. It is critical that student activity can be assessed in a manner that reflects the nature of the KLA; in other words assessment that is fair. Assessment can only be fair if there is a shared and meaningful understanding of the nature of the KLA, which can be achieved through being able to recognise and interpret student behaviour when undertaking technology activities. At present, there is limited guidance for teachers in this regard.

The research reported in this thesis, therefore, was developed in this context. It investigated actual issues associated with the implementation of technology in a primary school classroom with a view to developing an understanding of student and teacher behaviour when undertaking technology. From this, a more informed approach to classroom assessment is possible. The research was, therefore, addressing a number of fundamental concerns of school administrators, teachers, students and their parents.

1.2 Purpose

The broad aim of the research was;

to investigate the implementation of a technology syllabus in a primary classroom environment by a teacher with limited background in the KLA.
Data collection in this regard was undertaken in a single Year 4/6 classroom in a rural school, where the class teacher was trying to come to grips with a new curriculum area with which she had little familiarity.

1.3 Outline of format

This research will be presented in the following format. Firstly, the literature relating to design and technology, and its assessment in the classroom is reviewed in Chapter 2. This review of the literature is then used to identify issues within the field of research that may be addressed through a research program. A methodology is then developed to address the actual implementation of a research agenda, which is presented in Chapter 3. Data are then presented through the format of nine assertions that emerged from the experiences of the participants and researcher in Chapter 4. These assertions are then discussed within the framework of findings from both the research and the reviewed literature in Chapter 5, as well as a model to synthesise findings. The final chapter (Chapter 6) summarises the research and presents conclusions, implications, and areas for further research.
Chapter II

Literature Review

2.0 Introduction

To investigate technology in an educational context, it is necessary to examine what technology actually is. To this end, Chapter 2 consists of a review of literature relating to technology education. The literature that follows will enable a directed approach to the research project through a delineation of areas of uncertainty and ambiguity within the field. A number of issues will be explored that highlight emergent problems inherent in the implementation and assessment of an embryonic curriculum. Most notably the definition of what constitutes technology will be shown to be, at best, a fluid concept with certain characteristics unique within the school curriculum. The teaching, learning and assessment of design and technology will be shown to be dependent on context specific processes that are not necessarily compatible with traditional assessment practices, and that reliable assessments of student achievement will require information regarding how teachers interpret student performance in such contexts.

In the first section (Section 2.1), the literature has been organised to demonstrate the various features of the curriculum area as they apply to this research program. The findings in relation to design processes, as well as conceptualisations of technology held by teachers are of significance to this study. The historical development of design and technology and the language problems surrounding the KLA are also identified. The first section concludes that design and technology is a developing curriculum area that lacks definition, thus creating particular problems for those involved in its implementation.
The purpose of this section is thus to present the educational and historical context in which the research program was developed.

In the next section (Section 2.2), the use of outcome-based assessment as part of an alternative assessment framework will be examined as an appropriate medium for determining student capability where a number of educational and systemic requirements of design and technology are to be fulfilled. A review of this literature will show that there are issues influencing teacher assessments that need to be further researched.

The chapter concludes with a summary of the literature review in these sections which positions the research to be undertaken and from which the aim and specific objectives are derived and presented. At the end of each section a summary of the literature is provided that identifies the key issues influencing the development of an appropriate methodology for conducting the research.

2.1 Technology

As stated in Chapter 1, it is appropriate to clarify the use of key terminology used in this research. Although the term “design and technology,” or “design technology” may be used to describe the particular curriculum area in this research, the systemic context in which this research occurs (State Education in Queensland) uses the term “Technology” to identify the KLA. The KLA encompasses elements from previously existing curriculum areas such as home economics, manual arts and computing studies, but addresses itself to a broader conception of technology as being the study of human made artefacts. It focuses on the development of these artefacts through students working technologically, utilising materials, systems and information to achieve desired outcomes This research will use the term technology in this latter sense. This does not,
however, necessarily clarify a number of central issues associated with the identification of the KLA.

The difficulty in defining exactly what is meant by technology as a curriculum area and, as a consequence, developing educational practices that reflect such understanding, can be appreciated when one considers the unique history of the technology curriculum within the education sector. The brief, and at times turbulent, development of technology in education is indicative of a multiplicity of viewpoints held by those tasked with its introduction into schools, a situation which is still not completely resolved. Hill and Anning (2001, p. 112), for example, commenting on their research in Canada and the UK, contend that there is a:

… lack of evidence that examines, together, the triad of how teachers in the elementary/primary schools are translating curriculum requirements for teaching design, within technology frameworks, in their classrooms, how their students proceed with design, and how ‘school situated design’ relates to ‘workplace design.’ (punctuation as in original)

This lack of evidence regarding the implementation of technology in the primary years of schooling forms the framework in which this research occurs.

Some of the features of technology to be discussed in Section 2.1 are of a nature quite different to other curriculum areas and, as such, pose particular problems in relation to its implementation and assessment.
2.1.1 A brief history of technology in the curriculum

The history of technology education in schools is brief when compared to most other KLAs. Although, as noted by Kimbell (1995), the roots of technology education can be deduced in a number of other school KLAs, in particular the science and manual arts traditions, it is only in the past 30 years that steps were taken to establish it in its present form. This has resulted in a lack of a clear identity for technology, perhaps most notably by teachers (Jarvis & Rennie, 1996a, b; Jones, 1997a; Jones & Carr, 1992; Newton & Hurn, 1996). It should be of concern, therefore, that those who must implement and assess the KLA have considerable differences regarding conceptions of the KLA’s basic identity.

The syllabus in Queensland (Queensland Studies Authority, 2003), where this research occurred, is based on the National Profile for Technology (Curriculum Corporation, 1994) which was heavily influenced by the Design and Technology curriculum in the UK (Kimbell, 1997), and it is therefore instructive to undertake a brief examination of the development of the curriculum area in that latter country. An excellent summary of the development of the KLA in the UK is supplied by Kimbell (1995), where he noted that technology initially emerged from a number of initiatives, all of which have either science or practical arts leanings. He also noted that teaching and assessment in this context were initially dominated by acquisition and recall of knowledge, and that in the late 1950s and early 1960s, seminal reports on education in the UK identified a serious problem with lack of articulation between school and real world experience.

Two curriculum development projects were subsequently set up -Technology (science based, 1968) and Design and Craft (practical arts based, 1969) - and the focus of assessment changed to problem solving processes. Debate then shifted from
science/knowledge versus practical arts/skills, to one of defining technology as either a body of knowledge/skill or a process/activity (about 1975) and Technology, and Design and Craft developed along their own paths. Then it became apparent that reform of the education and examination system was necessary. As part of this rationalisation a new subject called Craft, Design and Technology was created which incorporated the traditions of both the hitherto separate subjects in 1985. In 1986/7, Craft, Design and Technology was renamed Technology (which also incorporated elements from other subject areas, home economics, business studies, information technology, art and design) with the development of the national curriculum in the UK. This was then renamed Design and Technology in 1989 (McCormick, 1990).

The traditions of technology have been traced back to the industrial revolution (Gradwell, 1996), while Custer (1995) utilises stone tools as an example of the history of human use of materials to address needs, long predating any possible scientific understanding. The research for this thesis is concerned with technology as a school KLA and is thus focused on developments within the school system, although echoes of the history outlined above still reverberate in the debates within the KLA today. The dichotomy that initially existed between science and the practical arts is still exerting an influence, as will be discussed, while the debate revolving around design processes and how to assess them continues (Davis, McRobbie, & Ginns, 2004; Lewis & Gagel, 1992; Mioduser, 1998).

In Australia the formal introduction of technology into schools can be traced conveniently to 1989, when the Australian Education Council’s Hobart Declaration of Common and Agreed Goals for Schooling (Australian Education Council, 1989) identified a new key learning area, Technology. This is to simplify what actually happened for, prior to this date, the Australian Education Council (AEC) had started a process in 1987 which was to lead to the development of an Australian national
curriculum in 1994 (Kimbell, 1997). The Hobart Declaration was the intermediate process that allowed the national statements to be drawn up according to agreed principles. In Queensland, ten years later, trialling of a syllabus heavily based on the national profile for technology model (Curriculum Corporation, 1994a) and the accompanying framework document (Curriculum Corporation, 1994b) was undertaken. It would seem from the experience of the author (a practicing primary school teacher of 15 years experience) that many teachers in the state of Queensland are as yet unaware of the scope of the KLA. It is, however, instructive to undertake a brief review of the current situation of technology as a Key Learning Area (KLA) in Queensland.

2.1.2 Queensland background

In Queensland a technology syllabus was formally released for implementation in schools in early 2003 (Queensland Studies Authority, 2003). Prior to this, a trial draft of the Years 1 – 10 Technology Key Learning Area Syllabus-in-Development (Queensland School Curriculum Council, 1999) was developed. This syllabus-in-development was trialled in late 1999, after which a more expansive pilot school phase was undertaken and subsequent editions of the syllabus-in-development produced. For the purposes of this research, where fieldwork occurred prior to the final syllabus release, the 2000 edition of the syllabus-in-development was used.

The syllabus-in-development was an outcomes-based student centred document that borrowed heavily from the National Profile for Technology (Curriculum Corporation, 1994), part of the deliberation on a national curriculum framework discussed in the previous section. In terms of structure it is divided into four strands (Technology Practice, Information, Materials, and Systems). These mirror the four strands of the National Profile for Technology (except that “designing, making and appraising” becomes “Technology Practice”). Each of the strands is divided into six
levels that represent progressions of sophistication in student abilities and understanding. The levels are described using a level statement that summarises the learning outcomes, as well as core learning outcomes that detail student achievements considered as essential to the syllabus. The final syllabus document (Queensland Studies Authority, 2003) is essentially similar, with some minor changes informed from the experience of school trials. The main structure and thrust of the final document remains the same as the syllabus-in-development used for this research.

To examine the roots of the syllabus and develop the context in which this research occurred, it is important that a number of recurring issues in technology education are examined. These issues emerged from the researcher’s reading of the literature and each will now be examined in turn in the following sections as indicated:

1. language problems (Section 2.1.3),
2. the dimensions of the discipline (Section 2.1.4),
3. the human element (Section 2.1.5),
4. the liberal tradition (Section 2.1.6),
5. why technology is not science (Section 2.1.7),
6. why technology is not craft/manual arts (Section 2.1.8),
7. the influence of science and manual arts (Section 2.1.9),
8. the design process (Section 2.1.10) and,
9. context (Section 2.1.11).

2.1.3 Language problems

One of the major difficulties with technology, it would seem, is that the term itself enjoys such wide and varied use throughout all sectors of the community that ascribing a specific meaning to the word is nigh on impossible. As noted by Cajas (2001), “the first
problem that one faces in studying the role of technology in general education … is the very meaning of the word technology” (p. 716) (italics in original). Benenson (2001) similarly argues that “definitions of ‘technology’ vary greatly in education” (p. 731) (punctuation as in original), including technology as computers, as a branch of vocational education or as an updated version of manual arts (‘shop’). He continues, “none of these positions begins to capture the wide range of artefacts, systems, environments and procedures that have been created by people to address their needs” (p. 731). Technology may mean modern appliances, organisational practices, traditional craft activities or even certain historical descriptions (e.g., stone-age technology) (Medway, 1989).

There has been a preoccupation with defining the KLA to the extent where “almost any text on the technology curriculum offers a definition” (Donnelly, 1992, p. 125). This does not necessarily clarify matters for, as Medway notes, “the term ‘technology’ itself is unhelpfully fluid and, unlike terms for many other disciplines, is not shared across languages” (pp. 3-4) (punctuation as in original). Claims have been made that there exists a need to employ a more appropriate linguistic label for the KLA, most notably the distinction which is made by the use of the German word ‘technics’ to denote engineering practice as opposed to engineering science (Cosgrove, 1999; Fores & Rey, 1989; Ropohl, 1997).

Such a debate in the context of this study, which will be employing a curriculum already defined as technology (see Section 2.1.2) is, however, of minor importance. It is recognised that a starting point must be an acknowledgment that defining technology unambiguously to an extent where all participants in the educational process are in agreement will be difficult. Some research also suggests that an alternative approach is needed which acknowledges that the KLA is different. As Stein (1998, p. 16) noted, “I had been trying to define technology as I have always defined other subject areas and the
paradigm does not fit!” Accordingly, a variety of definitions will be discussed further to elicit insights into the development of curricula in this area.

2.1.4 The dimensions of technology

While technology may be difficult to define in simple and unambiguous terms, there should be some agreement on what may be enacted within the classroom as technological activity.

Initially, one could accept the views of authors such as Medway (1989) and Kimbell (1994a) in describing technology as a multi-dimensional activity for, on this point at least, there seems to be consensus within the literature. The question that arises is exactly what are these dimensions?

A central feature of technology that should be included in any examination of the KLA is that of praxis, or practical activity, usually involving the use of tools (Allsop & Woolnough, 1990; Anning, 1994; Custer, 1990; Idhe, 1997; Lewis, 1991; Lewis & Gagel, 1992). While there may be some debate as to the extent to which such praxis should feature within a curriculum, there is no doubt that such practical activity should be included as a fundamental dimension of the KLA. Other common dimensions to discussions of technology include those of the creation of artefacts (Custer, 1995; Lewis & Gagel, 1992; Stein, 1998), the use of a process to achieve technological outcomes (Custer, 1995; Stein, 1998), the importance of design in achieving goals (Ankiewicz, 1995; Lewis & Gagel, 1992), communication of ideas (Anning, 1994), and the concept of “technological literacy” (Allsop & Woolnough, 1990; Barnett, 1995; France & Davies, 2001; Lewis & Gagel, 1992).
It is also important to delineate the boundary between technology and technology education. Gardner and Hill (1999) argue that technology education is that part of the curriculum concerned with helping learners become ‘technologically capable.’ Technologically capable is defined in terms of ability to identify human needs, to design and make appropriate products and to evaluate their quality and potential societal and environmental effects. Hill (1998) largely concurs with this understanding of technology education. An essential difference between technology and technology education may then be identified as awareness that the participants in a school setting are engaging with technology as part of a formal learning process, the primary goals of any activity being the development of student capability, rather than any specific technological outcome as such.

Of paramount importance to this study is the concept promoted by Kimbell (1994a) that the boundaries of technology are not set by any of the above dimensions, important as they are in assisting to focus on essential features of the KLA, but rather by human desires. He claims this involvement of a distinctly human element in technology should be recognised as a key defining feature of how technology is developed in the classroom.

### 2.1.5 The human element

The manner in which the terms curriculum or subject are often used in relation to technology seems to imply, that there exists within them, intrinsic value that is independent of human concerns. While the long history and established traditions of some KLAs have bequeathed them the status of entrenched value, the development of an area of learning such as technology is unique in that, while it may draw on a number of different traditions, it cannot be said to be a direct development of any one or another, and does not have a distinctive heritage. As noted by Kimbell (1995, p. 2), “its
antecedents are numerous and ancient.” Therefore, assumptions as to its content, mode of learning, emphasis, requisite skills or assessment cannot be made in terms of traditional KLAs. The curriculum is therefore undergoing a process of establishing its identity that is not to be achieved through the acceptance of traditional wisdom, but through human interactions and processes, for it is through the deliberation of meaning between participants that a shared understanding of what constitutes technology is achieved.

It should be remembered that technology is a substantially new KLA (Smithers & Robinson, 1994) and not a readjustment of an already existing KLA (e.g., Social Studies - Studies of Society and Environment [in Queensland context]) or the introduction of another tradition well established elsewhere (e.g., Languages Other Than English in the primary school). Rather it represents the first instance for most teachers where they will have to teach a KLA to which they have never been formally exposed. Even when teaching a KLA with which they may be uncomfortable (e.g., some primary teachers and science), all would at least have been exposed to the traditions of the KLA when attending schools themselves. Few such preconceptions are available with technology.

Teachers of technology will therefore find themselves in the unique position of delivering a KLA to their pupils that to a large extent will be defined not by tradition, but by themselves. This is the experience of what has occurred overseas. Lindblad (1990), in a study of Swedish teachers implementing a technology program, found that the teachers had to rely, in the absence of understanding of what the KLA was, on their own personal experiences. The KLA was thus defined by the teachers in classroom implementation. This is not an uncommon experience. Medway (1989) notes that until there is the development of a taxonomy of technology manifestations in schools, the educational outcomes of technology will be determined in part by the ad hoc enthusiasms of teachers. Davies and Rogers (2000) have also reported pre-service
teachers’ prior experiences and beliefs were significant in specific ways in their influence on lesson planning. A further restriction on the scope of technology within the classroom is that of lack of practical skills identified by Anning (1994), a situation most notable among a primary teacher population that is dominated numerically by women (approximately 88% in Queensland State Schools).

The style and scope of technology classes can also be heavily influenced by the teacher’s KLA background (Barak, Eisenberg, & Harel, 1995; Rennie, Treagust, & Kinnear, 1992), the latter authors also commenting on the narrow view of technology held by teachers of science. This is confirmed by Lewis and Gagel (1992) who conclude that conceptions of technology are value-based positions consonant with the academic position to which one ascribes. The work of Paechter (1992) also highlights how teachers’ prior knowledge and perceptions influence the way they define and implement technology education. These findings are important because, as noted by Lewis (1991), the values brought to the definitions of technology will “influence the way its content is defined, what goes in the curriculum, and how the subject is taught” (p. 144).

This essentially human quality of technology is also captured by Naughton (1994), where he identifies a key feature of technology as being human and social system involvement. In the example he discussed to highlight this point (the Apollo space program) he demonstrated how the defining of technology in terms of machinery is inadequate: Apollo was a supreme technological achievement primarily because of human factors involved in the program.

2.1.6 The liberal tradition

To understand the unique qualities of technology and the difficulties encountered in its implementation in the school system, an attempt will be made to establish what
relationships and influences other KLAs may contribute to the debate over the place of technology in the school system. To do so, it is instructive to first look at the Platonic conceptions of what constitutes valid knowledge, for the pervasiveness of these ideals is still evident.

The most influential of Plato’s dialogues in terms of its impact on western educational systems is undoubtedly the *Republic*, in which the stress on pure reasoning leaves no room for a systematic understanding of the world we experience (Annas, 1986). Despite the fact that in Plato’s later works he turns from producing a model of knowledge to asking what knowledge actually is, a change which results in less emphatic conclusions, the *Republic* remains the most pervasive interpretation of the Platonic world view (Annas, 1986). This influence is most instructive when one considers the western scholastic tradition of the liberal arts, which is heavily based on Platonic values.

The core of the liberal arts, which may be defined as directed to the general broadening of the mind and not professional or technical skills, is generally attributed to Augustine (Custer, 1990) and consists of two broad categories: the trivium (grammar, logic and rhetoric) and the quadrivium (philosophy, arithmetic, geometry and music). According to Custer, the original emphasis on the trivium in the Middle Ages was supplanted by heightened involvement of the quadrivium due to the incorporation of the emerging sciences in the Renaissance. The result of this enactment of Platonic philosophy has been to draw a line “between ‘pure’ and ‘practical’ knowledge” (Custer, 1995, p. 225), what is also termed as the “fractured inheritance” (Barnett 1995, p. 125).

It is, therefore, appropriate to examine how technology fits into the divide that exists between the practical and the liberal arts. To do so, an examination of why
technology does not fit into either of the paradigms to which it is most closely allied is illuminating.

2.1.7 Why technology is not science

Science is often seen to be the progenitor of technology, supplying the intellectual material for technologists to develop into utilitarian artefacts (Suzuki, 1990). The implication that follows is that technology is merely applied science, a subservient sub-branch of the discipline that does not merit a distinctive identity (Gunstone, 1994). This is a naïve approach (DeVries, 1997; Gardner, 1997), which is incorrect both historically, when one examines what has actually happened (DeVries, & Tamir, 1997), and in terms of a philosophical approach to the disciplines. Gardner (1995), for example, outlines the development of a number of technological artefacts which pre-dated scientific understanding of the problem at hand, perhaps most interestingly the use of the belly fur from an Australian rabbit in Chester Carlson’s prototype photocopier. Such a development could neither possibly have occurred through the application of known scientific principles, nor could have (to cite a few examples) the hot air balloon, the electric battery or vulcanised rubber (DeBono, 1974).

Indeed, as Raizen, Sellwood, Todd, and Vickers (1995) note, most of the technological developments that have irrevocably shaped the world in which we live, drew little from science. For example, the development of the steam engine in 1705 (Macquarie Library, 1983) preceded the initial development of thermodynamics by Carnot in 1824. It is evident that scientific understanding is not a necessary prerequisite for technological development, although in many circumstances such understanding may underpin the search for technological solutions.
On the other hand it should be noted that technological development may provide the means for scientific progress. For example, the development of the chronometer allowed scientifically accurate navigation and mapping of remote areas of the world (Sobel, 1996). Despite this, science is frequently seen in the gatekeeper role (e.g., university engineering course pre-requisite KLAS) (Gardner, Penna, & Brass, 1990), which is not necessarily warranted in light of the philosophical and practical differences between the two fields of endeavour.

While there is a degree of overlap between science and technology (Ropohl, 1997), they are quite different in their essential features. For example, the philosophical approaches of science and technology differ markedly, which Lewis (1991) explains in terms of the divergent objectives both seek. Science explains the world, he argues, while technology seeks to create a reality. The quintessential feature of technology, therefore, is seen to be praxis, or practice of an art. Smits (1988) also identified this demarcation between the theoretical and the practical that marks the distinction between science and technology, while Fensham (1990) utilises the work of Layton to contend that there are significant differences between the communities of science and the communities of technology. These differences include their ways of behaving, their ways of thinking and the problems they tackle.

The type of knowledge generated from the two activities also differs. Lewis and Gagel (1992) contend that the type of knowledge developed by scientific work is general in nature, while technological knowledge is quite specific. They use as an example the transport developed for use in Greenland, which would be inappropriate for Arizona, the point being that technological knowledge is situated and aimed at solving specific problems. The specific context of technological solutions can be considered to be a defining feature of technology; the creation of an artefact considered useful in a particular context. The end result in technology is therefore the creation of something
useful (Smithers & Robinson, 1994), whereas the end point for science is the understanding of phenomena (Gibson, 1993; Harrison, 1994).

2.1.8 Why technology is not craft/manual arts

From the above remarks regarding the creation of something useful, it might be inferred that technology as a KLA is underpinned by the manual arts tradition. Although this may be superficially true in that both may be focused on the development of artefacts, the explanation is inadequate for a number of reasons. Some of the features of technology which allow for the reader to make distinctions between technology and manual arts KLA’s may be surmised as:

1. The scope of technology is wide ranging while manual arts has a narrow focus on skill development.

2. Solutions to technological problems must be judged according to multi-dimensional criteria, including economic, social and environmental considerations, while this is not a necessary condition of manual arts.

3. Technology addresses human needs or wants, manual arts addresses skill development. (McCormick, 1990)

There are undeniable similarities between the two, most importantly the role of what Gardner (1995) terms ‘tacit’ knowledge in the creation of artefacts, but it is in the approach to the KLAs and their intentions which delineate them as separate bodies of endeavour. Technology is aimed at solving real problems, manual arts is aimed at developing specific manual skills. The distinction in this regard has been made by Allsop and Woolnough (1990), through the identification of differences between
traditional manual arts KLAs which trained students as technicians, and the new technology KLA which was directed towards a career as a technologist. A key difference seems to be the degree of intellectual respectability afforded through the removal of what might be termed the ‘workshop factor.’ This is what Banks (1994, p. 201) was referring to when he described how technology is:

more acceptable to the proponents of the liberal tradition than is craft
as they would value technology as an intellectual process applicable
in everyday life and across contexts.

He does, however, note the contentious nature of the last facet of the quote, and this issue will be discussed further in Section 2.1.11.

2.1.9 The influence of science and manual arts

While technology is neither of the entities outlined in the previous section, both have exerted powerful influences on conceptions and actual practice in technology education. The greatest influence has been on emphases within technology, whether it be the intellectual approach of science or the praxis approach of manual arts. In understanding the influence imparted by either approach, one must be cognisant of the traditions of western schooling which have dictated that manual arts occupies a low status in the educational hierarchy, being a place for the less intellectually gifted (Allsop & Woolnough, 1990; Archer, 1989; Down, 1989; Eggleston, 1994; Lewis, 1991), while the sciences have long occupied the elite status levels. This, it is argued, is due to the uncritical acceptance of the Platonic model of what constitutes valid knowledge, and practical knowledge is not to be recognised as such (see Section 2.1.6). This has led to some extraordinary statements such that technology may of necessity require a relationship with the sciences “if it is going to be taken seriously in the primary school”
(Smits, 1988, p. 24), although Smits does recognise that such an approach may restrict the KLA to the detriment of students.

A key feature of technology is a dynamic relationship between intellectual and manual skills, what Kimbell (1995, p. 12) terms “thought-in-action.” Many definitions of technology try to reflect this (Black & Harrison, 1994; Curriculum Corporation, 1994; Raizen et al., 1995), a typical example being from the Queensland Curriculum Council (2000a, p. 5) where technology is defined as:

(involving) envisioning and developing products that meet human needs, wants and opportunities and extend human capabilities.

Certainly there is evidence that different interpretations of such definitions lead, deliberately or inadvertently, to quite different outcomes under the banner of technology. As discussed previously, Lewis and Gagel (1992) identify a number of interpretations of technology that are reliant on the academic or disciplinary position to which one ascribes. This situation would seem to be in accord with Kimbell (1994a) who argues that teachers develop design technology tasks for their students which fit the picture they have in their heads of what technology is. Indeed, Ritchie and Hampson (1996) argue that the success of implementing design technology programs may be correlated to teacher background. This finding would also seem to be consistent with Jane and Jobling’s (1995) contention that teachers are lacking in confidence to introduce design technology into their classrooms because of limited conceptions of how to teach and learn the KLA.

This apparent inconsistency within the profession regarding technology may be ascribed to the lack of a long tradition of philosophy and methodology within the curriculum area (De Vries & Tamir, 1997), a situation which must pose difficulties in
making reasoned assessments as to its domain. De Vries and Tamir also argue that the epistemology of technology in education is by no means fully developed, which will need to be addressed if some degree of uniformity of approach is to be achieved. The challenge for teachers, therefore, is to implement and assess a philosophically embryonic curriculum without clearly delineated guidance. This was a problem identified by Hendley and Lyle (1996) in the implementation of a design technology curriculum in the United Kingdom.

As described above there is some degree of consensus as to definitions of technology from an educational perspective, but it should be apparent that these definitions should, at most, be regarded as working definitions. Jones (2001) contends that there are actually multiple communities of practice, such that we have “technologies, not just technology” (p. 5) (italics in original). This, he writes, “implies that there is likely to be a considerable amount which is not common across technologies” (p. 5). In the context of this research, this would further complicate the conceptualisation of technology by teachers unfamiliar with the curriculum area.

Technology represents a paradox to educational institutions and educators for, while it has elements from accepted and long standing curricula, it is not sufficiently like any of them to permit easy categorisation. Rennie (2001), for example, considers that even years after the introduction of technology into Australian schools “the shape of technology education is amorphous” (p. 50). This raises a number of fundamental questions, such as who will teach the KLA, the context in which it is taught, the resources that will be required, how it will be assessed and its relationship with other curriculum areas.

As a preliminary conclusion it may be surmised that technology is neither a body of knowledge to be learned, nor is it a set of pre-requisite skills to be demonstrated, but
rather it is a dynamic interplay between these two within a specific context with the aim of creating useful products or processes. The nebulous nature of technology is self-evident from such a definition that lacks the rigidity of curriculum identification associated with more traditional disciplines. To come to any understanding of technology requires one to investigate the processes that occur in an educational context, principal among these the design process. Hansen (1997) notes that by focusing on design, technology is linking itself to general cognitive abilities rather than practical skills, very much in the liberal arts tradition. He therefore argues that meaningful experience, rather than expertise should be at the centre of a liberal technology curriculum. Pendergast (1999) argues that students should not, however, see technology as a purely mental process. The dilemmas of the KLA are yet to be resolved, summed up in Rennie’s (2001, p. 50) stark comment about some of the issues associated with technology education:

At the primary schools level the Technology Learning Area has no curriculum history, there is no established body of content, proven pedagogical practice, or assessment strategies.

2.1.10 The design process

Any understanding of technology should involve an examination of the design process undertaken by students for, as outlined previously, it is this interactive process between intellectual and manual skills that is, for some researchers, the defining feature of the KLA. Indeed, some authors (Pendergast, 1999) would place the process component (with design as a key element) at the core of any technology curriculum, while others (Medway, 1989; Eggleston, 1994) simply state that design is at the centre of technology. There is, indeed, a degree of consensus regarding the importance of design to the characterisation of technology (Lewis & Gagel, 1992; Mioduser, 1998).
Others discuss the possibility of the design process offering a generic approach to the teaching of technology as a human process of problem solving (Rennie et al., 1992). However, there is no “Holy Grail” of design process (Johnsey, 1995; Norman, 1998), and there is particular concern that design processes may be viewed as a linear sequence of events that follows clearly identifiable stages. Figure 2.1 is an example of a linear sequence involving various elements of technology practice in the classroom.

![Figure 2.1. Example of simple linear model (adapted from Assessment of Performance Unit, 1994).](image)

The literature does not support the idea of such linear approaches which may be inferred by some by oft used phrases such as “design, make, appraise” (or similar) when discussing the design process (Davies, 1996; DeVries & Tamir, 1997; Donnelly, 1992; Hill, 1998; McCormick, 1997).

The process may be considered as cyclic, iterative or recursive in nature (Queensland School Curriculum Council, 1999; Figure 2.2), an interaction between “mind and hand” (Assessment of Performance Unit, 1994; Figure 2.3), an interrelated process involving several planning-making-testing loops (Ritchie & Hampson, 1996), or an interacting design loop (Kimbell, 1997; Figure 2.4) with the goal of creating a product. Fleer (2000a) found that children in the study she undertook did not necessarily use designs when making but, rather, “the materials themselves suggested what they should make” (p. 56), a suggestion that indicates conceptions of design in technology may need to be reassessed.
To do other than to accept the above more flexible interpretations, according to Pendergast (1999), does not do justice to the contribution technology can make to the curriculum, and may lead to a situation where a single process is blindly followed without understanding, a situation termed “design fixation” by Mayo (1993, p. 49). It is also evident that the assessment of products does not constitute an assessment of the process (Jones 1994), as will be discussed later, and that the role of design in the curriculum is diminished if such an approach is taken. Jones (1994) also identifies, for example, what may be called an artefact focus that is the result of emphasis on end products that inhibits problem solving. Barlex (1994, p. 78) likewise contends that:

> although pupils produce outcomes (artefacts, systems and environments) as the most obvious end product of design and technology in schools in trying to meet the needs and grasp opportunities it is the intentions (meeting the need or grasping the opportunity) and the procedural competencies developed and utilised in response to those intentions which are.

This does not, however, diminish the difficulty of identifying and, as a consequence, assessing the design process. McCormick, Murphy, and Hennessy (1994) when discussing problem solving in design technology, contend that the observer has great difficulty in identifying the specific processes that are occurring. This is compounded by observations such as those by Mayo (1993) that no design works unless it embodies the ideas that are held in common with the people for whom the design is intended. The obvious concern that must arise from this is the validity of assessments regarding such processes.

Another important discussion revolving around the design process is that of the role of context. De Vries and Tamir (1997) contend that at a minimum there is always a
situational aspect that must be taken into account, while McCormick (1997) forcefully argues that context and domain must not be considered secondary or irrelevant when compared to procedural knowledge, and that it is the relationship between the three which is central to an understanding of the design process. The critical question that arises from the issue of context is whether the skills involved in the design process are transferable, which should be of concern to educators developing teaching programs.

Figure 2.2. Ways elements of a technology process may interact (adapted from Queensland School Curriculum Council, 1999).

If technology educators consider real life activities as an essential component of classroom practice, then it is imperative that the practice of professional technologists undertaking design activities is examined. Once again there is a large degree of uncertainty regarding basic assumptions. Mayo (1993), for example, poses similar questions to that related to school technology when discussing the profession of design. He questions whether design is an identifiable field of endeavour, that the understanding of the design process itself is simplistic and doubtful in its extent and that the concept of the designer as sole creator of a product is a myth.
In relation to the first of these points, Walker (1990) considers that the difficulty in defining design relates to the fluctuating meaning of the word ‘design,’ a condition which raises questions regarding the applicability of the phrase ‘design, make, appraise’ which is commonly found in Australian curricula. Understanding of design processes is also problematic due to the almost unlimited “degrees of problem” (Kimbell, 1982) inherent in any problem, the qualifications imposed on the design (e.g., cost, materials, timeframes) defining the exercise. While not defining what the design process is, Mayo (1993) outlines seven key factors of a total approach to design, four of which directly relate to qualification of a design, namely: purpose; systems awareness (what other
elements bear on the solution); people (involve those connected with the problem with the solution); and change (build into the solution provision for future change).

![Diagram of an interacting design loop](adapted from Kimbell, 1997).

The process of design therefore may look chaotic because of the need to accommodate such qualifications (DeVries, 1997). For example, in a study of designing cultures, it was found that the mechanical engineers studied did not follow any design protocols, but worked back and forth from the general to the specific, working on a number of different features of a design simultaneously (Henderson, 1998). Hennessy, McCormick, and Murphy (1993) would also seem to concur with Mayo’s third key factor regarding individual endeavour of a designer, for although school is usually characterised by individual work and assessment, this is not the case outside school where sharing and negotiated meaning is the norm. Rowell, Gustafson, and Guilbert (1999) in their study of engineers’ perceptions of technological problem solving as a
parallel to technological problem solving in the classroom similarly identify that “understanding emerges from participating in interaction with a problem situation, most often in a social setting” (pp. 115-116). Davies (1996) reaches a similar conclusion in his study of professional designers working with school students, and emphasised the need for active engagement in real design projects.

Hennessy et al. (1993), and Hennessy and McCormick (1994) also identified discrepancies between school and real world work such as the incentives for working (artificial versus authentic), definition of problem (clearly defined versus poorly defined) and methods (reliance on pure thought versus active engagement with real world) (school examples former, real world latter). Although these authors were not specifically addressing design in this regard, the implications for technology, with its reliance on an active and authentic interaction with real world problems, are significant in that there may be difficulties identifying what technology in schools may/should look like.

An attempt to grapple with the difficulties encountered in understanding the design process may be seen in the use of the engineering profession as a model of technological practice (Gunstone, 1994; Rowell, Gustafson, & Guilbert, 1999). This may be seen as an attempt to define the context of the tasks in terms of what type of authentic activity is to be emulated for, as will be discussed below, the context of activities within a technology classroom has a large impact on the teaching, learning and assessment which occurs. The observation by Norman (1998) that a designer who is competent in one field of endeavour does not necessarily have the skills in another indicates the necessity to posit all conclusions regarding design ability in context. Further, as noted by Hennessy and McCormick (1994, p. 99):

what problem solvers of all ages in everyday and workplace situations actually do and know depends on the context in which
they are asked to work, and bears little relation to what goes on in the average classroom.

Another aspect of the design process that requires investigation is that of the role of drawings to develop and communicate ideas. While there has been some research undertaken on drawing in technology (Anning, 1994; Smits, 1988; Stables, 1995; van Harmelen & Boltt, 1999; Welch, Barlex, & Lim, 2000), the role of drawing in the classroom is yet to be clarified. While drawings are an essential part of graphical architecture and industrial design (Gibson, 1993), the appropriateness of drawings in the classroom has been questioned. Welch (1999, p.19), for example, found that, “novice designers do not design in the ways described in textbooks,” but, rather, develop their ideas through 3-dimensional models. Johnsey (1995) even questions whether drawings are necessary, and asks what their true function actually is.

Drawing in the classroom appears to be another aspect of “the most under researched area of the curriculum” (Gradwell, 1996, p. 239), leading to calls from authors such as Norman (1998) that “the highest priority for design researchers in this area remains the documentation and analysis of existing practice and knowledge” (p. 84). The reality of how students design in the classroom is, therefore, an area of research in technology that needs to be addressed, particularly the manner in which they may be asked to envision their design ideas through drawings.

In a fascinating article by Brown (2000), the differing contextual influences present in Great Britain and United States are examined in relation to communication through engineering drawings. It is apparent from his study that design drawings are not a universal language but, rather, must be interpreted through the context from which they emerge. It is also clear that the influence of context goes beyond a classroom/real world dichotomy, and part of the challenge of technology will be to develop within
differing contextual constraints. The implications for assessment in this regard will be addressed in subsequent sections.

2.1.11 Context

The context in which learning occurs can affect what is learnt, how it is taught and how it is assessed. Technology education, because it encourages the use of authentic activities that reflect real life approaches (there is certainly evidence that pupil performance is more effective when located in a real or contextual framework [Kimbell, 1994a]), must first of all identify what those real life approaches are.

The history of technology suggests that learning could occur in a number of diverse contexts - science laboratory, workshop, craft rooms, home economics classes or general learning classes - which do not necessarily allow such authentic activity to take place. Indeed, school activity takes place in the culture of a school, and the activities students undertake are not the same as those of practitioners (Brown, Collins, & Duguid, 1989). Even if it is possible to identify which particular practitioners (e.g., engineers, graphic designers, chefs) technology is to model activities on, there is a loss that occurs in transference to the classroom, which removes important contextual features (e.g., motivation, culture of workplace). Brown et al. suggest the use of a cognitive apprenticeship model to teaching whereby teachers make explicit their tacit knowledge, or model their strategies for students in authentic activity. They then support students’ attempts at doing the task through scaffolding their activities and thinking.

Herein lies one of the crucial problems in technology for, as previously noted, teachers hold a variety of conceptions as to what technology is and, therefore, presumably a wide range of ideas regarding what constitutes authentic activity. This must inevitably lead to the creation of a wide spectrum of contexts in which learning
takes place which is not necessarily conducive to the development of technological capability for, as noted by Jones (1997b), an appropriate classroom setting is crucial for the development of student learning. Jones also noted that student expectations of what they should be doing in a particular setting influenced the approach they took and what knowledge and skills they operationalised in a particular activity. The context of the classroom, therefore, needs to be examined as to how it may influence students, and what might be appropriate settings.

In a primary classroom the teacher must necessarily determine the most important influences on the setting and, therefore, the context in which an activity takes place. As noted by Linblad (1990) in a study of Swedish teachers (previously discussed), where there was uncertainty as to what technology might be, teachers utilised their own prior experiences to interpret and implement the KLA within their classrooms. It is apparent that one of the consequences of this was that students with different teachers may experience quite different forms of technology education. A question that must arise from this is whether assessments made under these conditions can be regarded as reliable indicators of student achievement between contexts.

It is evident that a more coherent idea of exactly what is meant by context within a classroom should be developed for, in defining context, one is defining to a large degree the meaning of the activities to be undertaken (Kimbell, 1997), and that pupil performance can only really be understood in terms of the context in which it occurs (Kimbell, 1994a). Context may be initially defined in terms of its etymological roots, for this provides a useful insight into how classroom context might be viewed conceptually. The Australian Concise Oxford Dictionary (Turner, 1988) cites the Latin contextus as the root of the word, with textere or text meaning to weave being the derivation of the word. The key point of such a definition is the association it makes with the concept of connection between things, for in a technology classroom it is the connections one
makes between things that make good technological practice (see Section 2.1.4). One of the key identifying characteristics of technology is this synthetic approach to problems (Fensham, 1990) where “(technologists) are interested in putting nature together in order to make something novel” (p. 9).

An examination of how teachers develop and understand contexts to deliver learning programs is one avenue to identify their perceptions of technology and, as a consequence, their perceptions of capability in relation to activities within the classroom. For example, McRobbie, Ginns, and Stein (1999a, 1999b) in their studies of pre-service teachers’ understandings of technology found large variation in what their participants considered as technology. Responses ranged from global definitions which identified technology influencing all aspects of human life, to very limited conceptions such as “technology means computer, television, video and spaceships” (1999b, p. 6). Other students placed importance on negative implications of technology, describing modern day technology as “a totally destructive thing” (1999b, p. 9). Tairib (2001) also noted that pre- and in-service science teachers needed help to develop a better understanding of technology. As it has previously been noted that a teacher’s background influences how he/she interprets and implements technology, it could be surmised that the connections made in the classroom which create the context of an activity must also vary markedly.

As noted by Brookfield (1987), context affects the behaviour of participants in a setting such that “practices, structures, and actions are never context free” (p. 8). Therefore, variation between contexts may influence the value that is given to certain capabilities. Regardless of this, it is evident that the contextual variables in the classroom influence what students achieve (Anning, 1994), an important consideration for all teachers of technology in general, and this research in particular.
2.1.12 Summary - Technology

Section 2.1 posited this study in the framework of a curriculum area that is not well defined. It concluded that this was due, in part, to the short history of the KLA in a classroom context, in conjunction with its novel attributes. The dimensions of technology were discussed in the absence of an agreed definition, and its relationships to other, more established curriculum areas were also discussed. A key feature of technology was its reliance on human elements for interpretation of the KLA, as was the design process. Such design processes were seen to be a defining feature of the KLA. The contextually dependent nature of technology, and the importance of context to classroom interpretation, was also discussed. It was concluded that technology was a developing curriculum with its own particular characteristics.

2.2 Assessment

Traditional assessments, such as the written test, may not have applicability to the particular features of technology outlined in the previous section. In this section of the literature review alternative assessments are examined. It emerges that such assessments, while having certain weaknesses, have suitable characteristics in terms of the aims of technology curricula. The purpose of this section is to broadly examine alternative assessments, with a particular focus on technology education.

Assessment is an aspect of schooling which, having long traditions within the education community, has achieved the status of an entrenched value within certain sectors in a similar manner to well established curriculum areas (see Section 2.1.4) The similarity is not coincidental, for the relationship between curriculum and assessment is not a passive one, and the two cannot be viewed as mutually independent areas of the
education process. Moreland and Jones (2000), for example, noted that in New Zealand, “coherence is yet to develop between the technology curriculum document’s achievement objectives, learning outcomes and assessment procedures” (p. 284). It is essential, therefore, to ascertain the nature of assessment and how it relates to a technology curriculum.

The elaboration of various constructs of assessment will be followed by an examination of why assessment is undertaken and a comparison of alternative methods to traditional methods such as multiple choice testing. Alternative assessment methods, it will be argued, are more congruent with the aims of a technology curriculum, and a more in-depth examination of their structure, implementation and implications will be undertaken. The difficulties in implementing alternative assessments will also be addressed.

2.2.1 What is assessment?

Assessment, on first examination, would seem to be a reasonably clearly defined practice with beneficial results for students. Neither conclusion is strictly correct in practice. A number of authors pose definitions that suggest assessment is a clearly defined activity. For example, assessment is:

A continuous process of collecting and interpreting information in order to assess decisions made in designing a learning system.

(Streumer & Doornekamp, 1989, p. 191)

Or,
The process of obtaining evidence of student achievement or competence and the act of interpreting or describing students’ achievements. (New Zealand Ministry of Education, cited in Compton & Harwood, 1999, p. 4)

The broad sentiment would seem to be that somehow a determination of student achievement is to be made. It is, however, limiting to assume that such a process is either easily defined or carried out, for there are a number of fundamental difficulties which are inherent in such understandings. The first of these is the motivation behind assessment. As teachers are all too well aware, assessment takes up a considerable amount of their classroom time (up to 30%, according to Stiggins, 1988) and may utilise a wide array of methods to achieve teachers’ goals. Despite this, it is quite possible that assessment practices have a considerable negative impact upon classrooms in terms of effective learning (Black, 1998). Why then do teachers persist with certain assessment methods? It would seem that the tradition of assessing is the main culprit for, as Eisner (1993) notes, “the term assessment is more an aspiration than a concept that has a socially confirmed technical meaning” (p. 219). To come to any understanding of assessment it is probably inappropriate to seek an unequivocal definition, rather it may be more useful to examine why assessment is undertaken. It may then be possible to see whether the aspirations of assessment are met by the practices.

2.2.2 Why assess?

There is a reasonable degree of consensus in the literature regarding the purposes of assessment. There are inevitable differences in emphasis but the essential features are quite similar. For example, the purposes may be defined as:
educational temperature taking, gate keeping, determining whether course objectives have been obtained, providing feedback to teachers and focusing on the quality of the educational programs. (Eisner, 1993, pp. 224-225)

or,

diagnosis, improving instruction, evaluating programs, accountability. (Fisher, Roach, & Kearns, 1998, p. 1)

or,

shaping subsequent teaching, accountability and comparability. (Newton & Hurn, 1996, p. 138)

or,

instructional feedback, accountability. (Mitchell, 1995, p.10)

Moreland and Jones (1999) and Jones, Moreland, and Northover (1999) also accept similar definitions as the basis for their studies, while Jones (1997a) and Mitchell (1995) are perhaps more to the point when they note that assessment gives out messages about what is important. It should also be pointed out that, in the Australian context, assessment and evaluation have differing meanings, assessment referring to students, while evaluation refers to judgment of teaching programs. To surmise from the above, one is drawn to two important conclusions. Firstly, that the purposes of assessment fall broadly into the realm of either classroom instruction or systemic accountability. The second is that traditional methods of assessment that incorporate a heavy emphasis on
norm referenced, closed option tests are usually intended to fulfill accountability purposes through the use of testing with high degrees of reliability. Further, some researchers (Filer, 2000, p. 84) conclude that what are regarded as formal, “apparently objective assessment results can be the products of earlier informal, subjective assessment and the differentiating processes that these earlier assessments set in motion” (italics in original).

The question has to be asked as to how formalised assessments of a technology curriculum with an emphasis on the creation of open-ended solutions to real life problems will occur. It will be contended here that what may be regarded as traditional (formal) assessment techniques are not appropriate and that alternatives must be sought. Assessment in technology requires teachers, therefore, to “recognise the effort and imagination that has been applied to modeling processes, not purely make valuative judgments about any final two-dimensional or three-dimensional models that result” (Davies & Elmer, 2001, p. 167).

2.2.3 Alternative assessments

As noted in the first section of this literature review, the technology curriculum about to be introduced in Queensland is quite unlike other traditional curriculum areas. It may, therefore, be wishful thinking to assume that a KLA area which does not fit into any of the existing long standing curricula traditions will be assessed using methods already in place for other disciplines. What can be safely assumed, considering the emphasis on praxis found in technology (Anning, 1994; Allsop & Woolnough, 1990; Custer, 1990; Idhe, 1997; Lewis, 1991; Lewis & Gagel, 1992), is that a traditional pencil and paper written test will neither assess the capability of students, nor will it enable teachers to be truly accountable for the programs they deliver. Such assessments do not
fulfill the purposes of assessment outlined above as a consequence. A more in-depth examination of the alternatives is thus required.

As with many aspects of this research, it is first necessary to define the language used. In this case the term alternative assessment enjoys a currency in the educational literature (Duschl & Gitomer, 1993; Hart, 1995; Mitchell, 1995), although it is an umbrella term that covers a range of assessments. They may be termed authentic, performance-based, non-traditional or portfolio, but it is argued that the distinctions between them are not significant (Hart, 1995; Mitchell, 1995). It is more instructive to look at what alternative assessments share, how this distinguishes them from traditional approaches to assessment, and why this makes them more suitable when considering an assessment technique for technology education.

To create a framework for the discussion of alternative assessments, it is relevant to identify some definitions of what constitute these alternatives. Thus performance assessment may be seen to be:

- assessment which focuses on evaluating examinees ability to apply or to use their knowledge to solve a problem or accomplish a task that has relevance either to the world outside of school or in facilitating learning in future academic settings. (Sudweeks & Clay, 1995, p. 2)

or,

- a broad set of strategies that allows an examiner to observe what a student knows and can do when confronted with problems in context. (Shymansky et al., 1995, p. 4)
While portfolio assessment may be identified as a systematic collection of students’ work (Popham, 2002, p.199) or:

a purposeful collection of work that serves as an exhibit of individual efforts, progress and achievements in one or more areas. (Wiedmar, 1998, p. 586)

or,

(giving) students the opportunity for creativity in designing their portfolios to demonstrate their progress in the course (of work). (Robinson, 1998, p. 318)

And authentic assessment:

(is where) knowledge ... is displayed as thoughtful know-how – a blend of good judgment, sound habits, responsiveness to the problem at hand and control over the appropriate information and context. (Wiggins, 1989, p. 705)

From the above conceptualisations of alternative assessments it is possible to ascertain a broad thrust of student-centred problem solving. There are a number of fundamental and subtle implications in the use of alternative assessments in the classroom. Whatever terminology is used for these alternative assessments, they all share a common grounding in the “active student production of evidence of learning” (Mitchell, 1995, p. 2). Salvia and Ysseldyke (2001, p. 236) identify three common goals of such alternative assessments; firstly, such assessments emphasise a more direct
examination of student performance, secondly, they seek to improve the validity of assessment by basing it on student performance; and, finally, they seek to link assessment and instruction more directly.

The following table (Table 2.1) is a survey of the contrasting perspectives that delineate a culture of traditional assessment models from alternative models. It should be noted that the aspects listed in either column are neither exhaustive nor essential to any interpretation of a particular assessment model, but reflect philosophical and educational reference points from which to examine practice. The table has been developed by the author to illustrate various reference points in relation to the purpose, learning theory, power relationships, curriculum and measurement associated with two contrasting styles of assessment. This table is used in subsequent sections to highlight issues of relevance to this study.

2.2.4 Implications of alternative assessments

From Table 2.1 it is possible to identify a number of issues regarding alternative assessments that require further investigation and are of significance in technology education. Most notably, these are the human element in assessment, the use of criteria, outcomes-based frameworks, curriculum and instruction, context and difficulties with alternative assessments. Each of which are now discussed in turn.

2.2.4.1 The human element in assessment

As can be seen in Table 2.1, there are changes to the assessment process when utilising alternative assessments. Significant changes in this direction include the permitting of students to select material to be assessed (Baron, Johnson & Acor, 1998),
<table>
<thead>
<tr>
<th>Traditional assessment</th>
<th>Alternative assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>Sorting, ordering and grading</td>
<td>Empowering, informing and providing complex feedback (Shymansky et al., 1995)</td>
</tr>
<tr>
<td>Monitoring institutions</td>
<td>Monitoring students (Resnick &amp; Resnick, 1985)</td>
</tr>
<tr>
<td>Monitoring standards</td>
<td>Setting standards (Wiggins, 1989)</td>
</tr>
<tr>
<td>Conservative</td>
<td>Reforming (Clark &amp; Clark, 1998; Mitchell, 1995)</td>
</tr>
<tr>
<td><strong>Learning theory</strong></td>
<td><strong>Learning theory</strong></td>
</tr>
<tr>
<td>Deficit model</td>
<td>Growth model (Duschl &amp; Gitomer, 1993; Jones et al., 1999; Wiggins, 1989)</td>
</tr>
<tr>
<td>Individual focus</td>
<td>Cooperative focus (Eisner, 1993)</td>
</tr>
<tr>
<td>Situation free knowledge</td>
<td>Knowledge situated (Eisner, 1993; Wiggins, 1989)</td>
</tr>
<tr>
<td>Cognitive based</td>
<td>Multiple ability based (Eisner, 1993; Kulieke et al., 1990)</td>
</tr>
<tr>
<td>Unreflective</td>
<td>Reflective/Introspective (Robinson, 1998)</td>
</tr>
</tbody>
</table>
Table 2.1 (continued)

<table>
<thead>
<tr>
<th>Power relationships</th>
<th>Power relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher controlled</td>
<td>Control shared with students (Duschl &amp; Gitomer, 1993)</td>
</tr>
<tr>
<td>Limited student choice</td>
<td>Student choice increased (Baron, Johnson, &amp; Acor, 1998)</td>
</tr>
<tr>
<td>Responsibility for learning with teacher</td>
<td>Student responsibility for learning (Kulieke et al., 1990; Robinson, 1998)</td>
</tr>
<tr>
<td>Extrinsic motivation for learning</td>
<td>Intrinsic motivation (Skinner, 1999)</td>
</tr>
<tr>
<td>Teachers ‘own’ assessment material</td>
<td>Students ‘own’ assessment material (Anderson, 1996; Popham, 2002)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline based</td>
</tr>
<tr>
<td>Artificial problems</td>
</tr>
<tr>
<td>Inert intellectual material</td>
</tr>
<tr>
<td>Curriculum limited</td>
</tr>
<tr>
<td>Knowledge based</td>
</tr>
<tr>
<td>Text book knowledge</td>
</tr>
<tr>
<td>Measurement</td>
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<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Simple</td>
</tr>
<tr>
<td>Quantitative</td>
</tr>
<tr>
<td>Narrow based</td>
</tr>
<tr>
<td>Limited perspectives</td>
</tr>
<tr>
<td>Atomistic</td>
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<tr>
<td>Limited correct solutions</td>
</tr>
<tr>
<td>Norm referenced</td>
</tr>
<tr>
<td>Standardised</td>
</tr>
<tr>
<td>Cross sectional information</td>
</tr>
<tr>
<td>Tests ‘secret’</td>
</tr>
<tr>
<td>‘Objective’ measurement</td>
</tr>
<tr>
<td>‘Teaching to the test’ discouraged</td>
</tr>
<tr>
<td>Test concludes instruction</td>
</tr>
<tr>
<td>‘Top down’ assessment</td>
</tr>
<tr>
<td>May be limited to solo performance</td>
</tr>
</tbody>
</table>
although this will undoubtedly be influenced by teachers and their expectations. Findings that relate to this have been reported (Jones, 1994; Jones 1997a, b; Jones & Compton, 1998), and it is concluded that student expectations of what were appropriate outcomes in a particular setting or context influenced how they approached the KLA. Such contextual influence must, in part, be ascribed to the input of teachers. It must therefore be surmised that teachers will influence the selection of material indirectly, despite claims of student autonomy in this matter.

Studies on formative assessment of technology in the classroom (Jones et al., 1999; Jones, 1997a) have demonstrated that the subculture of teachers’ backgrounds affects how they assess work, while the work of Black (1998) on formative assessment contends that teachers may in a similar manner restrict, usually unconsciously, the learning of pupils by teaching to attain desired answers. Clearly this must be taken into account when addressing assessment issues in technology education.

The implication of the above findings is that there is a subjective element in teachers’ assessments (Newton & Hurn, 1996). This would seem to be an essential realisation if one is to contemplate the use of alternative assessments. Effectively using the subjective nature of these assessments may lie in developing communication channels between teachers (Baron et al., 1998; Duschl & Gitomer, 1993; Jones & Compton, 1998; Jones et al., 1999; Kimbell, 1994a; Wiggins, 1989), and between students and teachers (Daws & Singh, 1999; Hodgeman, 1997). The preeminence of human interaction to describe assessment outcomes is firstly attained through describing and negotiating criteria for making judgments about student achievement.
2.2.4.2 Use of criteria

Duschl and Gitomer (1993, p. 9) describe what they call “criteria driven assessment conversations” to recognise a process within a classroom whereby students and teachers engage in discussions that are directed toward particular outcomes. Alternative assessments, because of the requirement that they articulate to students the standards by which they will be judged, are usually defined by the use of clearly stated criteria (Fisher et al., 1998). Such criteria should be both meaningful and demonstrable to teachers (Benoit & Yang, 1995) as well as being known and understood by students (Wiggins, 1989). There is, once again, an interplay between students and teachers to address the issue of criteria used in assessment which is not as simple as traditional assessment regimes because of the multiple outcomes possible in such frameworks (Popham, 2002). The end result with the use of criteria is, however, to attain a clarity of purpose (Erickson, Bartley, & Carlisle, 1993) whereby effective feedback is provided to students through identified learning outcomes (Jones et al., 1999).

It will be contended here that there is insufficient research regarding the interpretation of criteria and outcome statements for assessment in technology education and, as such, one of the prime concerns articulated in the objectives of the research is the investigation of this issue, which is central to an outcomes-based approach to technology education.

2.2.4.3 Outcomes-based frameworks

The Queensland Syllabus-in–Development (Queensland School Curriculum Council (QSCC), 1999) for technology was developed as an outcomes-based approach to learning. As such, there are assumptions made as to the nature of learning
and assessment that underpin the outcomes described in the document. This approach is described in the following terms (Queensland School Curriculum Council, 1999, p. 49):

(an outcomes approach to learning is…) an approach that accepts that learning is progressive and that stages along the continuum, leading to the desired endpoint of learning, can be identified. It emphasises the provision of developmentally appropriate experiences which give students opportunities to learn and demonstrate their learning. Outcomes are designed to extend students’ expectations of what they can do. All students should be given sufficient time and support to demonstrate the outcomes consistently, and in a range of contexts.

An examination of this definition indicates that it is grounded in generally accepted views of what constitutes outcome-based education. The key features that are indicative of such an approach may be found in the literature (Eisner; 1993; Gipps, 1994; Jones et al., 1999; Wiggins, 1989) and, as such, it is instructive to undertake an examination of these characteristics.

The first issue to examine is that of identification of student progression through stages. Such stages are indicated by the structure of outcomes-based frameworks, such as those outlined by Willis and Kissane (1997) with regard to Scotland, the UK, Australia and the USA, where each system has a clearly defined progression through increasingly demanding stages. The technology syllabus-in-development utilised for this research is such a system, having been developed largely from the Australian National Curriculum discussed by Willis and Kissane (see also Section 2.1.2).
The second point regarding the assumption of being able to identify the stages is more ambiguous. The key issue in relation to this matter seems to be the ability of teachers to recognise student performance as meeting the criteria for successful attainment of an outcome. Glover and Thomas (1999), for instance, state in the South African experience of teachers implementing an outcomes-based science curriculum that “teachers must become adept at perceiving clues to a learner’s thinking by observing science activities closely” (p. 1). In this statement lies one of the most persistent criticisms that is aimed at outcome-based assessments; that they are “no more than teachers’ arbitrary assignment of grades based on their own subjective criteria” (Baron & Boschee, 1996, p. 3).

In response to this, it is argued that singular evidences of achievement are incompatible with such a framework. Furthermore, a teacher cannot know what outcomes are achieved or how far a learner has progressed towards an outcome without assessing continuously (Glover & Thomas, 1999). The validity of assessments is obviously in question if such criticisms are not addressed. Marzano (1994) argues that validity may be obtained providing that a diversity of information is obtained and that the various proficiencies measured within a given task are independent of each other. Such validity is reliant on teachers developing a shared meaning and a commitment to the outcomes so that their professional judgment with respect to them is enhanced (Willis & Kissane, 1997).

The issue of providing developmentally appropriate experiences for students through their advocacy of flexible instructional design and delivery that better match the differences in student learning rates and aptitudes is an important one (Spady & Marshall, 1991). This issue is fundamentally connected with the concept of sufficient time and support being given to students in that it is recognition of the individual needs of students.
The provision of opportunities to learn and demonstrate learning is a recurring theme in the literature. Spady (1994), who is a leading figure in the outcomes-based education movement in the USA, describes stipulated outcomes as “high quality, culminating in demonstrations of significant learning in context” (p. 1). He, and others (Brandt, 1992/93), emphasise that content in itself cannot be an outcome, but must be shown through a demonstration of the utilisation of knowledge. O’Neil (1994) utilises the analogy of a pilot to indicate the importance of demonstration of competency; a pilot is required to demonstrate his/her facility at flying, just as a student should demonstrate the outcomes society holds to be important – it is not sufficient to be able to know content, one must demonstrate its use. Baron and Boschee (1996) and Boschee and Baron (1994) similarly concur that a student’s progress is based on demonstrated achievement.

A common critique of outcomes-based frameworks is that they lower expectations of students and, as a consequence, lower standards within the school system (Baron & Boschee, 1996), chiefly through a shifting of teacher expectations from content to more affective domains (Pliska & McQuaide, 1994). This is disputed in the literature (Brandt, 1992/93; Hettinger; 1999; Spady, 1994), where it is contended that, for example, the requirement of high quality and complete demonstrations actually raises the expectations of students.

Spady (1994) noted, in this regard, that traditional assessment practices accept and label all student performances whether complete or not. One of the aspects of the QSCC (1999) definition cited above is the expectation of sufficient time being given to students to attain their goals. This is, once again, a recurring theme in the literature. Spady and Marshall (1991), for example, identify three premises on which outcomes-based education is founded. The first of these is that “all students can learn and
succeed (but not all on the same day in the same way)” (p. 1). A similar theme was also identified by McGhan (1994), Baron and Boschee (1996) and Boschee and Baron (1994). The premise underlying such an approach is that student performance, and not time, is a key feature in the delivery and assessment of classroom programs.

A further expansion on the idea of increasing expectations and opportunities for students is that classroom activities must take place in a range of contexts. Spady (1994) identified the contextual circumstances of students as being paramount to classroom success. O’Neil (1994), similarly, cites good outcomes as having three elements: 1) content knowledge; 2) competence; and, 3) the setting. The philosophy of outcomes-based education is thus consistent with these concepts of classroom success in recognising that students require opportunities to display their learning in contexts that may not be available to them in a traditional classroom setting.

It can be concluded that the definition utilised in the Queensland Syllabus-in-Development is based upon widely recognised views of outcomes-based education. This is not to say that there are not criticisms of such models. A number of common criticisms may be identified from the literature that reflect concern from various interested parties. The most damaging criticism would have to be that outcomes-based education lowers standards within the school system, a claim a number of authors identify (Baron & Boschee, 1996; Boschee & Baron, 1996; McGhan, 1994; O’Neil, 1994; Pliska & McQuade, 1994). This is commonly connected with the claims of affective domains being emphasised at the expense of more rigorous academic aspects of learning (Boschee & Baron, 1996; Pliska & McQuade, 1994). A peculiarly American objection also can be found coming from what is commonly termed the Religious Right. Such critics consider that the teaching of what they see as values education to be the responsibility of families, and not the state (Burron, 1994; O’Neil, 1994). It would seem that there is a particular objection to the teaching of
tolerance (particularly towards other cultures and beliefs) as a goal, which is antithetic to Christian doctrines of moral absolutes (Burron, 1994).

It is also considered by some that the criteria used to assess students are sufficiently vague as to call into question their validity as instruments of measurement of student performance (Baron & Boschee, 1994; Boschee & Baron, 1996), while the practicality of implementing outcomes-based education in school systems not designed for the task has also been discussed (McGhan, 1994; O’Neil, 1994). More subtle arguments regarding the use of language within outcomes-based education that reflect a harnessing of education to economic imperatives are also advanced (Schwarz, 1994; Smyth & Dow, 1998).

Other criticisms include that the training of teachers in outcomes-based education does not reflect what is expected in classrooms (McGhan, 1994), or that students may not have sufficient maturity to complete tasks (McGhan, 1994). Baron and Boschee (1994) also identify the concern that the state intends schools, through outcomes-based education, to take control of students away from parents, or that it is merely disguised mastery learning. The use of excessive jargon in outcomes-based documents and curriculum materials has also been criticised (Schwarz, 1994). The comment that outcomes-based education systems will be used to collect databases on students, particularly in relation to their beliefs and attitudes has also been raised (Boschee & Baron, 1996; Pliska & McQuade, 1994).

In the context of this research it is important that there is an awareness of criticisms of outcomes-based education and, if possible, it is important to highlight any issues that impact on classroom teaching and learning implied by such an approach.
2.2.4.4 Curriculum and instruction

From Table 2.1, it can be seen that the adoption of alternative assessments is closely linked with curriculum and instructional change, as shown through the reforming nature of many of the examples given. Whatever curriculum is in place, “what is defined to be assessed gives clear messages to teachers, students and parents about what is considered important” (Jones, 1997a, p. 88). It is therefore essential that the assessment is closely linked with the curriculum for the two together determine to a large degree what is learnt in schools (Resnick & Resnick, 1985). The lack of coherence between curricula and assessment has already been noted as diminishing the potential impact of curricula (Jones et al., 1999), and the essential link between curriculum and assessment has been noted by other authors (Eisner, 1993).

A recurring phrase in the literature is “teaching to the test” (Mitchell, 1995; Resnick & Resnick, 1985; Wiggins, 1989), an apparently deliberate ploy to demonstrate a quantum change in outlook from traditional assessment through promoting a practice previously considered anathema to good teaching. It is argued by these authors that by teaching to the test, one is acknowledging that it is the test that sets the standards in a classroom, and that the quality of the test would determine the quality of the teaching. Fisher et al. (1998) agrees with the sentiment regarding the ability of assessment to improve instruction as do Khattri, Kane, and Reeve (1995). There is a fundamental shift implied in such a conclusion regarding the role of assessment for, as has been noted, assessment is traditionally regarded as following curriculum, whereas alternative models would regard assessment as a leading factor in curriculum delivery. Hodgeman (1997) also concludes that the main factor separating what was seen as teacher-centred learning and student-centred learning was the balance in assessment.
As a final note on alternative assessments and instructional reform, it is pertinent to note that such assessments seek to utilise ‘real’ problems to drive student capability and therefore, presumably, ‘real’ assessments to assess such capability. Real world assessments are instantaneous, temporary, negotiated and lacking in reliability (Mitchell, 1995), a situation far removed from the intentions of traditional assessments, as illustrated in Table 2.1.

2.2.4.5 Context

Aspects of the literature in technology education attest to the context specific nature of problem solving in the technology classroom (Levinson, Murphy, & McCormick, 1997; McCormick, 1997; McCormick et al., 1994; Murphy & McCormick, 1997), a matter of importance for the study of technology education. Indeed, Kimbell (1994a, 1997) contends that pupil performance can only be understood in terms of the classroom context in which it took place. It is also suggested that performance may be a function of contextual variables (Butterworth, 1992). This is also in accordance with the views of scholars such as Brookfield (1987) who argue that critical thinking requires an awareness that actions are never context free, and that in light of this there needs to be a development of reflective skepticism regarding actions of participants in a setting.

Francis (1994) has also observed that the difficulties in measuring complex intellectual processes have been problematic to reform of curriculum and instruction. Furthermore, it is also of concern that there has been little published work which analyses student activity in terms of their learning of concepts and processes in technology (Jones, 1997a). These “ephemeral” processes as Torrance (1995) terms them, must necessarily draw teachers into the assessment process, for, in a similar manner to contextual factors, they cannot be fully appreciated by an outsider. Spivey
(1997, p. 5) makes this very point in regard to the understanding of text from a constructivist point of view; “(a constructivist framework) allows for different meanings for the same text because of differences in people (knowledge, perspective, purpose, contexts)” (parentheses added).

Therefore, the teacher must be involved in any assessment, for he/she knows the context of the performance better than an outsider and can make a holistic assessment of the performance not possible by one not aware of the context. That is, “capability in design and technology involves the active, *purposeful deployment* of understanding and skills—not just their passive demonstration” (Assessment of Performance Unit, 1994, p. 66) (italics in original). A broader approach to assessment, one which might be termed holistic, is strongly inferred by the statement.

An issue which must necessarily arise from the context dependent nature of assessments, particularly those in relation to problem solving, is that of the reliability of such assessments. This issue is a matter of great importance if one is to ascribe a generally recognised level of achievement to pupils. It is interesting to note that the Syllabus-in-Development in Queensland stated that “technology education enables students to develop transferable knowledge practices and dispositions necessary for functioning in contemporary society” (QSCC, 1999, p. 6). The acceptance of transferability between contexts is evidently not supported by much of the literature, although this is obviously necessary from a systemic point of view.

### 2.2.4.6 Difficulties with alternative assessments

A number of problems with the implementation of alternative assessments have been identified. The first of these is the issue of expense in terms of time, materials and equipment that is necessitated by the assessment techniques that rely on active
demonstration of proficiency (Baron et al., 1998; Popham, 2002; Sudweeks & Clay, 1995; Wiggins, 1989). It should, however, be remembered that the use of alternative assessment implies measurement that is part of normal instruction, and to judge its efficacy in terms of expenses would be misleading.

A second problem that has been identified is that of teacher understanding of alternative assessment, particularly in relation to the interpretation of criteria (Popham, 2002; Khattri et al., 1995; Norman, 1995). The issue is related to professional development (Mitchell, 1995), whereby teachers need training to develop their skills in the use of unfamiliar assessment techniques. Benoit and Yang (1995) ascribe the necessity for professional development to the ‘bottom up’ approach of alternative assessment, where changes are initiated in the classroom, rather than through systemic reforms. Regardless of any professional development, it should always be recognised that assessments made under an alternative framework will have a subjective character that is both its strength, through intimate knowledge of students, as well as its weakness, through a possible lack of reliability.

Assessments that allow for groups to work on a problem must also allow for the fact that assessment in schools ultimately focuses on an individual. Barlex (1994) and Denton (1994) have highlighted some of the problems that arise from such group approaches. They include the acceptance of validity/reliability of assessments by teachers; teachers utilising groups for logistical, not educational reasons; individual students not contributing fully to the group; and relationships within a group which affect performance but are not evident to teachers.

A final barrier to implementation that is infrequently mentioned in the literature is that of public relations (Mitchell, 1995). The use of alternative assessment in the United States has been attacked by conservative elements who wish to retain, for a
number of reasons, a traditional testing regime. To put it simply: “multiple choice, norm referenced machine-scorable tests appear to have a sound track record and they don’t mess with thinking” (Mitchell, 1995, p. 8). For alternative assessment methods to succeed in such a climate it will be necessary to demonstrate some degree of reliability and validity in the assessments made, and this to be communicated to educational stakeholders. Regardless of the differences between Australia and the USA in terms of assessment, it is apparent that any assessment on a system wide context must display a degree of reliability and validity.

2.2.4.7 Reliability and validity

The validity of an assessment includes concerns with the issue of whether teachers are assessing what they think they are assessing. In relation to alternative assessments the evidence for such validity is sparse (Benoit & Yang, 1995), beyond the concept that it ‘looks like’ it captures learning. The term validity in terms of criterion referenced assessment (an alternative assessment) is taken to mean content validity which includes three elements (Hodgeman, 1997, p. 4); the domain of adequately defining the criteria; appropriate and applicable content design; and answering the question: Are teachers assessing what they think they are assessing?

A problem with validity must therefore ensue if teachers are unsure of exactly what the KLA is that they are teaching (see Section 2.1). This theme will be explored further in subsequent sections of this research, although it should be flagged here that the key theme to validity will be that assessments do not have validity unless they take into account a holistic approach to tasks which recognise the context dependent nature of student performance (Kimbell, 1997, 1994b; Wiggins, 1989).
Reliability is the measure of repeatability of a particular test (Kimbell, 1994b), and is of importance in terms of the ramifications if it is absent, for reliability is an essential feature of accountability in a school system. It is for this reason that far more attention has been paid to the reliability of alternative assessments (Benoit & Yang, 1995; Shymanski et al., 1995; Thomas et al., 1995). Report in this regard have been inconclusive, however, with Thomas et al. (1995) describing the results of a large scale portfolio assessment in California as “encouraging,” while Benoit and Yang (1995) consider it difficult if not impossible to attain high reliability without significantly affecting the educational appeal of portfolio assessment (see Table 2.1).

A number of authors do, however, offer suggestions that focus on the reliability and validity of assessments. Shymansky et al. (1995, p. 3), for instance, consider the ‘do-ability’ of assessments in these terms: 1) Can meaningful tasks be developed? 2) Is it reasonable and feasible to administer these tasks? 3) Do students respond to these tasks by showing what they think and can do? 4) Can multiple, independent judgments provide comparable decisions about the performance ‘evidence’ of students?

Stiggins (1988) also discussed the criteria that are linked to what he terms the quality of assessments. By quality he means reliability, validity, communication value and efficiency, and lists those criteria as follows (p. 367):

1. The match between instructional objectives and the focus of assessment.
2. The time required for and the ease of developing an assessment.
3. The time required for and the ease of scoring an assessment.
4. Administration time.
5. Degree of objectivity.
6. Issues of test security.
7. Applicability of computer technology to an assessment.

When considering computer portfolio assessments, it is considered that reliable and valid information about an individual is obtainable if the portfolio is effectively planned, designed and developed (Wiedmar, 1998). If this is done then evidence is available on what an individual knows, how the knowledge was acquired, how the knowledge has increased over time and how the individual has developed. It may also be possible to identify where the individual may be heading, and what an individual’s overall accomplishments are.

While the focus in the above list is on the validity of assessments, it could be argued that comprehensive information of this sort enables reliable assessment procedures to be put in place through the standardisation of classroom procedures.

Mitchell (1995) reasons that accountability depends on assessment and, therefore, it is imperative that alternative assessments display some degree of reliability so that they may be considered for systemic purposes.

2.2.5 The Queensland context

The Queensland Education Department (Education Queensland) has in place a long term plan to reform education by the year 2010 which is philosophically in accord with alternative assessment features listed in Table 2.1. This should facilitate the use of such practices more readily than in many overseas and interstate contexts, where systemic support for alternative assessments may be lacking.

A summary of the developments to date on this particular initiative, known as Education 2010, must take into account the fluid nature of discussions that are
shaping understanding of any changes. The objectives of the initiative include (Education Queensland, 1999a, p. 16):

1. establishing specific long term directions for State School education in Queensland,
2. producing clear statements on the purpose of education, the forces for change faced by public education and the strategies Education Queensland will adopt,
3. providing a framework for measuring progress and outcomes,
4. improving morale and renewing organisational vision, enabling Education Queensland to define the product that is to be marketed,
5. providing the basis for better educational outcomes for students.

These objectives do not represent, in themselves, any radical departure from state education initiatives in the past. In their implementation are interesting features, for they are based on what is termed, for marketing reasons, the *new basics* (Education Queensland, 1999a). These new basics are intended to allow the development of future oriented schools whereby more flexible arrangement of curriculum delivery is encouraged. They are based on four areas of interdisciplinary learning (Education Queensland, 1999b, p. 1): Life Pathways and Social Futures; Communications Media; Active Citizenship; and Environments.

The pertinent features of such changes for the nature of this research are twofold. Firstly the nature of curriculum is changed whereby the relationship between these basics and existing and emerging Key Learning Areas (KLAs) is redefined. The KLAs will no longer be mandated learning areas but rather resource materials that may or may not be necessary to achieve the objectives of the new basics (Education Queensland, 1999a). The key element for the direction of pedagogy in schools is the
three yearly “rich tasks” that students will undertake as part of statewide assessment procedures. There is also a change in focus on assessment in such a climate.

The assumptions that underpin these changes (adapted from Education Queensland, 1999c, p. 1) include that much assessment, for both formative and summative purposes, will occur as an integral part of the teaching and learning process. It should be noted that these assumptions are the same principles that underpin the national frameworks and the student performance standards of the mid 1990s (Cummings, 1998). Assessment for summative purposes will be an audit (italics in original) process and consequently teachers will neither be required nor expected to gather masses of data or data relating to every outcome. The aspects of each rich task outcomes to be audited will be decided at school level and identified in school curriculum programs. The aspects of the audit may change from time to time by negotiation as teachers come to shared insights about the performance of students.

Another assumption is that a system of formative assessment and the making of judgments by teachers will only be reliable and will only be valued by the community if there are shared understandings among teachers about acceptable performance and standards. Shared understanding can only be developed over a considerable time frame and requires both the circulation of a range of exemplars of student performance and time for “moderation style” professional development within clusters of schools. Testing procedures developed and managed by the system can provide data to assist teachers to be confident about their judgments of performance. This is particularly so when testing is done on samples of students and when instruments and sample results are shared with schools so they can compare performance with groups in “like schools.” Issues of practicality, test narrowness and cost imply that system-wide testing procedures can inform, but cannot replace school-
based assessment for teacher-based judgment about performance of rich task outcomes.

It should be evident that such assumptions must necessarily lead to alternative assessments being central to all school assessments. There is a recognition within these assumptions that traditional methods of assessment are inadequate for assessing a more diverse set of expectations that are to be placed on schools. The parallels with discussions of a technology curriculum are also evident, the implication being that a technology curriculum which requires new forms of assessment will more readily be accepted into such a system should it be realised.

2.2.6 Summary - Assessment

A number of basic questions were raised as to the purpose and meaning of assessment in the classroom. It was concluded that the use of alternative assessments was compatible with the nature of a technology curriculum. The differences between alternative assessments and what are described as traditional assessments were highlighted, while the implications in terms of the use of these assessments was discussed. It was concluded that while alternative assessments are philosophically in accord with the aims of a technology curriculum, it is necessary from a systemic accountability viewpoint to examine the limitations/strengths of such assessments in terms of their reliability and validity.

It was also necessary to be aware of the particular circumstances of the state in which this research will occur, for fundamental changes in the state education system over the next decade may facilitate the implementation of a technology curriculum that can be assessed in an educationally sound manner. It should also be accepted that the syllabus-in-development to be utilised in this research is based upon a particular
(but widely accepted) view of outcomes-based education, and will be considered as an important premise upon which classroom assessment will be based.

2.3 Summary of Chapter

The conclusions from the first two sections on technology and assessment suggest issues for further research into technology education. It is evident that both technology as a curriculum area, and assessment as a technique to determine capability are inextricably linked with human interpretations and actions. These interpretations need to be understood to some degree if the assessments are to have any meaning. Investigations, therefore, need to consider what behaviours or activities or performances teachers value in a technology program, for it is through these insights that a more meaningful understanding of how teachers assess technology may be attained.

Similarly, the reality of how teachers enact their understandings of technology in the classroom should be investigated to provide guidance to practicing professionals in this area. An investigation of this kind could provide both exemplars of good practice as well as demonstrations of difficulties that have been encountered. In relation to assessment it is also vital that information regarding how teachers develop and interpret criteria in relation to student performance is examined. Such activity is important in the accountability of teachers, as well as in the development of meaningful systems-wide assessment of students.

It is evident that the context of classroom activity influences both student performance and the meaning of assessments. A number of issues are not fully understood and need to be investigated, such as how teachers contextualise their technology programs. This research will provide important guidance to others
regarding the manner in which technology may be developed in their own classrooms. In other words, what can technology look like in the classroom? The situated nature of technology also requires that contextual information be included in any assessments. To date, however, there is little guidance as to what contextual information needs to be included in assessments.

Assessments also need to be examined to determine whether they are appropriate to the particular context in which they occur. This issue addresses concerns of validity and reliability. It may also be an issue that the context students learn in may affect their performance. How this is manifested in a classroom is of importance because teachers need to be aware of its effects on the performance of their students.

The design process is regarded as a crucial element of any technology program. It is, however, a difficult concept to define and, consequently, to observe in the classroom. Whether a design process can be recognised and recorded by teachers is a crucial issue, in terms of the formative assessment that teachers may provide to their students, as well as summative assessment of student achievement. It is also of concern that such teacher understandings will enable the development of appropriate technology programs for different age/grade levels. These understandings will also enable teachers to recognise how design processes are restricted or facilitated in their classrooms, clearly an issue in good teaching practice.

It is also of interest, considering the many interpretations of design process that are possible, how teachers view the undertakings of the students in their classes. It may be that new insights from teachers are possible through their engagement with students with whom they have a greater familiarity than any researcher. In relation to this research, the technological pathways students undertake were examined with the
aim of providing “a better understanding how children work and more directions for teachers in supporting children’s learning” (Fleer, 2000a, p. 57). Johnsey (1995, p. 216) also notes that:

Our new knowledge should be based on real observations of children as they design and make, rather than solely on potentially misleading, theoretical models of what we think happens.

The relationship between assessment and instruction in this research is seen to be essential if meaningful assessments are to be made. How teachers plan units of work which have integrated assessment is an issue that requires enlightenment, particularly, in terms of the guidance that this would provide to other classroom practitioners. The considerations made when determining assessment methods would also allow an insight into how the teacher may view the technology programs in his/her classroom, as well as the practicalities of assessment on an everyday basis. How the relationships between assessment and instruction is evidenced in the classroom also need to be investigated, as this would indicate how the theoretical implications of an outcomes-based assessment program are realised in the classroom.

It is, therefore, appropriate to elaborate the aims of the research in relation to these conclusions drawn from the literature review to direct the development of a suitable methodology, particularly in light of observations such as those by Jones (1997a, p. 83) that:

It is now time to place a greater emphasis on in-depth research on student understanding of technological concepts and processes and ways in which these can be enhanced.
2.4 Aim of Research

The aim of this research was to investigate the implementation of a technology syllabus in a primary school classroom environment by a teacher with limited background in the KLA.

The specific objectives of the research were to:

1. Identify and analyse technology design processes occurring in the classroom,

2. Investigate the planning and implementation of classroom assessment in an outcomes-based technology program,

3. Investigate the development of strategies by the teacher regarding planning and implementation of an outcomes-based technology program,

4. Draw implications for the development of theory and practice of technology education in the primary classroom.

Chapter 3 presents, and provides justification for, the design and methods utilised to achieve this aim and objectives.
Chapter III

Design and Methods

3.0 Introduction

Having defined the aim and specific objectives of the research, a program of implementation is now presented. In this section the theoretical and methodological underpinnings of the research are developed. The purpose of this section is thus to justify the research design and methods in terms of the aim and objectives of the research.

This chapter first elaborates on issues associated with the implementation of a technology syllabus in a primary school classroom environment, followed by a design for a research program. Methods of analysis of data are discussed, followed by criteria for qualitative research that underpin the research program. The research is focused on the interplay between a number of elements that interact in a particular situation, with a view to highlighting the perceptions of participants. The research is necessarily interpretive, relying on human interactions and interpretations of experience, and therefore seeks to establish the meaning of assessment, teaching and learning to participants (Burns, 1994; Erickson, 1998).

3.1 Design

This research is an interpretive case study of the experiences of the students and their teacher who was coming to terms with a new KLA. While there are a variety of methodological approaches that may be considered suitable for this research, an
examination of the research aim and objectives suggested that the following had to be considered before any decisions were made:

1. The phenomena under investigation presented a situated, bounded entity.
2. There was a requirement that issues associated with the practice of teaching be examined.
3. The research required an intensive investigation of factors associated with a particular issue, in this case the practice of technology in a single classroom.

These characteristics indicated that a case study approach would be appropriate to the needs of the research. Hitchcock and Hughes (1994, p. 74), for example, consider that the aim of a case study is to, “locate the ‘story’ of a certain aspect of social behaviour in a particular location and the factors influencing this situation.” This would describe the broad intention of this research into a particular and bounded situation. Mason and Bramble (1997) also consider that case studies “are conducted to foster understanding of how current situations or characteristics developed for practical reasons” (p. 39). It is evident that this research was focused on such “critical problems of practice” (Merriam, 1988, p. xiii), particularly as it related to technology in the primary school classroom. Furthermore the research was intended to investigate intensively the “factors that contributed to the characteristics of the case,” (Mason & Bramble, 1997, p. 39). In this research this consisted of the classroom experiences of participants undertaking a technology program.

The characteristics of a case study approach were, therefore, believed to be the best methodology for addressing the aim and objectives of the research agenda. As technology is an area of the curriculum that is not as widely researched as other
KLAs, it offers the opportunity to examine a unit (a class of students and their teacher) in considerable detail, such that it may provide insight into the workings in other such units (Burns, 1994). This would include evidence that illustrates more general findings in relation to, for example, student design processes, as well as the possibility of “refocusing the direction of future investigation” (Burns, 1994, p. 314). This would therefore be termed an instrumental case study (Stake, 2000) in that the case was being studied “mainly to provide insight into an issue or to redraw a generalization” (p. 437). The aim and objectives of this research were addressing issues that may apply to other classrooms, as well as attempting to build on theoretical understandings of the subject area. The case study therefore offers a viable means to attain useful research outcomes in that it addresses both the “particular phenomenon and the context in which the phenomenon is occurring” (Yin, 1993, p. 31) (italics in original).

The teaching/learning environment for the students was in accord with normal classroom practice, being developed and implemented by their own teacher in their usual classroom. The teacher developed the program to suit the needs of her class, as she perceived them, based upon the syllabus documents. The students were aware that they were participating in a research study, albeit as part of normal classroom activity.

There was intervention on the part of the researcher in regard to teacher planning, implementation and assessment in that the teacher involved requested guidance at certain stages of the implementation of the technology teaching unit. This was noted in the data when it occurred. As such, the researcher should be considered to have taken on the primary role of observer, and a secondary role of collaborative colleague.
3.2 Implementation Cycle

There was a cycle of program development and implementation utilised in this research throughout which the teacher developed and implemented a program of teaching and learning in technology education. She also assessed student learning from that program. The classroom agenda that was developed and implemented is outlined in detail in Section 4.2.

3.3 Participants

The participants in the research were one class (combined Grades 4 \( n=10 \) & 6 \( n=14 \)) and their teacher in a rural/regional Queensland school. The class and teacher were recruited through informal enquiries with potential participants, followed by an approach to the Principal at the identified school, as principals represent the ‘gatekeepers’ with whom preliminary agreement regarding the implementation of any research must be reached. From the school, a single class was recruited to participate in the research process.

It was desirable for the teacher to be comfortable with the research intentions and prepared to undertake the extra work involved. She also needed to be able to demonstrate a willingness to implement the technology curricula in her classroom. It was not necessarily required that the teacher be currently implementing technology.

It was intended that the selection process for the teacher would follow a pattern of progressive refinement and focus until a participant teacher was recruited. The process for the recruitment of the teacher (see also Appendix 1) involved identifying a classroom on the basis of location (realistic accessibility for researcher), size of school population (equating to class sizes which enable a range of students and
capabilities) and type of school (preferably a State primary School, with which the researcher was most familiar). Permission was then obtained from the relevant government department to undertake research in potential school sites.

An informal approach was then made to a potential participant teacher to ascertain her interest in undertaking the project, followed by an informal approach to the Principal of her school to identify the willingness (or otherwise) of the school administration to support the research project. A formal approach was then made to the Principal of the school in accordance with Education Queensland guidelines in relation to research projects. In depth interviews with the potential participant outlining the scope of research were then made. Permission from the participant teacher and the parents of students in her class was also obtained following Queensland University of Technology (QUT) guidelines.

3.4 Data Sources

The data collection was intended to allow the development of a “picture” (Jones, 1997b) of student capability in conjunction with teacher perceptions of this capability and the planning and strategies she employed. It was designed to allow insights into technological processes as they appeared from the range of participants’ perspectives (Burns, 1994). Furthermore, the issues associated with the implementation of a technology syllabus were to be explored in-depth. These included classroom strategies used by the teacher involved, the design processes used by the students in the class, the role of assessment in the classroom from the point of view of the teacher and her students, and the manner in which participants characterised technology in the classroom.
Data were collected through observations of classroom activities of students, their interactions with each other, their teachers and with the researcher. Data sources were:

1. Electronic recording media (1 x video camera and 1 x audio tape) of student and teacher activity during lessons, as well as during interviews.
2. Photographs of student artefacts and general location of activities.
3. Field notes made by the researcher during and after interaction with the class and their teacher.
4. Interviews with participants (formal meetings during and after classroom technology program, as well as informal interviews with participants during lesson activities).
5. Collection of artefacts from participants, including written materials and produced artefacts.

Contact with the class was over a period of 8 months (April to November, 2001). This included 19 contact visits to the research site for the purposes of data collection, liaison with key personnel, formal interviews and familiarisation lessons. The researcher attended classroom lessons prior to data collection to familiarise himself with the classroom workings and participants. Fifteen lessons [30-40 minutes duration each] in total were observed and a weekly telephone contact with the teacher between site visits was maintained (see Appendix 1). Total engagement with the research site was a period of 10 months.

Formal (outside classroom activity) and informal (during classroom activity) interviews with students and their teacher were undertaken (see Appendix 1), as well
as the collection and analysis of students’ portfolio content such as written work, drawings, plans, reflections and self assessment. Formal interviews were undertaken with representative students from a range of age, gender and grades, while informal (in class) interviews were undertaken with all students (with parental permission) at some stage of the research. Log books, written reflections and planning developed by the class teacher throughout a developmental cycle were also collected during the research (see Appendices 2 - 5).

In the following chapters, all physical data (document/physical material/photograph) are identified as artefacts by the prefix ART. Field notes are prefixed with FN. Electronically collected data will be identified by two letters, the first identifying the physical location or style (C=classroom, E=exterior, I=interview) followed by the means of collection (A=audio, V=video). The numbers following electronic data sources identify the chronological order of collection of the particular type of data. For example, CA-01 would be the first piece of data collected by audio in the classroom. The number following a forward slash indicates the order in which this particular data source has been presented in this research. Field note prefixes will be followed by a date only, while artefact prefixes will be followed by an identifying number. For example, FN-30/4/01 was a field note written on the 30th of April, 2001, and ART-01 is the first artefact utilised in this report. Appendix 1 tabulates all the data sources used in the report, their identifying labels and date of collection.

3.5 Analysis

The analysis of the data took place within a constructivist framework that seeks to explain the world in terms of subjective experiences related to classroom activity. As such, a number of assumptions were made that pertain to this study (Guba & Lincoln, 1981, 1989). The first of these assumptions related to conceptions of reality.
This inquiry assumes that there are multiple realities, none of which could be considered more ‘true’ than any other, and none of which could be considered in isolation. A second assumption was that the inquirer must necessarily interact and affect the phenomena under study (Guba & Lincoln, 1981). A realistic approach to such a situation is to attempt to understand the influence of the inquirer on the information that is collected. Thirdly, there is an assumption that the knowledge one is attempting to understand is necessarily focused on particular events, and that it is the differences that one observes between such events that often reveal more than the similarities (Guba & Lincoln, 1981). In this regard the research is a phenomenological interpretation of the experiences of the students, teacher and researcher and aimed to portray to some degree the shared understandings of these participants. Dooley (1995) noted that “the researcher should try to discover the meaning of things and events to the members of the social group of interest” (p. 263).

The researcher, having been a teacher and small school principal, was able to bring his own experiences to bear on the research and its analysis, and was aware of the need to guard against allowing this experience to unduly influence interpretations. The appraisal of this influence (termed subjective bias by Burns (1994)) needed to be considered carefully in the researcher’s analysis and collection of the data, although it should be apparent that the phenomenological nature of this research necessarily entails a subjective viewpoint that is to some degree shared by the participants. It is through this shared subjectivity (or intersubjectivity) that one understands the environment, the goal of which is to “explicate how objects and experiences are meaningfully constituted and communicated in the world of everyday life” (Holstein & Gubrium, 1994, p. 264).

Data analysis proceeded in parallel with data collection, the aim being to develop an analytic file that reflected both the data collection techniques as well as
the initial interpretations of that data. In this manner a rudimentary coding scheme to process the data was developed (Glesne & Peshkins, 1992, p. 130) to guide the organisation of phenomena and interactions so as to facilitate later interpretation. This rudimentary coding scheme was based around initial interpretations of data that evolved into the assertions presented in subsequent chapters. Huberman and Miles (1998, p. 185) proposed a list of what to store, retrieve from and retain which proved to be a useful starting point in this regard. From this list a number of conditions that relate to this study were addressed.

Firstly the collection and processing of data was made through field notes, video and audio tapes, photographs and written artefacts from the students and teacher. These data sources have been retained in their initial raw form, as well as in a partially processed format. Write-ups of field notes and transcriptions also included reflective remarks, made by the researcher during or after the data collection, and frequent reflections on the collected data were undertaken to ensure that initial interpretations were refined, modified or discarded as the study progressed. Data were progressively written up and coded. In this research a code that identified the source and type of data, date of collection and number of uses of the source was used (see Appendix 1). The researcher’s reflections on the conceptual meaning of the data have also been retained. These reflections were made in conjunction with field notes, and represent a useful guide to the development of explanations of the data.

Also retained were successive drafts of what is written on the design, methods, and findings of the study. The researcher stored such iterations electronically. A general chronological log or documentation of data collected and analysis work was also retained. This log is found in both the field notes and the list of data sources (see Appendix 1), and allowed for cross-referencing between data sources. All of the
above processes were considered to be part of the development of an analytic file and provides an audit trail of the data collected to the interpretations drawn and reported.

This analytic file proceeded from raw data through a cyclical process that refined and rejected assertions throughout the data collection process. As such, it provided guidance to subsequent data collection, as well as a reflective tool for the researcher. The file worked through allowing the researcher to access data in a number of different forms, from raw material, to chronological episodes or thematically collated material. The cyclical revision of this data allowed for the researcher to build up understandings of the classroom activity that he had observed, and to test assertions to explain these observations through reference to this material. The outcome of this process resulted in a number of assertions that are presented in Chapter 4.

Although the interpretation and analysis of data progressed throughout the research, the stated aim and objectives of the study (derived from the literature review) were used as a general guide to the collection, filtering and sorting of data. The process undertaken could thus be described as a hermeneutic dialectic process (Guba & Lincoln, 1989), whereby a higher level synthesis of divergent views was achieved through the continual interpretation and reinterpretation of events thereby allowing connections to be made to facilitate a dialogue between participants. Guba and Lincoln (1989, pp. 149-150) outline a number of conditions for the successful implementation of a productive hermeneutic dialectic negotiation, these being also used as guidance for this research. There must be, for instance, a commitment from all parties to work from a position of integrity. In this regard there was no deliberate attempt on the part of the researcher to lie, deceive, or mislead participants. The initial meetings with the teacher assisted in the development of a situation through the presentation of an honest appraisal of what was entailed in the research, as well as the
development of rapport between her and the researcher, thus facilitating a reciprocal
approach on her part. From the researcher’s point of view, this appeared to be
maintained during the research process.

From such a basis it was also possible for the researcher and teacher to share
power in the classroom. This was assisted by the fact that the researcher was an
experienced teacher. This collegiate respect also facilitated discussions in which the
researcher and the teacher could openly discuss their difficulties and values as the
research progressed.

For the outside observer, however, the issue of trustworthiness is central to
interpretive studies such as these. Lincoln and Guba (2000) identify four components
of trustworthiness in relation to naturalistic inquiry namely: credibility,
transferability, dependability and confirmability. These four factors mirror the
traditional realist tenets of internal and external validity, reliability and objectiveness.
These concepts are now examined in relation to this study in more detail.

3.5.1 Credibility

Lincoln and Guba (2000) discuss four concepts of trustworthiness under the
banner of ‘truth values.’ They also argue that traditional criteria for validity and
reliability in qualitative studies are inadequate and that they are inappropriate for an
interpretive study.

The first of the components they discuss is that of credibility. This corresponds
to the traditional concept of internal validity, which is rejected on the basis that there
are multiple realities in a given situation, whereas a single reality is implicit in
experimental designs that utilise such concepts of validity. To demonstrate what is
termed the ‘truth value,’ the naturalistic inquirer must demonstrate that he/she has represented the multiple constructions of reality adequately. It is concluded that there is thus a twofold task that the inquirer must undertake in relation to credibility (Lincoln & Guba, 1985, p. 296):

1. Carry out the inquiry in such a way that the probability that the findings will be found to be credible and,

2. Demonstrate the credibility of the findings by having them approved by the constructors of the multiple realities being studied.

The credibility of this study was considered to be enhanced through five methods outlined by Lincoln and Guba (1985). Firstly, this was achieved through prolonged engagement, persistent observation and triangulation. The total time of engagement with the research site was ten months (see Appendix 1), allowing for the development of relationships between the participants, as well as for meaningful reflection on what was occurring. Differing data sources were also used to ensure that triangulation could occur (see Section 3.3). Secondly, credibility was achieved through peer debriefing, and this occurred regularly with the researcher’s supervisors, as well as with other teaching colleagues.

Negative case analysis, whereby one continually refines hypotheses until they account for all known cases without exception was also undertaken. This resulted in the development of assertions that are used to frame the presentation and discussion of data in subsequent chapters. The technique of referential adequacy, whereby conclusions were tested against archived raw data such as video tape recordings not used in the initial interpretations was also employed. As assertions were developed, archived material was accessed to test their adequacy. Finally, member checks, where
interpretations were tested with members from whom the data was originally collected, were undertaken. This process has been discussed in terms of the authenticity of research by Guba and Lincoln (1989). Both the students and the teacher involved were used to test developed assertions through focused interviews.

3.5.2 Transferability

Transferability is the parallel of external validity in qualitative studies that, it is argued, is not applicable to naturalistic inquiry where it is not necessary to generalise results to either the population of the sample or to another sample. The responsibility in determining applicability lies with those other than the researcher. As noted by Marshall and Rossman (1995, p. 144), it is possible by referring back to the original theoretical parameters to “determine whether or not the cases described can be generalised for new research policy and transferred to other settings.” It is clear that the responsibility of the researcher in this regard is to provide “sufficient descriptive data as to make such similarity judgments possible” (Lincoln & Guba, 1985, p. 298).

Efforts to ensure transferability included detailed descriptions of the time and context to assist in the assessment of assertions by the reader.

3.5.3 Dependability

Reliability is a concept from realist inquiry that is underpinned by assertions of tangible and unchanging entities. Naturalistic inquiry of phenomena that are continually changing cannot be understood in such a framework. The alternative conception of dependability is based on the inquirer taking into account factors that contribute to instability within a phenomenon, as well as factors induced by the design of the study.
The argument regarding the development of dependability in a study is based on the following understanding (Lincoln & Guba, 1985, pp. 316-319):

1. If credibility is established, then it can reasonably be said that dependability is likewise established.
2. The use of triangulation or overlap methods are used to complement the above argument.
3. ‘Stepwise’ replication, whereby a team of inquirers are utilised to independently investigate a phenomenon. This is not applicable to the study.
4. By the inquiry audit process, whereby the processes and products of a study are examined in an ‘audit trail’ manner.

The dependability of this study was addressed through the process utilised for data collection, refinement and retrieval (see Section 3.6), as well as through the development of credibility (see Section 3.6.1). The ‘audit trail’ described above would thus be found in the process of developing an analytic file previously described in Section 3.6.

3.5.4 Confirmability

In a naturalistic inquiry, objectivity, or confirmability, is obtained not through notions of intersubjective agreement where collective experience is considered to be objective (and individual subjective). Rather, the emphasis is on the data, the key question being whether or not “the data help confirm the general findings and lead to the implications” (Marshall & Rossman, 1995, p. 145). Confirmability was
established through the audit mentioned above, and outlined by Lincoln and Guba (1985, pp. 320-327).

The techniques to establish trustworthiness criteria are held together, according to Lincoln and Guba (1985) by what they term the reflexive journal, a “kind of diary in which the investigator on a daily basis, or as needed, records a variety of information about self (hence the term ‘reflexive’) and method” (p. 327, italics and parentheses in original). The journal kept by the researcher, which included reflections on the findings as they developed throughout the fieldwork, fulfilled this role in these circumstances.

The analysis of the data took the form of an examination of the themes and issues that, to the researcher, were integral to the understanding of classroom activity during a technology program. These themes and issues could not be delineated a priori, but emerged as the study progressed, although broad guidance was initially provided by the literature.

The themes and issues were used to construct a synthesis of the experience of the research process which identifies within the themes aspects such as commonalities, uniqueness, contradictions and missing information (Lidstone, 1999). In this manner the data were recontextualised so that it has meaning as a whole entity, and not as a series of unconnected experiences.
3.6 Ethical issues

As this research involved human experimentation (in organisational terms), a number of ethical issues were addressed. Miles and Huberman (1994) discuss a range of issues that must be considered when undertaking a research program. These issues formed an important part of considerations in this research program. For example, the question needs to be asked as to whether the research was really going to add significantly to a domain broader than personal self-interest of the researcher. In this regard, chapter two indicates that there is indeed a need for further research in the areas of technology in the primary classroom. Furthermore, the aims and objectives are derived from the experiences of others so as to address specific needs in this research area.

The competence of the researcher, as outlined by Miles and Huberman (1994), also needs to be considered. The key question here is whether the researcher has the expertise to carry out the research. In addressing this concern, the academic and educational experience of the researcher was in the area to be investigated (primary education), while the supervisors of the researcher are highly experienced researchers in the area of technology education. From the outset it was considered that the research had a good chance of success in light of this.

Informed consent is a key aspect of ethical research, and Section 3.6 outlines the steps that were taken to ensure that all participants (or their guardians) gave informed consent to the research.

Consideration of the benefits and costs to participants also needs to be made. In the case of the researcher, benefits are self evident (enjoyment, improved qualifications, publications, academic recognition), but there needs to be a
consideration that the commitment of others in the research needs to be balanced with beneficial outcomes (Miles & Huberman, 1994).

In the case of the teacher involved, the benefits include developing professional skills in a new curriculum area, providing input to academic debate and having an extra professional in her classrooms to work with. The benefits to the students included having a novel and (hopefully) interesting curriculum to work in and the chance to contribute directly to the education they received. For the other staff at schools, who may not be directly included in the research, the benefits included having access to professionals with particular skills, and having the opportunity to contribute to the debate surrounding the research.

Harm and risk are an aspect that may attend research programs. The main risk is that through publication of the research participants may recognise themselves and feel that they have, in some way, been criticised or demeaned. Utilising the approaches outlined in Section 3.6.1, whereby participants are encouraged to examine their own interpretations of data collected minimised the risk of unexpected conclusions being made. Pseudonyms are also used in any reporting, as was made clear in information packages supplied to participants. Negotiation parameters outlined by Guba and Lincoln (1989) in their discussions regarding authenticity and fairness were considered in this regard.

The researcher must also consider to what degree he may intervene in situations he may encounter at the research site. In this regard the researcher, being a registered teacher in a school setting, followed the professional standards expected of a teacher in Queensland.
The ownership of data was also examined before research was undertaken. Although the control of data and conclusions rested primarily with the researcher, it was recognised, and publicly known (through provided information packages), that participants may have access to data which concerns themselves, and that they may comment on conclusions made upon data that derived from their input (see Section 3.6).

3.7 Chronology of events

The students in the classroom undertook a number of apparently disparate activities. For the purposes of this research they will all be considered to be part of an overall unit of work, and they will not necessarily be discussed in chronological order but, rather, at the most appropriate juncture to illustrate particular issues. More detailed descriptions of the programs undertaken are supplied in subsequent sections of this report.

3.8 Summary of Chapter

This section has outlined the theoretical and methodological underpinnings of the research. It concluded that an interpretive case study design was appropriate to address the aim and objective of the research. The gathering and analysis of data was outlined, as were the issues that needed to be considered in relation to credibility, transferability, dependability and confirmability and ethical issues associated with the research.

Chapter 4 presents the initial investigations and outlines the context in which the research occurred.
Chapter IV

Initial investigations

4.0 Introduction

While the majority of data will be presented in subsequent sections, it is important that some contextual and background material be presented to the reader to better assist their reading of assertions made in this research. As such, the mode of data presentation is explained, as are some of the initial contact experiences between the researcher and the classroom teacher. A chronology of events is also presented. The purpose of this section is thus to contextualise the data that is to be presented in subsequent assertions.

4.1 Initial Planning and Context

As noted in the section dealing with selection processes (Section 3.4.1), a number of meetings (four in total) occurred with the participating teacher, Mrs. Lange (a pseudonym), before the commencement of electronic data collection (see Appendix 1) (field notes were used to record these meetings). These meetings consisted of an initial informal approach, followed by more in-depth meetings to ensure that she was familiar with the requirements of a research program. During these meetings, Mrs. Lange gave her consent to participate in the research agenda.

In these early meetings the nature of the technology syllabus was discussed. At this stage, Mrs. Lange was under the impression that the technology syllabus would involve a lot of computer work, one of her questions in a meeting being “…how
many computers will we need?” (FN-12/4/01). This is consistent with the findings of Rennie (2001, p. 50), where she stated that, in relation to primary school teachers:

… at the outset many primary teachers were somewhat confused about what technology was. Some teachers thought of technology in terms of science, others considered it to be synonymous with computing studies.

Also, in field notes taken after the last of these preliminary meetings, it was noted by the researcher that Mrs. Lange stated, “I’ll just need time to digest all this….it’s not what I thought technology would be, and I’ll need some time” (FN-30/4/01). It was decided not to take any firm decisions regarding any teaching programs until Mrs. Lange had had a chance to read the syllabus and support documents (FN-30/4/01). In such a circumstance where the teacher involved needed to come to terms with some basic ideas regarding the KLA, this appeared to be prudent. Note also that in regard to planning within her classroom, Mrs. Lange was not operating entirely independently, as outlined below.

The school had decided the previous year that they would, for reasons relating to systemic change (see Section 2.2.5), implement an outcomes-based curriculum throughout the school. Part of staff skill development in this implementation was to plan in year level groups. At the start of the year Mrs Lange’s class was entirely made up of Year 6 students \(n=21\) and thus she did her planning in conjunction with the two other Year 6 teachers. Shortly after the commencement of the school year, a lower than expected enrolment required the transfer of a teacher out of the school, with a subsequent shifting of teaching load to other classes. The result of this was that Mrs. Lange acquired 10 Year 4 students (and lost 7 Year 6 students) in her classroom.
Although these younger students formed a significant minority in her classroom, she continued her planning sessions and activities with the other Year 6 teachers.

A further result of this group planning was that Mrs. Lange was not entirely independent in making choices in her classroom, and that certain parameters had already been set within her planning schedule. These parameters included the overall theme of the activities, namely disasters, and the objectives within each KLA. In a document provided to the researcher at an early meeting, a thematic sequence of activities to be followed by all Year 6 teachers was outlined (see Appendix 2). Five main themes were to be explored: war, natural disasters, man-made disasters, man’s effect on the environment and a culminating activity based around a disaster simulation. In field notes it is recorded that these ideas drove the discussion and that “Mrs. Lange had a number of basic topics to explore and we discussed how they might be implemented” (FN-12/4/01). For example, Mrs. Lange at one stage proposed that they would have to develop the culminating activity, an aeroplane crash scenario, and that it would “tie up all the activities to date….but (myself and the other teachers) are not sure how it will happen yet” (IA-02/1). As such, neither the exact form of the activities was decided by Mrs. Lange, nor could it be due to the collaborative aspects of planning being undertaken between Mrs. Lange and the other Year 6 teachers.

At one meeting Mrs. Lange remarked on how difficult the technology syllabus was to understand, in particular what the outcomes actually meant (FN-30/4/01). For example, she noted, “I’m not too sure (about) the outcomes…how they fit in to what we’re doing.” Indeed, her planning at this stage also contained outcomes that were not from the technology syllabus. For example, the technology component of the classroom program was listed under two headings, “publishing” and “research” (ART–01, see Appendix 3). The outcomes under these headings were associated with
information technology and the use of computers, for example, “Students locate and reference information from CD ROMs and the internet using advanced search strategies” (see Appendix 3). In a later interview with Mrs. Lange she confirmed that these had come from “our school (information) technology program” (CV-04/1) (parentheses added). In the context of this research such a document would be identified as relating to information technology, rather than the technology component of the KLA of interest to this research.

In coming to terms with technology as understood in this research program, Mrs. Lange found the elaborations (QSCC, 2000b) more useful because of their “concrete examples” (FN-30/4/01). This assertion was repeated in later interviews where she noted that:

I couldn’t understand that (the syllabus outcomes) without the other half of the syllabus, the other half you gave me…the elaborations. If I didn’t have the elaborations I would not have a clue in the world what I was doing. (IA-02/3)

The format of the elaborations, which outline possible ideas for classroom activities in technology, clearly provided a more meaningful source though which Mrs. Lange could access the KLA. While it was decided, in collaboration with the other Year 6 teachers, that the outcomes to be utilised would focus “largely on the systems aspect of technology” (FN-30/4/01) (for both Year 6 and 4), the actual determination of what outcomes would be utilised in her classroom would be left to Mrs. Lange, within the provisions already noted regarding the year level planning being undertaken by the Year 6 teachers. In these initial activities, as will be seen, assessment very much became a secondary concern within the classroom. Mrs. Lange
then developed a teaching-learning program utilising the supplied syllabus and supporting documents over several weeks.

The outcomes selected by Mrs. Lange to be utilised in the first of the classroom activities (see Appendix 4) were the following (note, in the actual syllabus documents these outcomes have a further identifying number attached to them, for example, SN 3.1):

- SN 3 Students explain the relationships between elements of a system and identify how they contribute to the input, process or output of the system and identify subsystems within systems (QSCC, 2000a, p. 35), and

- SN 4 Students identify and explain the principles and logic of systems and subsystems within systems (QSCC, 2000a, p. 36).

Prefixing all outcomes in the draft syllabus are two letters and a number. The first letter identifies the strand (P=technology practice, I=information, M=materials, S=systems) (see also Section 2.1.2 for background on syllabus), while the second letter identifies the organiser for that strand. These organisers differ for each strand. For the technology practice strand they are I (investigation), D (ideation), P (production) and E (evaluation). For the information strand they are I (the nature of information) and T (techniques used to work with information). For the materials strand they are N (the nature of materials) and T (techniques used to manipulate materials). For the systems strand they are N (the nature of systems) and T (techniques for assembling, managing and controlling systems). The number indicates the level of the statement (see Section 2.1.2).
Following the identification of outcomes, Mrs. Lange then outlined the actual activity that would take place to address these outcomes, which included students identifying “a scenario where a biological warfare (or release of a toxic virus) has occurred in the town” (see Appendix 4), as well as “discussing the systems involved in the spread of the virus.” The two chosen outcomes related to the two different age groups within the class (Years 4 & 6). Although all the students in the class undertook the same activity, there was no differentiation made between the activities undertaken by the two year levels.

The second activity was to “devise a disaster management plan for (the town)” (see Appendix 4) (parentheses added). The students were to discuss the plan that they developed in groups, and to vote for the most important aspect of each plan. The outcomes that Mrs. Lange chose to apply to this exercise were as follows (Appendix 4), again with no differentiation between the actual activity undertaken by students at different year levels:

- SN 3 Students explain the relationships between elements of a system and identify how they contribute to the input, process or output of the system and identify subsystems within systems (QSCC, 2000a, p. 35), and

- SN 4 Students identify and explain the principles and logic of systems and subsystems within systems (QSCC, 2000a, p. 36), and

- PE 3 Students use real-life and life-like situations to make judgments about the effectiveness of products, key design features and how they can be modified (QSCC, 2000a, p. 23), and
• PE 4 Students gather feedback from users to evaluate how design ideas, production processes or products could be modified to meet original needs and wants (QSCC, 2000a, p. 24).

The technology practice strand of the syllabus had become a second focus for assessment, with a primary focus being on the systems strand. Activity three was for the students to design a fossil fuel free car and was related to the following outcomes (see Appendix 4);

• ST 3 Students use techniques to assemble, disassemble, trial and modify systems, and systems with subsystems (QSCC, 2000a, p. 35), and

• ST 4 Students select and use techniques to organize, assemble, disassemble, trial and refine systems for specific users (QSCC, 2000a, p. 36).

Activities 4 and 5 (see Appendix 4), which involved a disaster simulation and a safety audit respectively, had not at this stage been developed to the point where outcomes had been identified. By the end of the data collection, neither of these activities had been developed nor implemented.

In the event, Mrs Lange implemented the first and second activity related to disaster management and systems, although in a modified form to the proposed activity (see following) as well as the activity related to the use of renewable energy. All activities were, however, considerably abbreviated from their intended form. For example, in the original planning provided by Mrs Lange in relation to the disaster management plan, it was intended that, among other things, “children present their plan to the class for consideration explaining why they would instigate each plan” (Appendix 4). The students were also to “share their plan with their parents and ask
for feedback” (Appendix 4). Neither of these occurred. The students also did not produce a disaster management plan in a final form, only discussing it and mapping out ideas, and the actual production of artefacts for the renewable energy activity did not take place at school. From the data collected, a number of emerging issues were identified for further investigation.

The activities undertaken by the students are summarised in Table 4.1.

4.3 Summary of Chapter

This section of the research has presented contextual information regarding the implementation of the research agenda to better assist the reader in understanding the milieu in which the research occurred. This understanding is essential in interpretive research such as this, as it allows the reader to understand the contexts that influenced how participants behaved and responded in various circumstances.

The next chapter presents detailed results from the research in the form of nine assertions.
Table 4.1  
*Activities to be Undertaken by Students (see Appendix 4)*.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Focus or purpose</th>
<th>Artefacts produced</th>
<th>Classroom management</th>
<th>Date of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological warfare activity</td>
<td>To examine the means by which a contagion may spread, thus examining systems.</td>
<td>A map of the water supply in town</td>
<td>Group activity with group production of artefacts. Whole of class and small group discussions.</td>
<td>8/5/01 to 21/5/01</td>
</tr>
<tr>
<td>Disaster management plan</td>
<td>To develop a document to manage the reaction to and spread of contagions.</td>
<td>Document to manage response.</td>
<td>Group activity with group production of artefacts. Whole of class and small group discussions.</td>
<td>4/6/01 to 12/6/01</td>
</tr>
<tr>
<td>Fossil free vehicle production</td>
<td>To develop a vehicle.</td>
<td>Actual vehicle</td>
<td>Individual activity. Whole of class, individual and home activity</td>
<td>10/7/01 to 17/7/01</td>
</tr>
<tr>
<td>Disaster simulation</td>
<td>To respond to disaster simulation in various roles</td>
<td>Artefacts required for role-play</td>
<td>Whole of year level activity</td>
<td>Not attempted</td>
</tr>
<tr>
<td>Safety audit</td>
<td>To audit the safety of the school grounds</td>
<td>Documented evidence of audit</td>
<td>Whole of class activity</td>
<td>Not attempted</td>
</tr>
</tbody>
</table>
Chapter V

Findings

5.0 Introduction

As explained in previous sections, the analysis of data occurred throughout the research process, with various assertions being developed, refined and rejected/accepted as the study proceeded. Nine assertions have been accepted and are presented in the following sections of this chapter. The purpose of this chapter is thus to present these assertions, and to present evidence from key incidents to support them. The implications of the assertions will then be discussed in Chapter 6.

The emerging issues have been identified from a cross section of responses and experiences throughout data collection. The three activities (see Table 4.1) undertaken by the teacher and her class were treated as their teacher intended them: that is, as parts of a single unit of work (see Appendices 4 & 5). They are not treated in a chronological order, and instances from differing activities are cited where appropriate to illustrate various points. The order of data presentation is based on the broad applicability of the assertions to the specific objectives of the research. The first objective (see Section 2.4), which addressed issues associated with design and practice in technology classrooms, is investigated through Assertions 1, 2, 3 and 4. Objective 2, relating to issues of classroom assessment, relates to Assertions 5 and 6 in particular, while the third objective of the research relating to understanding and implementation of curriculum is addressed through Assertions 7, 8 and 9. The implications (Objective 4) will be discussed in conjunction with all of the Assertions. It should be noted, however, that there will be a degree of overlap between these assertions with all contributing to the general aim of the study, and that the broad
topics of design and practice in technology, assessment, and understanding and implementation of curriculum are not mutually exclusive categories.

5.1 Assertion 1 (Objective 1-Design and Practice in Technology Classrooms)

The processes being undertaken by the students in their technology exercises may be characterised as being contingent on the development of understanding created through actual interaction with the artefacts involved.

The design process identified in this research has been termed contingent primarily because of a developmental process that allows students to design despite the uncertainties they have regarding the exercise. Furthermore, the decisions they make are based on progressing their design, although not necessarily as they initially envisaged. It is also pertinent at this point to define the key term in this section of the report, that of contingent, or contingency. Contingent is defined in the Australian Concise Oxford Dictionary (Turner, 1988, p. 220) as:

of uncertain occurrence; fortuitous; incidental to; true only under existing or specified conditions; non-essential; conditional or dependent (on, upon). (italics and parentheses in original)

The term contingent is thus used in this context of multiple unpredictable outcomes in a technology activity. It should be noted that the outcome of the design process is thus flexible in its nature. The design brief given to the students by Mrs. Lange in relation to the renewable energy powered vehicle they were to construct was fairly broad (see CA-04/3, Section 5.2) and the students, quite legitimately, changed the possible material outcomes as circumstances dictated. The changes that the students made to their designs were a result of encountering novel situations with
which they were ill equipped to make predictions as to realistic outcomes. Their understanding thus developed in a concurrent fashion with their design (all names are pseudonyms).

**Interviewer:** Where’d you get your ideas from Kristal?

**Kristal:** I originally had designed and constructed a balloon-powered sky glider sort of. It needed a rail and it just hooked on and…like, I put this (inaudible word) in – little thing – blew it up and I let it go. And I tried doing that and it sort of worked. My brother helped me sort of construct one on land. And it worked the first time I made it. Then he said make it better the second time, and it didn’t work that time because the poles were touching the ground which made too much friction to move. And so I just – my Dad suggested… . (IA-02/1)

The novel situation Kristal found herself in required her to utilise an approach to design that is contingent on the outcome of situations that she cannot make reliable predictions about. The exchange continued:

**Interviewer:** This is on your sky glider thing, there’s too much friction?

**Kristal:** Yeah. No, this is on the land one that I tried to make. And then my Dad suggested a mouse-trap thingy, and then I didn’t think it’d really work.

**Interviewer:** What do you mean a mouse-trap thing?
Kristal: A mouse-trap car? I don’t know how mouse-traps work, but he suggested a piece of string would be joined to the axle of the car and the metal bit – the top metal bit of the mouse-trap. (IA-02/2)

The act of designing may be considered an ongoing activity that is contingent on a number of facilitating or restricting conditions. This is termed ‘contingent’ design, the terminology being used to convey both the uncertainty and the context specific nature of such undertakings. The definition of contingent (previously cited), illustrates how it may be viewed in the context of designing and building an artefact. For example, the following exchange took place after the topic of vehicle design was introduced, the students having been given time to develop their initial prototypes. The whole of the class (in particular Tom, year 6) was discussing with their teacher and the researcher how they might design a switch to operate the motor in a car. The comments from Mrs. Lange, in particular, are closely aligned to the conception of contingent design proposed here.

Tom: What you do is you get two pieces of alfoil and you put them on a pieces of stick and bend it, that way when you press the stick and bend it together the stick’ll touch and…

Interviewer: Did you try it did you?

Mrs Lange: If anything you’ve got to try something haven’t you and say, ‘Well that didn’t work because my stick broke,’ and you’ve got to redesign it again and say, ‘I wonder what?’ You know what amazes me is how much thought has to go into these designs, and how much rethinking has to go into
it; often your first idea isn’t quite working out the way you think it will, so you rethink it. (CV-08/1)

Mrs. Lange is, in essence, identifying key features of what is termed contingent design in her classroom. This also appeared to be a common experience, as reiterated by the students in post activity interviews.

Interviewer: Bella, where did you get your ideas from for that (vehicle)? Everyone in this class had a different idea.

Bella: I was going to make just a little boat with a propeller. I wasn’t sure how I was going to make it so I didn’t make that one because it broke. This one I just found everything in my house.

Interviewer: So originally you wanted to build one that was powered by a propeller?

Bella: Yes. (IA-03/1)

In this exchange Bella indicates how the design of her vehicle was contingent upon the availability of resources and that when this became impossible, the progress of her design became adjusted accordingly. Helen had similar difficulties.

Interviewer: So where did you get your ideas from for this (vehicle)?

Helen: Well, when Mrs. Lange was talking in class to tell us what we had to do, I was kind of thinking of a vehicle that goes on the road that could go in the
water as well. But I couldn’t find a propeller so I just made it a road vehicle. (IA-04/1)

It was not simply the availability of resources that limited or facilitated particular design concepts. It may have been that a particular interaction that occurred between the materials that were used was not to expectations, and that modifications had to be made, as illustrated below.

Interviewer: What was your problem (with your design), Henry?

Henry: I had the first one (a boat) and it sort of leaked. I had this like a paddle-wheeler and you put the motor in there and the wheel sort of went and pushed it along, except the wheel kept knocking the sides so that didn’t work. And the big problem with this (battery) is probably the weight of it.

Julie: (the) battery?

Henry: Yeah, the battery’s heavy and like I’ve got the switch over this side because I couldn’t really put it in the middle because it wouldn’t stay. So I’ve got the switch over one side and it makes it sort of a bit heavy this side and I sort of have to even it out a bit by putting the battery over this side a bit more. (IA-03/2)
Henry (Year 6), in the above exchange, is developing his vehicle through a contingent approach to the problem of balance. That is, his understanding (and his possible design outcomes) is developing as he interacts with the problem.

Similar contingent approaches to design can be seen in the following exchange with Leon (year 4), where he makes significant changes to his design as the result of material availability, as well as actual experience with the designs he is developing.

Leon: Firstly, I started with the boat then I went to a helicopter then a plane then a…..
Interviewer: So why did you keep changing?
Leon: We didn’t have the stuff (to make them).
Interviewer: So why did you choose them in that order?
Leon: We got the boat but the boat kept sinking. (IA-05/1)

The result is a ‘messy’ process that owes much to the concurrent development of understanding of the factors affecting the development of an artefact as the design progresses. This is not the process of ‘trade offs’ but, rather, a fundamentally different phenomenon. As has already been noted, contingent design is utilised when a lack of understanding prevents designers from making reasonable suppositions as to how decisions may affect the outcome. Trade-offs in design, conversely, are the result of good understanding of the design being undertaken. To make trade offs in a design situation requires specific knowledge, and these trade offs are made with a predictive intention. Crismond (2001) investigated adolescent and adult subjects undertaking investigate-and-redesign tasks, noted that trade-offs appear when discussing conflicting design specifications as well as when discussing the science underpinning the design. Whether the students in this study would have the skills and experience to undertake such discussions, and the sophisticated conceptions they entail, is
questionable. As will be developed in the next section, conventional design procedures that require sound prior knowledge, the sort of knowledge that allows designers to make trade offs, in most contexts will be inappropriate for the primary classroom. Mrs. Lange recognised this in the classroom through the indeterminacy of the activity the students were undertaking when she noted:

> With buildings, for example you can’t change the design, whereas in this case because it was so open ended I think they (the students) could keep building it and changing it. (IA-06/1).

This contingent designing evident in the students’ classroom activity is contextually dependent. Mrs. Lange, for instance, speculated that the students did not know if their design was ever finished.

> I think a lot of kids, especially these kids here, don’t know if it ever is finished, I mean they finished it for me that day, the day they brought it in, it’s finished for that day, but a lot of them were already talking about how else they could use it, you know, what else they could use it for, how it would go on the grass, as opposed to when we ran them on the cement down here… I don’t think it was finished for them that day. (IA-06/2)

While it was acknowledged by Mrs. Lange that time was a factor in the design of the students’ artefacts, the differing capabilities and resources of the students created a situation where they were differentially enabled to complete the task. This was noted by Helen, where she stated that:
Henry and Kylie, they’ve got a lot of help from Kylie’s Dad because Kylie’s Dad is an electrician and Henry’s Dad’s a shire worker. (IA-04/2)

The design was, therefore, contingent on the skills of the students (and their parents) as well as their access to resources. As Mrs. Lange noted, one of the main skills that was a requirement of the activity has never been taught to the students.

You see I’ve never asked them this year to design anything, that was really the first time that they’d had to sit down and design anything, there’s not another time this year I can think of that we’d talked about design, so maybe it is a skill they have to learn. (IA-06/3)

This theme will be further pursued in subsequent sections, although it should be noted that the broad thrust of this concept of contingent design is that of limited skills, resources and knowledge on the part of the designer to envisage a realistic final product. The design must therefore progress in a manner that is dependent on new knowledge being developed through the creative process. Students, therefore, learn from what might be called contingent events, such as the failure of a mechanism or the realisation that two materials interact in a surprising manner. Interestingly, the design that most closely mirrored the final product (apart from those drawn post completion), were the simplest designs, which, it may be speculated, would be most easily realised. In this regard an examination of the boat designed and made by Katelyn (Year 4) is instructive (Figures 5.1 & 5.2).
Figure 5.1. Boat design by Katelyn (drawn design) (ART-03)

Figure 5.2. Boat built by Katelyn (Photograph of final artefact)(ART-04)
The prior knowledge required to build this boat was well within the realm of everyday experience for a Year 4 student. The use of cardboard and sticky tape is an activity to which most students at this grade level could aspire. Michael (Year 6) was also able to realise his design by using commercial materials with which he was familiar (see Figures 5.3 & 5.4)

Mrs. Lange also elaborated on the role of students’ prior knowledge and how teachers need to take this into account when implementing a technology program.

We assume that their (students’) knowledge is what we know, but it’s not, it depends on, if they’ve got at home and they’ve played with it (various materials) before and then they know what it does. (IA-06/4)

A technological solution to a problem that is contingent upon a continuous development of understanding is therefore a necessary means of dealing with the unknown factors involved in the creation of artefacts. The question that must be asked is the extent to which this may be utilised within a classroom, and how knowledge of this process progresses the effective implementation of technology. It is evident that students are motivated to complete tasks that they are given in technology, and that much of the designing is of a contingent nature, such as expressed by Mrs Lange.

….they wanted to do it, …..and I don’t think they could conceptualise what they wanted to do without doing it……I think it was changing so much in their minds, and once they got started they realised ‘oh! I could use that other thing,’ but they were more concerned with actually
Figure 5.3. Car design by Michael (ART-05)

The Balloon blows it air into the plastic bag which moves the car

Figure 5.4. Car built by Michael (photograph of final object) (ART-06)
building it and constructing it and doing the design; it was an evolving design. (IA-06/5)

Assessment of how students have arrived at a solution is similarly difficult to achieve. Mrs. Lange suggested that “more controls” might be a means to ensure that valid and reliable assessment may be made (FN-23/7), the suggestion being that control of resources may be a means to determining genuine student capability. In this research program this was not possible to investigate fully.

5.1.1 Summary

Students do not design in a simplistic and orderly manner that is sometimes supposed. Of particular interest is the manner in which they confront novel situations with what is here termed contingent design. Contingent design implies incomplete knowledge of the problems being faced, and the continual modification and exploration of not only artefacts by students, but of the problems itself. Contingent designing may progress through the gradual (and sometimes fortuitous) development of student resources, skills and understandings. Each of these factors may, in turn, allow for the development of a design in unexpected ways. The role of students’ parents, for example, provided a means for students to progress their designs in ways that were not envisaged by them in the classroom environment.

This section of the research shows insights into design processes seen within the classroom environment. The understanding of such design processes suggests a more realistic approach to issues of assessment through enabling teachers to make judgments of student activity based on the manner in which students actually design. The teacher in this classroom clearly identified the contingent manner in which
students were designing, although assessment approaches that reflected this understanding were not fully realised.

5.2 Assertion 2 (Objective 1-Design and Practice in Technology Classrooms)

The implementation of certain design approaches may be inappropriate in this classroom setting.

In the interviews with students following the technology exercises, a number of instances that provided evidence of the above assertion were found. The students were asked to draw a design before they commenced building their vehicles. To attempt to ensure that the students kept these designs for research data collecting purposes, the researcher then asked the students to file them because he wanted to see how their thinking changed as they progressed. It should be acknowledged that such a strategy may have influenced the responses of the students and should be taken into account by the reader. Regardless of this, it may be postulated that the drawn design on paper was of little consequence to many of the students.

Interviewer: So Kylie, you’ve actually got a design in front of you. Did you draw that before or after you made the thing?
Kylie: After.
Interviewer: Why did you draw it after?
Kylie: I drew it today because I didn’t have my model here and I wanted to show you.
Interviewer: Did you actually draw a design before you made yours?
Kylie: Well, I drew a design of the glider and the boat but not actually this.

Interviewer: So why did you not bother drawing a design for your boat that you eventually made?

Kylie: Because by the time we thought of that it was on Saturday morning or Friday night, and we just started work on it and we had to give it lots of coats of paint and so we didn’t really have time and we pretty much had sorted out how we wanted it. (IA-02/3)

This practice, of drawing the design after the completion of the artefact, was “quite common in the class” (FN-17/7/01). The practice may be indicative of teachers’ expectations of what constitutes a ‘proper’ (or conventional) design process more than anything else. Teachers may expect a paper design because that is what they believe professional designers do. In an interview with Mrs. Lange, it was proposed by the researcher that students did not actually follow the designs they had drawn, and that the students had said in interviews that they had thrown them out.

Mrs. Lange: ….or they just drew them for me…

Interviewer: ….or “we drew it at the end….we built the thing and then we drew the designs.”

Mrs. Lange: And it wasn’t what we wanted, it wasn’t the way we felt they’d do it, that’s what it was. I thought they’d have the design first and then go and create it, but that’s my thinking, that’s how I thought they’d do it, but they didn’t want to do it (that way).
Interviewer: Why didn’t they?

Mrs. Lange: They wanted to do it……and I don’t think they could conceptualise what they wanted to do without doing it. (IA-06/6)

The flexible nature of the design process, that which has previously been argued as being contingent, contributed to the students’ approach, as shown by Kylie.

Interviewer: Where did your ideas come from to come up with that boat, because no-one else came up with a boat. In fact everyone came up with something different. Where did your ideas come from?

Kylie: I started thinking about making a glider – a glider out of some balsa wood but then Dad pointed out that the glider wouldn’t work because the Lego man we put in it unbalanced it so it didn’t work. He (Dad) pointed that out in the design so we didn’t do that. (IA-02/4)

Kylie, it appears, was evolving her design ideas and conceptual understanding through, in part, some input from outsiders to the classroom program, such as her father. She continued:

And then I was going to make a steam-powered boat where you get balsa wood and you put a candle on it and you have a copper tube. You put the copper tube through the balsa wood and you coil it round above the candle, and then you stick it back through, and when you light it, you put water through it – like, you suck it
through, and then you hold it both ends so the water stays in there and you light it, and the steam pushes the water round the coil and back out, and that drives it. But Dad said when he tried to make it they couldn’t find any copper tube. (IA-02/5)

In this explanation, Kylie identified the fluid nature of the design process she was undertaking. As materials became unavailable, or unsuitable, the design was modified on the run. To have drawn a design that was a meaningful contributor to the design process would require a knowledge of materials and how they may interact with each other that the students did not possess. The design process that these students were undertaking, although not the idealised process often ascribed to professional practice, is still aimed at the creation of a meaningful artefact. Without the specific knowledge outlined above, it becomes necessary to achieve this through a continuous exploration of materials, a process that has already been defined as contingent design. Kristal was then questioned about a mousetrap powered car that she had proposed designing, and what she understood in terms of how the machine would work.

I don’t know how mouse-traps work, but he (my father) suggested a piece of string would be joined to the axle of the car and the metal bit – the top metal bit of the mouse-trap and when you---But then I thought of things that move like – and rubber bands seem to be pretty stretchy and I thought if it was….like, joined – they were both joined to something, and you spun it round and you let it go, it’d go. (IA-02/6)

What must be questioned, in light of this, is whether the imposition of a particular design process in the classroom as a pedagogic tool is a productive
exercise. Clearly the students involved undertook a number of differing and, it must be acknowledged, unpredictable means to achieve their design goals. A more formalised approach, it will be argued, can only be a success if students possess the necessary skills to undertake the required tasks. In relation to a drawn design this was not the case for this particular class. The role of drawn design can be illustrated by a couple of interesting responses, where Kristal and Kylie are talking about their drawn designs:

Interviewer: Why didn’t people bother following the designs that they’d done?
Kristal: Well, some…mainly because some people didn’t have the right stuff to use, like Michael he said that when he made he had four thingys on it but then he said he didn’t have enough pieces of (indecipherable) and everything, but some people tried it out and it doesn’t seem to work and so you just think of something else and it works.

Interviewer: So you change the thing itself rather than going back and changing the design
Kristal: That’s what I do. I don’t really draw another design. I just….because then you know what is the problem and what’s working and what isn’t. (IA-02/7)

The students in all the interviews had a conception of a design process that understood the artificial nature of certain aspects that they had been asked to accomplish. This was evident most clearly in the drawn design that they were asked to do. The focus the students had in the activity, as can be seen in the above
exchange, was almost entirely on getting the object to work. Almost without exception, as noted previously, the students regarded drawn designs as something that was a ‘required’ but not an ‘essential’ component of the design process, as may be seen in the following exchange with Jenny and Helen (both Year 6).

Interviewer: So you had to try the materials first to see what worked? Well, why did you draw designs then. You’d already finished making it. Why did you do it?

Jenny: Because you asked us to.

Helen: You said you wanted to see how people’s minds change as they go through processes of making stuff----I suppose you’re a bit disappointed…. (IA-04/2)

Helen clearly sees the purpose of the paper design in a completely different light from its expressed teaching purpose; that of guiding the manufacturing process. She regarded it as something to do for the researcher, and it actually had little relationship to her own experience of design. Mrs Lange acknowledged this requirement in an exchange during a class activity (“I thought they’d have the design first and then go and create it, but that’s my thinking, that’s how I thought they’d do it, but they didn’t want to do it” (IA-06/6)). Other students expressed the value of a written design in a more dramatic fashion, such as Tessa (Year 4).

Interviewer: Where did your ideas come from then?

Tessa: A piece of paper.

Interviewer: You actually drew it. (Have you) still got the paper?

Tessa: No. Threw it in the fire. (IA-05/2)
Although perhaps apocryphal, this was indicative of an almost universal expression of the value placed on such elements of design. Tessa and Amber (Year 4) were certainly in accord with their older class colleagues.

Interviewer: Did any of you draw a design at all? …. (girls respond in affirmative) So the girls did. But you’ve thrown yours out. Have you still got yours?

Amber: It’s in a book.

Interviewer: Can I look at it some time? Why did you do yours Tessa? Did you need it?

Tessa: No, I just draw something – like I had little pictures of each what I was going to make – like a car there and a boat down here.

Interviewer: So did you need that at all to build that?

Tessa: No, I just looked at it because I just drew it up like…..

Interviewer: So did you need yours then, Amber?

Amber: Not really.

Interviewer: Why did you do it?

Amber: Because you asked us to

Tessa: You told us to draw picture but I didn’t bring mine.

(IA-05/3)

Some of the written reflections of the students also identified the real meaning for them of the drawn design. In response to the question as to why they drew the particular designs, Shannen (Year 4) wrote “because our teacher said we had to make boat, car or plane for homework” (AFT-5).
Also revealing was the manner in which one student (Jon, Year 6) who struggles with many aspects of schooling, drew his design. According to Mrs Lange he is quite adept at geometry in school (FN-16/7/01), and is proud of his ability in this regard. He also has a father who is a mechanic, and he is familiar with technical drawings. His design (Figure 5.5) reveals an attempt to draw using the conventions of the drawn design he would be familiar with. Its relationship to the final product is marginal (Figure 5.6). Jon explained in his reflection sheet that the discrepancy was due to the fact that “I changed my mind” (AFT-06).

One of the Year 6 interview groups, who were asked what was the purpose of their drawn designs that they apparently did not need, identified the following imperative.

Henry: To show you. You wanted the designs so we had to draw the designs and show you. I wouldn’t have done them (otherwise).

Julie: I wouldn’t have bothered.

Interviewer: Would you have bothered doing them if I hadn’t mentioned I wanted to see them?

Both: No. (IA-04/3)

In field notes the issue of enacting a conventional design process created a need to account for what was being seen. Early notes consider that “students are trying to achieve a balance between competing elements that make up a design” (FN 4/6/01). If a design does not assist students to achieve this, it was surmised, then it will be seen as irrelevant. Assessment clearly needs to be aimed at identifying meaningful processes that are undertaken by students, and not artificial impositions. In this regard the students recognised that assessment of their drawn designs would be meaningless,
Figure 5.5. Car design by Jon (AFT-07)

Figure 5.6. Actual artefact made by Jon (photograph of final object) (AFT-08).
and that there was a mismatch between the teacher’s (and researcher’s) expectations and the process that the students undertook.

5.2.1 Summary

The idealised conception of design as involving preliminary drawing of the design as a guide to the manufacture of an artefact may be inappropriate in design technology classrooms at this level in that it does not reflect the manner which students actually go about the manufacture of their artefacts. An understanding of how students actually go about design processes has important implications for teacher planning and implementation of classroom technology.

5.3 Assertion 3 (Objective 1-Design and Practice in Technology Classrooms)

The physical environment of this classroom impeded productive technological activity, and more planned utilisation could be made of community resources and support.

Students in Mrs. Lange’s class expressed the opinion that technology was not always particularly suited to the classroom as illustrated by the interview below with some of the Year 4 members of the class (Desmond, Amber, Tessa, and Leon).

Interviewer:  My question is: would it have been easier or harder to make (your artefact) at school?
Desmond:    Probably harder because you probably wouldn’t have the stuff (materials) at school?
Amber:     Harder, because you might have needed a lot of space.
Leon: Easier because you’ve got mates around and they might have better ideas and make your idea much better.

Tessa: Harder. Because there’d be too much noise like when the little kids have their lunch and when they come back they like scream. (IA-05/4)

The older students tended to focus on the scarcity of resources in relation to technology that may be found in schools, such as the following extract with Julie and Henry (both Year 6) illustrates.

Interviewer: If you had to do it in class would it have been easier or harder?
Julie: Harder.
Henry: A lot harder.
Interviewer: Why?
Julie: You wouldn’t really have much stuff (materials) that you need for your design or building as you would at home. (IA-03/3)

Even if resources were provided at school one of these students, Henry (Year 6), argues that it would still be harder to achieve the same results.

Interviewer: You three all seem to be saying an important thing is the resources you can get at school. So imagine you’ve got everything you want here at school in your room: switches, leads, sails, matchsticks.....what about then?
Interviewer: Why?
Henry: Like storing something so it wouldn’t get broken (would be difficult). (IA-05/5)

The researcher proposed that this could easily be solved, but the student continued to protest that the method of allocating time to work on a task was not productive.

Interviewer: Oh, we’ll get a room and we’ll lock them up. No-one will get their hands on them.
Henry: The same amount of time?
Interviewer: You’ll have time...a couple of hours a week at least....maybe longer.
Henry: Yeah, but you’ve sort of got to...
Interviewer: A couple of afternoons a week we’ll give you.
Henry: Yeah, but you’ve sort of got to work on it all at once. Like, I didn’t stop. I just did this all at once so you don’t forget stuff. (IA-03/4)

The students also inferred that perhaps the teachers did not have the necessary skills that they would require for their technology activities, such as the following from Kylie.

Like, I don’t know how to use the sanders properly and everything, so Dad helps with that. (IA-02/6)
The limited experiences of the students in regard to technology means that conclusions regarding the limited technological knowledge and capabilities of teachers may be premature in many instances. It would certainly be worthwhile further exploring what students see as the limiting and facilitating aspects of their school environment. In particular, the resources available to schools, the physical environment and the development of appropriate timetabling need to be investigated as variables that may or may not have a bearing on the effective implementation of technology in schools.

It is also of importance that there are recurring references in the students’ responses to the input of their parents (particularly fathers) and siblings to their technological creations, and that this input had not been planned for in any of the activities. These responses are documented in a number of the presented assertions, and reflect the reliance that the students placed on their home context in solving issues they were facing in the completion of their tasks. It is apparent that this resource was, however, not utilised in any coherent fashion.

Geoff also expresses his ideas regarding the inconvenience that students sometimes attached to different activities.

Because they probably wouldn’t let you use the drills at school because you’ve got to have permission because they send a note home. (IA-02/7)

The classroom, it should be noted, was of 1950s design with four multipurpose rooms sharing a common corridor. Changes in instructional style by the teacher often required rearranging of classroom furniture to accommodate activities. It is a common classroom design in this state and would be familiar to many teachers.
5.3.1 Summary

The classroom in which this research occurred was appropriate for the delivery of academic KLAs that, in some ways, have different characteristics to technology education. This is not necessarily conducive to the effective implementation of technology in the primary classroom. It was also evident that there may be an underutilised community resource in the form of parents and community members that may need to be further explored by teachers of technology.

5.4 Assertion 4 (Objective 1-Design and Practice in Technology Classrooms)

Student activity in this classroom was enacted within a framework that allowed for multiple outcomes within a common goal.

As in any situation where students are asked to play a role, it is vitally important that the ground rules be established. Without an understanding of what is or is not acceptable, it is unfair to create expectations of what the students may produce. The development of the meaning of the activity defines the parameters in which end results may justifiably fall. Note, however, that this does not define a particular result, but what has been termed by this author as the ‘field of possibility’ of the activity. This assertion therefore deals with the conceptualisation of technology, particularly from the point of view of the classroom teacher.

It is possible to make this field of possibility large or small. Making a large field of possibility, it will be argued, permits designers (including students) to realise novel solutions, while a small field permits more defined and predictable outcomes. Such a continuum of possibilities has important implications for the assessment in a classroom. For example, Mrs. Lange was clearly in a quandary as to how she should
assess the students in her class when she said that, “It was just a chance for every kid to do something” (EV-01/1). The degree of interpretation that was required for the outcome statements in the syllabus placed Mrs. Lange in a position where she had to make decisions as to what these statements actually meant, in which case she turned to the syllabus support documents (“if I didn’t have the elaborations I would not have a clue in the world what I was doing” (IA-01/1))

In terms of feedback that is given to students, an approach that aims at large fields of possibility requires responses that are more dynamic, allowing for the range of outcomes that would be considered acceptable. This can be seen in the following, quote where Mrs. Lange was talking to her students:

…..if anything you’ve got to try something haven’t you and say, ‘well that didn’t work because my stick broke,’ and you’ve got to redesign it again and say, ‘I wonder what?’ (CA-06/1)

A narrow field of possibility would, conversely, necessitate feedback that allows students the necessary identifiable knowledge and skills to achieve a particular outcome, such as when Mrs. Lange is attempting to get two of the girls in her class to achieve a solution to the problem of water borne contamination within certain parameters. Initially the girls are suggesting a course of action that Mrs. Lange considers unworkable and she counsels them:

It isn’t going to solve our problem, so you probably need two things here. You need things that you can do straight away, and things you can do over the next few weeks, to start to prevent the problem. (CA-05/1)
The chief difference between a narrow and broad field of possibility is that a narrow field of possibility has products that are judged through criteria that more stringently align with the product itself. Any criteria must be met in a clearly defined manner. A broad field of possibility, on the other hand, has criteria that must be more flexible and, as such, will only have meaning in the interaction between creator, user and any physical manifestations.

Both these styles of feedback occurred simultaneously in interactions between Mrs. Lange and students in her class. The interaction following begins when one of the students (Benn, Year 6) suggests that they clean out all the water supply pipes as a solution to a contamination problem.

Mrs. Lange: What do you mean by clear them out?
Benn: Like, get to all the pipes and everything that’s inside it, all the cleaning things and everything, and clean those out properly, so get acids and everything.
Mrs. Lange: How do you know what acids and things to put in there?
Benn: Research (laughs)
Mrs. Lange: Are there people that know? How are you going to know what to put in?
Benn: My Dad, he’s good at it, I’d get my Dad.
Mrs. Lange: So like Benn’s Dad, what do we call people like Benn’s Dad? You’ve got plumbers, you’ve got Henry’s Dad who works at the sewerage treatment, what do you call these sorts of
people? ……….(waits for response) could I say experts?

Benn: Yeah. (CV-05/1)

The initial response of Mrs. Lange was to respond in an appropriate fashion to the suggestion made by Benn, and in particular to clarify exactly what he meant by the suggestion. This is an example of feedback being given to guide the process students are undertaking, rather than for a specific outcome; Mrs. Lange provided guidance, through her questioning technique, which permitted the student to continue with the process they had identified in a productive manner. The next section, where Mrs. Lange proposes the use of experts, is an example of ongoing formative assessment that is directed towards a particular outcome. The guidance is necessary for the students because it directs them toward an acceptable solution; that of utilising experts to assist in the problem at hand. The two styles of feedback are naturally intertwined in the discussions, and allow the student to develop his/her ideas in an appropriate direction. (Note also the use of parents and community as a resource in the creation of artefacts as discussed in Assertion 3)

It was clear that the participants struggled to come to terms with what the activities meant, and yet this determined, to a large degree, what possible final results might be considered acceptable by them. In a hypothetical example given by the researcher to three students (Kylie, Kristal, and Geoff, all Year 6 students), they were to consider the building of a small model house, each student being limited to certain resources. Of particular concern to the students was that some students may get extra marks for going beyond what was asked of them, as illustrated in the following negotiations with Kylie and Kristal, where they were asked whether they would require precise instructions as to what they should produce:
Kristal: Yeah, because otherwise if you just say a house, someone might build a house that big and that big (indicates different sizes of houses with hands), and then you’d probably give more marks to the biggest.

Kylie: Someone might make a big mansion – a two-story thing.

Kristal: With 30 straws.

Interviewer: Remember (you will only have) limited resources.

Kylie: I suppose. Or someone might make a little shack, but then they might use the rest of theirs to make really good people or something.

Kristal: …Well, because some people have like say the little shack thing and they made really good people, you didn’t ask for the people, so if they didn’t make a really good house and they made really good people, then...they’ve got to sort of work on the house and if they’ve got extras, then they can make the people, but....

Interviewer: You don’t get extra marks for it?

Kristal: (yes)

Interviewer: So I’d have to be very clear exactly what I want.

Kristal: Yeah, and say you can have people but it won’t give you marks. (IA-02/8)

The students in the discussion above are grappling with the concept of whether the assessment requires a narrow or broad approach and that this matter must be clearly identified by the teacher setting the task.
In the discussion below, the students are referring to activities where they were initially required to examine water systems in the case of biological warfare affecting the town in which they live. After giving the students an outline of what they would be doing, Mrs. Lange then linked the introduction with previous learning that the students had undertaken in relation to the disaster scenario.

Mrs. Lange: We were talking last week about, what was that disaster during war where we said a lot of places would be completely annihilated, what sort of bombs were we talking about?

Unidentified: Nuclear.

Mrs. Lange: Nuclear bombs, we talked about how whole countries could be annihilated with nuclear explosions…We then started talking about another type of disaster that could happen today, it wasn’t necessarily nuclear warfare we had another name for it…do you know what it was?

Unidentified: Biological warfare. (CA-01/1)

The lesson then progressed to discussions of germs, allowing the students to make linkages with previous knowledge, as well as to posit the technology exercise within other themes operating in the classroom. It should be noted that although one of the students suggested “nuclear bombs” as an answer (CA-01/1, line 3), one that would not lead to the desired outcome, the answer was accepted, then turned to the topic Mrs. Lange wished to discuss. In this manner, the field of possibility is being defined for the students. Knowledge of technology curriculum issues, identifiable developmental phases (Ginns, McRobbie, & Davis, 2001) and syllabus strands is
clearly not sufficient to enact a technology program at a classroom level. A teacher must also possess what might be termed good generic teaching skills.

Although teachers may feel uncomfortable with the KLA (“it wasn’t until I got to those (elaborations) that I really understood what the outcomes meant” (IA-01/2)), it would be natural to ensure that the topics covered in discussions and the general direction of any activities remains within well-defined borders. It appears that in the case of the spreading of disease activity, Mrs. Lange had certain background knowledge that she wished to utilise as a basis for discussions, and this was central to her developing a conception of what the field of possibility was for this task for her students.

Naturally, the discussion eventually turned to experiences that were meaningful to the students, this occurring prior to more widespread community awareness of anthrax attacks in the wake of terrorist attacks later that year.

Mrs. Lange: Why would a country or a group let out diseases or germs into a community…sometimes people could choose to do it on purpose, sometimes we do have germs and thing spread through the community and it’s not necessarily on purpose, can anyone thinks of a time when germs like that could spread through our community but people didn’t really mean to do it? Bella, or Henry?

Henry: When people have got colds.

Mrs. Lange: So we spread colds all the time don’t we? (CA-01/2)
It is in this exchange that Mrs. Lange introduces, for the first time, the key idea to be utilised in this particular unit of work, that of disease vectors and modes of transmission. This idea is developing the field of possibility for the students through the creation of both the language and the ideas that they might use in their classroom activities. It is this key idea, therefore, that directs the lesson and gives structure to what could be a discursive lesson, as can be seen from the exchange below, with Kristal, which occurred shortly afterwards.

Mrs. Lange: Can you think of any other times when whole populations could be affected by things?

Kristal: Like foot and mouth disease or….

Mrs. Lange: (aside to researcher) That’s an interesting one isn’t it?

Kristal: The crazy cow (general laughter)

Mrs. Lange: Crazy cows and mad cows, and foot and mouth. We just talked about foot and mouth recently didn’t we?

Because it’s happening right now. People don’t mean to spread things but they do just spread.

People didn’t set out to spread that disease but it did spread to the community. (CA-01/3)

Mrs. Lange, in the above example, managed the possibilities that were envisaged by the students in her class, thus permitting her to define the field of possibility for this particular activity. Her response to Kristal’s suggestion allowed the students’ experiences to become part of the discussions, without misdirecting the intent of the activity.
5.4.1 Summary

It is evident that technology activity and the manner in which it is envisaged, implemented and assessed in the classroom is greatly influenced by the characterisation of what may or may not be regarded as acceptable final products. Effective classroom technology practice requires teachers and students to articulate the parameters of what might be considered acceptable outcomes in relation to goals identified in the design brief. This means that all involved need to know what has been termed the field of possibility, and further to recognise that any assessment must be made with reference to this field. The data indicate that interactions to manage the field of possibility are possible, but teachers need to be aware of background information on the topic explored, particularly if they require students to operate within a narrow field of possibility.

5.5 Assertion 5 (Objective 2-Assessment)

An understanding of the design processes involved and the artefacts produced in this classroom required an interaction between participants in the design, construction and assessment of artefacts that may best be defined in terms of a narrative.

Evidence supporting this assertion can be found in exchanges between the interviewer and the students when discussing assessment, in particular, considerations made when assessing the various products (and processes) the students had created. In the following exchange Kylie and Kristal (Year 6) were discussing with the interviewer how to make judgments between diverse artefacts. In this case they were discussing the various vehicles that were developed by them as part of their studies of renewable energy, which included boats and cars.
Interviewer: (do you) Put them (artefacts) in different groups (to assess them)?

Kristal: You can’t really because you’ve got to really ask them and see how well they think. You can’t just go on speed because some might be mountainy (sic) and it might take longer to go over the mountain than to go through water, so you just really have to look at how well they’ve done and thought about it. (IA-02/9)

Kristal, in the initial response, identifies two key factors in the assessment of elements such as may be found in a technology program. Firstly, there is the issue of intellectual property; whose work is it anyway? The students in all the interviews were certainly concerned that the credit for a particular item be attributed correctly (FN-23/07/01). It was therefore considered necessary to “see how well they think.” This also demonstrates how the students were concerned that their artefacts be placed in context to make a fair assessment. The exchange continued, with the students being asked to clarify what they meant about seeing how well someone thought, and whether this implied the necessity to actually talk to the designer or builder:

Kristal: Sort of, because when you just look at it, say you’ve…someone just had a cup and it had a motor and wheels, and someone had this big fancy thingy, you can’t just really say theirs is better, because you don’t really know how well they’ve thought of it……..and the big fancy thing might go “Bang” and break down..
Interviewer: ..and?

Kylie: And the little car might go real fast.

Kristal: If you ask them then they...then you know that they actually did it. (IA-02/10)

The second issue that was raised by Kristal is that artefacts may be designed for differing circumstances, and that to compare them in an arbitrary manner would not be fair. This has previously been discussed in the literature review, in that instance in relation to the inappropriateness of snowmobiles in Arizona (Section 2.1.7). The impression from the exchanges that flowed from this response is that the artefacts must be interpreted through the person who made it, that as part of a story, or narrative, and not the story in itself. If this proves to be a common theme in classroom technology, there needs to be an investigation of this relationship between the creator, that artefact and the person judging it. Perhaps the judgment of an item, such as may be undertaken in an assessment schedule, is more a reflection of the values of the judge, than an assessment of the article per se. Kylie illustrated this point while discussing assessment:

Well, if you did have to judge them, on your report card you’d give someone a high mark if they went home and they made something with what they’ve already got. They might already have a set like this. And they make something really good out of that. And then someone else might make something that does exactly the same thing, like, two boats with electronic propellers that stick in the water. But one person might have gone out and bought real flash stuff, like stickers and real good stuff like plastic and have it carved professionally and paid a heap of money to get this real flash little car. And someone
else made something that did exactly the same but it wasn’t as flash looking and you’d give the person more marks for using limited resources. (IA-02/11)

In this response Kylie has identified certain values that she holds regarding the worth of individual items (“you’d give the person extra marks for using limited resources” (last two lines in last quote)). In doing so, she is contending that assessment of an item without consideration of contextual features would be misleading and, by implication, unfair.

Assessment, once again led to discussions regarding the relationships inherent in a classroom technological exercise.

Interviewer: If you had to give marks and say which was best—say out of a hundred. How would you do that, because everyone’s done something different?

Kylie: Well, what I’d do is I’d make like…I’d get several…3 or 4 different terrain…like, uphill, downhill, cross-country, one could be (very quiet?). And I’d make a certain distance they’d have to go and they’d get like say 25 marks for each distance that they go. And like one might…

Interviewer: Do they have to know this before they start though?

Kylie: Well, you do. Whenever I build something like out of Lego—

Interviewer: Yeah, but not for you. We’ve got to do it for everyone.
Kylie: I suppose. Like, when you build something, if you put a lot of effort into it, you make sure that it’s not going to hit a wall like Henry’s, and then just smash apart. (IA-02/12)

Kristal, when faced with the difficulties of applying a fair assessment to different artefacts, utilised the interpretation of such items through the contextual features that framed its creation (as well as the person who created it). She is, in effect, asking that the story, or narrative, of the object is central to its understanding. The following exchange between the researcher, Helen and Jenny (both Year 6) illustrates this point. (Note also the role of parents, as discussed in Assertion 3)

Helen: Well, with Henry and Kylie they’ve got a lot of help from Kylie’s Dad because Kylie’s Dad is an electrician and Henry’s Dad’s a shire worker or something. So they all had the gear on hand.

Interviewer: Do you need to know something about the person who’s making it?

Helen: Yeah, Henry had that switch and that. I kind of expected him to do something good.

Jenny: Yeah, because he’s like that kind of person. Kylie like really……

Interviewer: So it makes a difference what resources you’ve got access to?

Helen: I showed my Dad actually after I’d finished, and he told me it was good. He said he might have had something up in the shed I could have used,
but when we went up to look the shed’s a pigsty
so we couldn’t find anything. (IA-04/4)

The ultimate test of how well someone has done, in the students’ eyes anyway, is not how good the object is that they have made but, rather, how well they have developed their own thinking within the contextual confines they find themselves in. Examples of this were also found in discussion with Mrs. Lange where, first of all, she outlined the difficulty in assessing the students’ work.

Mrs. Lange: ….because each kid picked different things, so they were having different learnings, so you can’t assess the kids on one thing because they’ll all be doing something different. The little (grade) fours, they might have been just learning about the wheel, the circular wheel, and how it wouldn’t move better if it was bumpy or something.

Interviewer: That was one issue that come up (in the interviews with students), how do we assess, say, a boat with a car?

Mrs Lange: Yes, it was a difficult comparison, and the only way you could assess it was the children’s understanding of what they had made, what they had learned about their particular thing. (IA-06/7)

Implied in this response is the opportunity to assess the students at different level outcomes, as would be necessary in a mixed grade class such as this. Despite this, Mrs. Lange did not capitalise on her realisation that the students’ development of understanding, rather than their created artefacts alone, could form the basis of any
assessments, and no such assessment of student in terms of outcomes took place. Note also that levels of outcome statements of achievement for students were not a consideration. This development of understanding is part of what is termed, in this assertion, the narrative that accompanies the artefact. Mrs. Lange also discussed the importance of understanding the students in her class and how this affects what they may derive from a particular technology program. She stated:

… because kids do have access to different things, so how can I compare children who have access to motors and things against someone who wouldn’t have any equipment at home? It was just a chance for every kid to do something. (EV-01/1)

In this educational setting there seems to be a readjustment of the traditional methodologies utilised to assess the work of students. Mrs. Lange, for example, considers that the important issue at stake in the implementation of the technology program is the students’ understanding of the technology activity, not the creation of artefacts themselves, whereas in much traditional assessment the artefact produced is often the only item used in student assessment. She articulated this in the following statement:

What was important for me was the children’s understanding of what was happening with their particular creation. Like, had they come to some sort of understanding about what makes things move? (IA-06/8)

How then, would this assessment be achieved? From Mrs. Lange’s point of view:
…the only way to assess it would be (to) look at your observations, but also (to) discuss it with the kids. You can do that with four types of assessment; observation, discussion, peer and self assessment, and an analysis, a critical analysis, but you really do have to look at observations (of what they are doing) and also discussing with the kids, they need to explain to the others how theirs moved. (IA-06/9)

Mrs. Lange is articulating a clear need for the narrative (i.e., how it came into being) of the artefact to be part of assessment. Would the classroom teacher, then, have assigned marks to the students involved? Mrs. Lange was asked if she would have felt comfortable doing so, and replied:

No, I couldn’t have given them a mark, all I could have done is write an anecdotal note about that child’s understanding of the way something moved. (IA-06/10)

A key question in relation to development of assessment regimes and classroom program development was then asked of the teacher, and the answer has a number of significant implications.

Interviewer: Did you have any ideas before you started what those (understandings) were?

Mrs Lange: No, it emerged from the activity because, as I said earlier on, we were just flying by the seat of our pants, and I hadn’t thought about assessment
in great detail because we were just trying out the activities involved in it and trying to get a grip on that, rather than how to assess it, seriously assess it and, in retrospect now, it would have been hard to assess. I would have had to leave assessment to the end, because I can’t think of any other way we could have done it, now that I’ve done it. (IA-06/11)

Traditional views of assessment and teaching implicit in this response are also evident in discussions with the students in the class, where Leon, Amber, Desmond and Tessa (all Year 4) are deciding whether another student was deserving of a particular (imagined) mark.

Leon: I think Helen’s would be better because she put more work into hers.
Interviewer: So it’s how much work you put it into it?
Leon: Yeah, Henry, he bought this Lego thing and they come with motors.
Interviewer: So it wasn’t as hard for him?
Leon: Yeah.
Amber: I think you should just give them the same.
Tessa: Like 100 out of 100?
Amber: Like if one of—Helen gets only 99 out of 100 I think Henry should get 99 out of 100 too because they both go and they both go a long way but Helen’s is just slower. (IA-05/6)
The students’ discussion then became somewhat convoluted as to how they would assess the vehicles, culminating in Tessa’s interesting view of the relative merits of boats and cars.

Tessa: Like if the wall wasn’t there and it was all cement here, they (the vehicles) could probably go around the school.

Desmond: I’d give them both (Helen and Henry) 100 out of 100 because they got a long distance and it doesn’t matter if Henry’s goes faster, it may win a race against Helen’s but it’s still good because they go a long distance.

Interviewer: How would you tell which is better out of a boat and a car?

Tessa: Easy. Because like boats go further distances than cars sometimes (IA-05/7)

5.5.1 Summary

It is evident that the assessment of classroom technology concepts and processes requires an interaction between participants that amounts to a narrative that defines the meaning of the created artefacts to the creator and the assessor. This interplay is termed a narrative because of the necessity to involve the experiences and expectations of the participants to establish the meaning of any artefact to them. The interpretation of artefacts, from the point of view of the teacher and the students, was contextualised in terms of relationships between the artefact, its creator(s) and its user(s), in this case the classroom teacher. Conceptualising the process of developing an artefact as a narrative would permit a more flexible approach to assessment that
reflects the reality of classroom technology observed in this research, in particular, the human aspects of technology (see Section 2.1.5).

While artefacts are the visible outcome of technology activity, understanding the meaning of such artefacts is not as straightforward as a simple examination of material manifestations. The data presented here indicate that including the artefact as part of a narrative (that may or may not have finished) places the participants in a more constructive framework for interpretation (and assessment).

5.6 Assertion 6 (Objective 2-Assessment)

Differing understandings of assessment existed within the classroom, and these understandings influenced the behaviour of participants (both students and teacher).

Within the classroom it was possible to observe differing understandings of assessment. The students were quite concerned about plagiarism (also see Assertion 5), or stealing of ideas during activities. While interactions illustrating this have already been noted, the following exchange between Henry, Bella and Julie (all Year 6) further demonstrated this area of concern for the students.

Henry: Yeah. Like, another thing is if you did it at school people would sort of…
Julie: Steal your ideas.
Interviewer: Steal your ideas?
Henry: Yeah. Everyone would sort of do the same thing.
Interviewer: Is that important that no-one else pinches (sic) your ideas?
Both: Yes.

Interviewer: Why?

Henry: Because you make the same thing.

Julie: Yeah, and it wouldn’t be as good because like everyone would be the same and…yeah.

Henry: And like you’ve thought about it for a long time and somebody just takes it and…

Bella: And if you make something and it didn’t work and theirs did…

Henry: Yeah.

Bella: …it’d be really…

Henry: It’d be a bit…because it’s your idea. (IA-O3/5)

It remains to be seen how this is reflected in a broader context, particularly if students are undertaking group activities, although the other groups in the class focused on what would be considered to be traditional methods of assessment. Amber (Year 4), for example, when asked how she would assess students’ work replied, “just make sure that they go and if they don’t go, they---if they do go and they only go a little way, you could give that like 50 out of a 100 or 80” (IA-05/8), indicating the application of a specific value to the students’ work, in this instance based on how far the artefacts moved.

The above response is in stark contrast to other statements made by students where they expressed more holistic conceptions of what might be appropriate assessments (e.g., you’ve got to really ask them and see how well they think [IA-02/9]). Other conceptions of appropriate assessment did occur, such as with Leon (Year 4) who argued that the effort that students put into artefacts should be
considered. He compared the efforts of one student to that of another who had access to commercially bought materials.

Leon: I think Helen’s would be better because she put more work into hers.

Interviewer: So, it’s how much work you put it into it?

Leon: Yeah. Henry, he bought this Lego thing and they come with motors. (IA-05/10)

Students working in groups, as occurred in this research for certain activities (see Table 4.1), further complicate the issue of assessment. This difficulty is evident in the experiences of Mrs. Lange where she remarked that, “what was important for me was the children’s understanding of what was happening with their particular creation, like, had they come to some sort of understanding about what makes things move?” (IA-06/8). Furthermore, as noted previously, she also added that, “No, I couldn’t have given them a mark, all I could have done is write an anecdotal note about that child’s understanding of the way something moved” (IA-06/10). This attitude of Mrs. Lange to assessment had clear implications for the manner in which she implemented the technology program. The difficulty in actually enacting what she envisaged were appropriate assessment procedures, as exemplified above, led to her abandoning any summative assessment, and no marks of any kind were assigned to the students’ efforts, nor were they assessed in terms of any of the originally defined outcomes (see Section 4.1) or levels of outcomes.

It is evident that participants in the technology process bring differing meanings of what is a successful outcome for the activities and that this must be taken into account when making assessments within the classroom environment. The students in the class also argued that their behaviour could be affected by the assessment that
they considered might be attached to their efforts, as shown by Kristal (Year 6), who, when asked as to how ideas should be shared in the class said:

If it was a friend, I’d help and suggest a few ideas, but I wouldn’t necessarily tell them that mine was a rubber-band powered car and it had this and this and this. I’d just…because…I like having original ideas. (IA-02/12)

Henry (Year 6) also identified that an assessment regime that assigned marks could be damaging to students, and suggested that teachers could approach assessment in a different manner:

(When) you’ve got the whole class here you wouldn’t say “That’s bad.” “That’s good.” You’d give them a mark personally, like talk to them personally so you don’t upset everyone else if someone hasn’t tried as hard. (IA-03/6)

While the students were provided with a design brief for their activities, at no stage leading up to or during the activity were any evaluation or assessment procedures discussed in terms of the design brief. Indeed, assessment in general was also not discussed in relation to the activities. This appears to have created the situation where there was little clarity within the class as to how judgments of student efforts might be undertaken.

5.6.1 Summary

Assessment has differing meanings for participants in the classroom. The assessment of technology capability requires participants to be cognisant of this, and
to ensure that participants come to an understanding of what assessment actually means in the context they are participating in. In this particular research context it is not clear that the students or teacher had a common understanding in this regard.

5.7 Assertion 7 (Objective 3-Curriculum)

The technology curriculum posed particular problems for this teacher in relation to her planning for units of work.

This assertion is developed from observations of what was planned to happen in the classroom, and what actually occurred. The following examples relate to the students’ undertaking of activities relating to their disaster management plan (see Table 4.1) where, following the students’ work in small groups, Mrs. Lange decided to bring the class back together as a whole to discuss what had occurred. A discussion took place between the researcher and Mrs. Lange regarding the purpose of such an activity.

Mrs Lange: What I want to do is just bring them all together (her students) and just sort of get a few ideas, list them a few down so they’ve heard what each other have said and then turn over (the sheet they are working on) and just find any starting point at all at a site they think this is where it happened.

Interviewer: So just try and follow it through?

Mrs Lange: And then just get to draw (out) how people caught it (the pathogen) from that source, see what comes up.

(CV-04/2)
At this point the strategies being employed by Mrs. Lange would seem to be directed by a single issue (a point source of infection by the hypothetical pathogen) that had emerged from the activity itself, through discussions with her students. The conversation then continued with Mrs. Lange.

Interviewer: That group over there, they were starting to come up with this idea of, I guess, a point source, they were talking about starting at the local dam and going through the pipes and that sort of thing.

Mrs Lange: ……it was painted on (that statue in the park), so that find the source, so identify where the source came from, where they think it could have come from and then join all the ways that people may (have) got infected, and it spread from there, just to see what it looked like, because it’s all going to be different.

Interviewer: Yes, and I guess that when they finally get onto doing up this plan they’ve got to consider, that we probably can’t cover every individual.

Mrs Lange: Yes…..broad plans that cover as many possibilities that they can think of, so I don’t suppose they can be super specific (Mrs Lange goes to front of classroom and talks to whole class). (CV-04/3)

In this exchange, the development of some sort of direction for the activity is being attempted. In the first statement by Mrs Lange, she proposed that the students turn over the sheet that they have been working on and start mapping the direction of disease from a given starting point. The discussion with the researcher was to clarify
how the activity would proceed. It appears that the planning of Mrs. Lange was a representation of her own expectations of what may occur, and may have been more effective if it took into account the less predictable aspects of this KLA (e.g., an acknowledgement of the open-endedness of the activity and the multiple directions students could take). That is, the expectations of teachers regarding the predictability of their planning acquired through classroom experience with other curriculum areas with which they have considerable experience, may need to be re-examined given the lack of experience and knowledge with the technology curriculum area. As noted earlier, Mrs. Lange had difficulty in understanding the syllabus and the implications with regards to outcomes, and so she had to rely on the specific examples given in the elaborations, which limited her expectations to those examples. It is argued here that these elaborations provided a framework of expectations that enabled Mrs. Lange to visualise the possibilities of the activities in a manner she could not do from experience. Therefore they assisted her in circumstances where her experience would normally be expected to provide guidance. It also may explain why Mrs. Lange did not use the outcome statements she selected from the syllabus beyond their initial identification; these outcome statements did not allow her to conceptualise classroom activity in the manner that the elaborations could. Any assessment in terms of these outcome statements was similarly diminished as they no longer drove the development of classroom activities, thus weakening any links between them.

This lack of experience with the curriculum area and limited technology knowledge may also be illustrated by the manner in which Mrs. Lange responded to misconceptions the students had regarding certain concepts. The connections between the planning and the implementation in the classroom appear to have become tenuous in circumstances where students were encountering conceptual difficulties, as she did not have the required technology knowledge to redirect the discussions towards the achievement of her identified outcomes, becoming focused on the activity itself. In
the following exchange, between Mrs. Lange and Helen (Year 6), it is clear that the students had a number of misconceptions regarding the transmission of disease, the key concept that underpins the activity.

Mrs. Lange: I know you haven’t got them finished, but I want to see some of the ideas that you’ve got so you can hear what other peoples’ thinking is in case they have a really good idea that you hadn’t thought of. Helen, can you tell what you’ve got down on your list for the air-borne (diseases)?

Helen: In the streets.

Mrs. Lange: So you’re saying that the people in the streets, they could end up with these things. Can you tell me why you put streets down? What’s special about being in the streets that could get you this germ that’s air-borne?

Helen: There’s lots of people there.

Mrs. Lange: So a place like the streets where there’s lots of people there. Now what else have you got written there?

Helen: Parachuting.

Mrs. Lange: Parachuting? Tell us about that one.

Helen: You said germs carry in the air and if you like float in the air germs could like fly up and get into you.

(CV-04/4)

The above exchange illustrates how planning for a KLA without specific content outcomes may be difficult. Helen understood that the concentration of people
was a key concept behind the transmission of disease. The next idea (parachuting) is based on a misreading of information that was given to the students. In the first instance, the information regarding the concentration of people in an area perhaps needed to be developed. It must, to be useful in this context, be applied to the development of the emergency plan and to the outcome statements identified in the planning. In the end, as will be discussed later, this does not occur, and such information becomes an end in itself, in that it is not applied to assist the students in their technology activities or achievement of identified outcomes. In the last exchange, Mrs. Lange accepts the first explanation and identifies the general principle that underlies it. She also accepts the second explanation, although it is not reinforced or developed, and the lesson continues with an exchange between Mrs. Lange and Kylie (Year 6).

Mrs. Lange:  OK who else has got some really good ideas for airborne (diseases)?
Kylie:    Smoke exhaust fumes etcetera, being sprayed in the air.
Mrs. Lange:  Kylie, where would you be if it was carried by the exhaust and the smoke and the fumes, what sort of place would be spreading that disease
Kylie:    The main street.
Mrs. Lange:  Why the main street?
Kylie:    Because of the truck exhaust and the car fumes.
Mrs. Lange:  OK, so it’s coming out of an engine, that you would avoid the streets because that could be a place where you could get it easily, OK? (CV-04/5)
Once again, the question must be asked as to how this particular misconception (that equates pollution and air-borne infective agents) is addressed, and the influence that it has on the students. There may be instances in which these conceptions become an end in themselves, rather than assisting in the development of a particular learning objective, in this case the disaster management plan. Such an approach is more in line with traditional subject matter where knowledge is valued for itself (see Section 2.1.6), rather than being valued for its utility in addressing particular issues. Further discussion then ensued regarding the actual circumstance that required the control of disease.

Mrs. Lange: What else is there like aeroplanes that you’re in a confined space for a long time? Let me just tell you this story, Mr. Davis have you been overseas?

Interviewer: Oh, a couple of times, New Zealand, don’t know if that’s classified as overseas or not.

Mrs. Lange: Because when you come back into Australia, what they actually do on the planes when you land, you’re all sitting there and the pilot comes on and says “everyone remain in your seats, do not leave your seat” and even though you’ve taxied down and you’ve come to a stop, the customs comes on (and) they have two spray packs, in aerosol containers like Pea-Beau (an insecticide), and he stands at the front of the plane and, one in each hand and he starts to walk down the plane right down the middle of the aisle spraying you and spraying all your things, what do you think he’s doing that for?

Unidentified: He’s sterilising it (CA-05/1)
Mrs. Lange proceeds to develop this idea further in relation to the students’ understanding, trying to gain from the students more information as to the purpose of such an exercise. Kristal (Year 6) responded in the following manner.

Kristal: Killing all the germs on everything because if one of the ladies was serving fruit and came past and touched your hand, she could have had foot and mouth and if she touched your pen you could touch it and have foot and mouth and touch someone else and they could have foot and mouth.

Mrs. Lange: And also what other little things like to catch rides in aeroplanes?

Unidentified: Bugs.

Mrs. Lange: Yes, little bugs that might have just come in on the back of your shirt when you board the plane in Hawaii, and it’s still on the back of your shirt, it’s flown up to the back of the aeroplane while you’ve been on the flight. (CA-05/2)

The relationship between exchanges such as the one above and the intended direction of the lesson as derived from planning is in the identification of vectors of diseases. How this was applicable to the students’ tasks in the classroom is, however, somewhat tenuous. The student activity this related to concerned primarily an understanding of systems (see Section 4.1) in a highly specific context. Such exchanges are typical of the more generalised knowledge that may be valued in traditional KLAs. The central question is, then, how is this directed to the identified
educational outcomes exemplified in classroom planning through the outcome statements of the syllabus?

Further, as the students undertook the tasks, in particular the initial stages of their development of a disaster management plan, it was important that the boundaries of the teacher expectations of what did or did not come within the scope of the envisaged activity are evident to all participants. It may even be true to say that the boundaries are negotiated. This negotiation is apparent in a number of discussions between Mrs. Lange and her students, thus revealing a degree of flexibility that must be an essential component of any planning. What is not evident is the linkages between this negotiation and the syllabus documentation. At the conclusion of a whole class discussion the following interaction took place between Helen and Mrs. Lange.

Mrs. Lange: Any questions? Helen?

Helen: Why can’t we just evacuate the town?

Mrs. Lange: Because if it was a real situation you might not be able to evacuate the town.

Unidentified: If you evacuated the town, those people who are already infected carry it to another place.

Helen: You said it was going to be in our town.

Mrs. Lange: It’s just a scenario Helen, a pretend story. (CV-04/6)

In a curriculum area where the direction of classroom activities cannot always be determined, the expectations of the teacher reflected in her planning are certainly of interest in the context of this study. The teacher expectations imposed on the scope
of the activity are clearly important in the interpretation and meaning for all of the participants. These expectations were not found to be driven by the syllabus, in particular the outcome statements, in all circumstances.

In the activity that involved the design of vehicles, certain limitations (fuel, materials, where the activity could occur, how students presented their artefacts) determined what the activity could mean for the students. This activity was based around the concept that fossil fuels were damaging to the environment and that alternative fuels would be needed for transport. Kristal (Year 6) and Mrs. Lange had the following exchange:

Mrs. Lange: What’s happening to our environment by using lots and lots of these fossil fuels? We talked briefly about some of the things that are starting to happen, what was one of them Kristal?

Kristal: Well, um, like when you burn things all the smoke gets up and it just pollutes the air.

Mrs. Lange: So we get some pollution, good girl. (CA06/2)

This exchange highlights how Mrs Lange developed a context for the activity the students were to undertake. Thus she was providing an opportunity for students to develop a common meaning of what the activity actually meant. A background scenario was then developed by Mrs Lange in which the activity was to take place, with contributions from Ben (Year 6), Henry (Year 6) and Leon (Year 4).

Mrs. Lange: Every year our population is getting bigger and bigger, not just in Australia but in the whole world, not just by a couple of people but by millions and
millions, now all of those people still need to have electricity, and they need to have cars, especially in the developed countries. In the rich countries like Australia and America the people who can afford cars and the things that we need to make our cars go and for our electricity to be generated are all these fossil fuels. Now we’re finding that because our population is so big and because we’re using all these fossil fuels that very soon we’re not going to have many of those fossil fuels left….If we continue to use as much coal as we’re using every day, as much natural gas as we’re using, all, of a sudden we’re just going to run out; there’ll be no fossil fuel left. What’s that going to mean for us? What sorts of things won’t you be able to have or do?

Ben: There’d be no electricity.

Henry: There would be electricity, because there’s solar power.

Mrs. Lange: So if we don’t have the fossil fuels we’re going to have to find another way. What’s another name for ‘another?’

Leon: Alternative. (CV-07/1)

The discussion continued in this vein covering hydro-electricity, geothermal power, wind power, solar power and nuclear power. The students were then asked to develop designs for vehicles that took the information that had been discussed into account. It is clear that much of the planning that took place for this lesson was to
develop an appropriate scenario or context that would have meaning for the students in the class. For example, part of the planning for the unit involved looking at issues with which rural students could identify, such as salinity, farming practices, and deforestation (ART-2). It also appeared that the nature of this task, which identified a clear outcome in terms of materials, was more accessible to Mrs. Lange than the previous activities on systems. Following the discussion above, Mrs. Lange presented the ‘design brief’ to the students.

…..you’re going to design for me a machine, a vehicle, that can carry a person. This vehicle cannot use fossil fuel, so it can’t be powered by petrol, or coal or natural gas, you can’t use any fossil fuels to drive it, you have to use one of those alternative sources; you can use solar power, wind power, probably not nuclear power.

(CV-07/2)

The planning for this unit revolved around framing the parameters for the activity and envisaging how the students may interpret them. For example, the overall learning outcomes the students were expected to undertake (including other KLAs as well) were, thinking, investigating, creating, communicating, participating and reflecting (see Appendix 3). These processes were used by Mrs. Lange to frame the activities the students undertook in the classroom (see Appendices 4 & 5). Technology outcomes were then identified utilising this framework. The issue of such identification of the KLA has been covered in previous sections (see Section 2.1), and it will be contended here that the experiences of the first activities (relating to systems and disaster management) may have informed the development of the final activity (fossil fuel free vehicles). Mrs. Lange had noted to the researcher how the indeterminacy of the first activity resulted in her finishing it up early, because she
could not see how an end point could be reached, where she said that she had stopped that activity because “they could go just about anywhere” (CA-04/1). In the final activity a pre-determined end point, the production of an actual artefact, was identified as the goal of the program (see Appendix 4), simplifying the conceptualisation of the activity in terms of an identifiable ending. The difficulties associated with the syllabus may, therefore, be related to the particular strands, and teachers may need to develop more effective understanding with these areas of the syllabus.

The planning undertaken in this particular classroom developed as the teacher broadened her understanding of the KLA. The following exchange took place between the researcher and Mrs. Lange during students’ group activity on the disaster management activity. At the time when this conversation took place, the students had identified preliminary ideas regarding how they might tackle the problem of a biological contaminant in the water supply.

Mrs. Lange: (indicating various groups) These guys have thought about the immediate and the longer term (problems), these guys have got on to announcements to the people too, the boys over here are actually doing a flow chart so that ‘if this, then this.’

Interviewer: Good.

Mrs. Lange: That’s interesting, just the different ways they talked about how it could work.

Interviewer: Are they relating it back at all to the diagram that you drew during the introduction (to the lesson)?
Mrs. Lange: Yes this group here did, because they were actually able to show me on their map, they were going to stop the river from flowing, and I said where are you starting on here and they were able to show me…And I think they’re at least starting to understand how the system is coming together…I don’t know what I’ll do from here (in class), I’ll get them to prioritise in a minute, but most of them have started to think about it, and I’m not sure if we’ll get much further, so I’m just thinking what we should do. (CA-02/1).

The researcher at this stage offered some suggestions as to where Mrs. Lange could develop the activity, but she was still unsure as to whether this was possible, for example:

I don’t know, I’m not really sure where to go from here with it, it’s hard…. (CA-02/2)

At a later stage the researcher offered some more opinions as to how things might progress.

Interviewer: What if they do it …, are they talking about it in terms of information, what is the important information we need to know, then what’s going to come from this information?

Mrs. Lange: Give me an example of what you mean by this.
Interviewer: OK, this is confined to the houses on the Western side of town.

Mrs. Lange: Oh I see.

Interviewer: Therefore our action is we’re going to test the water in the Eastern side of town and if that water is still OK we’ll stockpile it or something.

Mrs. Lange: We could throw in some more detailed scenarios. (CA-02/3).

It is evident that new strategies may need to be developed in relation to, in particular, the planning and subsequent implementation of technology programs. Once again, this strand relating to systems presented particular difficulties for Mrs. Lange, and she was endeavouring to explore the issues to develop her own understanding, particularly through the use of an actual example.

5.7.1 Summary

It is evident that teachers like Mrs. Lange will need considerable professional development in their pre-planning and subsequent implementation of technology activities if they are to effectively capitalise on the open ended nature of those technology activities. This will include a balance between this capitalising on the open-ended nature of technology activities and the many directions and possibilities that this includes, and directing those activities towards the achievements of specific outcome statements. It may also be of benefit to identify particular strands of the syllabus that present problems to teachers, to address more effectively the lack of familiarity with certain key concepts.
5.8 Assertion 8 (Objective 3-Curriculum)

Evidence of the development of student and teacher understanding was observed in this classroom environment.

It has already been noted in the literature review (Section 2.1.10) that teachers observing what students are actually doing in the classroom have proven to be problematic in relation to assessment. In the following extracts, the development of student understanding of a contemporary issue (a foot and mouth outbreak in the UK) is elaborated on to demonstrate how such development of understanding may be seen in the classroom environment. Kristal, for example, explored her understanding of foot and mouth disease, and, in particular, transmission of the disease in the following excerpt:

I saw in a magazine, I think it was yesterday, that there was like this barn sort of thing but there were all these different sorts of animals, and you had to wipe your feet on this disinfectant mat before you went in because, like if you walked on the disinfectant mat it would get all the foot and mouth or whatever you’ve, because they didn’t want the foot and mouth get carried in and that. (CA-01/4)

The students in the class were utilising their prior knowledge to attempt to make sense of the concept of disease transmission. This linking of knowledge to new concepts may be seen as the development of new knowledge and understanding. In this case, however, Mrs. Lange was less sure of herself, particularly as the method of transmission, the key concept in the program, was an unknown to her. This was addressed by referring to the researcher.
Mrs. Lange: I’m not sure with foot and mouth, Mr Davis, it is actually saliva from the cows isn’t it?

Interviewer: It can actually travel a certain distance through the air as well, which is why adjoining farms get infected, even though they don’t move the cattle around or anything they can still, not a long way I think, but they usually close off a couple of kilometres around the farm because it can go on the wind for a certain distance.

Mrs. Lange: So it’s actually carried on the wind? If you have a look on my board you can see I’ve got the word that means to carry in the air; it’s actually two words, can you see up there what it might be? (CA-01/5)

In this exchange, the lesson once again returns to familiar territory, and a less unpredictable milieu. As noted earlier, the students in this class, as they can in any class, tend to get off track at times, such as can be seen with Liam.

Liam: What about nits?

Mrs Lange: Well they’re not germs are they?

Liam: A couple of years ago, you remember, a person stole a truck and drove through town and all things fell off, if it was a different type of truck, say a garbage truck, all sorts of diseases could be just released.

Mrs. Lange: OK, so maybe the truck, rather than just being a semi trailer with white goods on board like that
truck was and little computers and things, it could
have been a truck that they might have been
carrying some special germ to a laboratory test and
maybe the germ got out. (CA-01/6)

In the exchanges above Mrs. Lange was required by circumstances to redefine the boundaries of the discussion. In the first instance Liam offered the suggestion of nits as being in the same category as germs. Certainly in schools they are treated as an infection, and the premise on which he based this conjecture was reasonable. The question must then be asked as to how this exchange can be interpreted from the standpoint of the student as well as that of the teacher. The student is clearly making the association between infection and head lice, one that is not intended by the lesson. The response from Mrs. Lange is that they “are not germs are they?” (CA-01/6). While there seems to be a collective (and unspoken) understanding of what germs are, this is never articulated at any stage, and it is not clear that the students, in this case, have progressed in their understanding of the issues. This is an issue of prior understanding that perhaps needs to be addressed. Just what is the students’ understanding of what constitutes ‘germs,’ and is this relevant to the conduct of the unit? In terms of the teacher’s point of view, the feedback given in this exchange was to remind students of this prior understanding. The feedback is, in essence, stating what is to be accepted without necessarily examining the student’s understanding of the issue. In terms of lesson structure it allows the lesson to progress without being misdirected. Once again, it may be that this exchange is indicative of a teacher coming to terms with a new KLA, keen to keep the key idea in focus, where teachers, according to Mrs. Lange, “will do the things they feel comfortable with” (IA-06/12).

In the second part of the exchange above, Liam has made an interpretation of transmission of disease in an almost literal manner, utilising the example of a stolen
truck ‘taking’ diseases around the town. The feedback given by Mrs. Lange accepts
the input given by the student, and feeds it back to him (and the class), with subtle
changes that reflect another key concept that is involved in the structure of the lesson,
that of particular germs being involved in the infection of people. This development
of ideas reflected an understanding by Mrs. Lange of what was required by her class
to develop their conceptions of the issue. The idea of infection by particular agents
was certainly tied up with the variety of means of transmission that are discussed
shortly afterwards. The concept of transmission, however, clearly needed to be
redefined in this case, and Mrs. Lange returned to this theme, where she stated that,
“OK then, let’s think about foot and mouth. How is the foot and mouth disease, or
germs, being carried? How are they being carried?” (CA-01/7).

In relation to this, at the front of the classroom was a blackboard/whiteboard
arrangement that had the following headings already written on them;

- Air-borne
- Wind-borne
- Human contact. (FN-8/5/01)

A discussion took place between Mrs. Lange and the class as to what these
categories actually meant to students, within the context of a discussion of foot and
mouth disease. Mrs. Lange noted that the category ‘human contact’ may be
inappropriate, and that it may be modified to ‘contact’ (CA-01/8). This is illustrative
of how Mrs. Lange envisaged the lesson progressing, that it would focus exclusively
on human diseases. It is evident through the changes made by Mrs. Lange that her
own understanding of the topic was developing alongside that of her students. The
utilisation of foot and mouth disease necessitated a minor modification to this
planning. An exchange shortly after this illustrated a misconception Benn (Year 6) had that was not addressed by Mrs. Lange.

Benn: Back to how you get diseases …. couldn’t it be…. by pollution and trucks and everything?

Mrs. Lange: Which one of the three on the board would that be Benn, if it was that sort of pollution … What’s it being carried in?

Benn: Oh, air.

Mrs. Lange: Yeah, so it’s probably still air pollution, sorry still air-borne, be carried in the air. (CA-01/9)

Benn has equated disease carried by air with other substances also present in the air. The distinction is clearly important in terms of the objectives of the lesson, that of understanding transmission of disease as a means to understanding systems (outcome SN 3 - Students explain the relationships between elements of a system and identify how they contribute to the input, process or output of the system and identify subsystems within systems [see Appendix 4]), and yet Mrs. Lange does not make the connection. Although the distinction was made previously between head lice and germs (“well they’re not germs are they?” (CA-01/6)), that between germs and pollution is not made. Possible explanations as to why Mrs. Lange did not provide guidance in this regard may be that she was focused, as had been previously discussed, on the key idea of transmission methods (“OK then, let’s think about foot and mouth. How is the foot and mouth disease, or germs, being carried? How are they being carried?” (CA-01/7)). Benn did demonstrate, however, a development of his own understanding in terms of air being a means of transmission, however inappropriate it may have been in that particular context.
Once again it may be that Mrs. Lange was concerned with the nature of the KLA, of not letting it become discursive, and of being in control. In field notes at the time the researcher noted that “(Mrs. Lange) is already starting to narrow down the activity for next week. Is she worried about unpredictable/undirected outcomes?” (FN-8/5/01). It was certain that any discussion of the distinction between pollution and ‘germs’ would take a little time, but without it students may have failed to make an important conceptual progression. Within this context it may have been that providing ‘accepted’ knowledge, such as discussed above, may have been a means of meeting the necessary objectives of the lesson. Such provision should, however, be regarded as scaffolding to allow the lesson to develop, and must be returned to at a more appropriate time. To do otherwise would be to allow the misconceptions clearly present in the above exchange to remain legitimate in the minds of the students. This example may be regarded as offering evidence of a lost opportunity to teach students a key concept, although it was partially addressed by Mrs. Lange’s questioning to establish air as a means for disease transmission.

To be fair to Mrs. Lange she did, immediately after this exchange and possibly because of it, establish the ground rules relating to the discussion of transmission of disease. She also reflected back to the students their own learning, as well as provided scaffolding regarding the concept of transmission through contact.

Mrs. Lange: OK guys, you’ve been talking to me about two things, you look on the board, we’ve been talking about germs and diseases and things being carried air-borne. You’ve talked to me about contact, things are carried by coming in contact with either a person, an animal, but not actually going up, not just touch Henry like this (Mrs. Lange reaches out
and touches Henry on the shoulder). But that’s real contact isn’t it, but can you understand what I mean it’s got, contact, I think Benn was talking about …. when you sneeze, who was talking about sneezing?

Unidentified: Bella. (CA-01/10)

Mrs. Lange can be seen here to develop the understanding of her students through the use of an actual example of touching. This conceptualisation would seem to be necessary in a teaching program that revolves around an issue such as the transmission of a disease, where visualisation of what is happening may be difficult for students. Mrs. Lange then utilised the student example to explore the theme of transmission through the air.

Mrs. Lange: OK Bella, now if you sneeze, the little droplets when you sneeze that come out of your mouth they’re nearly invisible just like a little tiny fine spray, they would also land on someone’s desk, or on someone’s clothes, and if your hand touched that, that’s the contact, because of your hand touching a surface, ….when you put it up to your mouth and that’s how you could get …. there’s a third one that no one’s talked to me about, have a look on the board. Who can tell me what they think I mean by water-borne? If it’s carried through the water? Maria?

Maria: Carried on the, like, its been put in the water and its been carried. (CA-01/11)
In the first part of the above exchanges, Mrs. Lange summarises the interplay between the class and herself to date in relation to the three methods of transmission. It is clearly imperative for the students to address all three methods and not just focus on the methods as they apply to foot and mouth disease. The students quickly recognise the one method they have missed and provide an example.

Mrs. Lange: How do germs get carried in the water?

Unidentified: Like some cows drink at a river, and they might accidentally spit in and water could carry through and it could go in the irrigation pump. (CA-01/12)

However focused the students may be on foot and mouth disease, the student above has started to go beyond simple transmission, to transmission through man made systems showing the developing understanding of these issues. As this was the overriding theme that directed the topic (e.g., SN 4, students identify and explain the principles and logic of systems and subsystems within systems—see Appendix 4), Mrs. Lange was quick to utilise this moment to the benefit of the class, and changed from a discussion on the nature of germ transmission to the specific example the students are to work on in class. It is evident that the students in her class, from the responses they provide (“and water could carry through and it could go in the irrigation pump” (CA-01/12)), that they are developing an awareness of some of the key concepts utilised in this teaching program. The next explanation followed directly on from the quote above regarding cows and transmission of diseases through water.

…this is your job; here’s the scene, here’s what’s happened, remember it’s been a disaster, OK, some one has accidentally, or however it happened, we’re not sure,
has let go something that is disastrous, a germ, a virus, we’re not too sure what it is, it’s been let go here in the town. (Mrs. Lange, CA-01/13)

In this, Mrs. Lange has provided what amounts to a design brief for the students in her class. She then broadly describes how the virus is affecting the community, before outlining to the students what they are to do.

Your job is to think of all the ways it could be spread. I want you to think of all the ways it could be spread in the air….. not just the ways it spreads, you might also like to think about the places that people could be when it’s being spread. If it’s being spread in the air, where could somebody be to be getting this thing? (CA-01/14)

It is through this detail that the students may come to a realisation of what the activity involves. Mrs. Lange demonstrated her own development of understanding through her summary of the key issues involved. Mrs. Lange then guided the students’ thinking through a series of questions that outline the parameters of the exercise, where it can be noted that she now uses the phrase ‘contact’ rather than ‘human contact’ as she originally intended.

So I want you to just list down, put them in point form if you like, all of the ways of being spread in the air, all the places that people could be getting it if it’s in the air, right, then I want you to think about if it was in the water, if it was water-borne, means carried in the water, how could it be spread? How could water be spreading it?
How, what places could you be in to catch it, to get it if it was traveling in the water? And the last thing I want you to think about, contact, if it’s spread by contact, and that’s physical contact like this (touches student), or, it could be contact where I cough and leave little droplets and someone touches those and gets the disease, that’s also contact. (CA-01/15)

In these directions given to the students Mrs. Lange first sets the scene for the task that is to follow. The students were then presented with requirements or expectations that they should attempt to fulfill. In the first instance this involved “think of all the ways it could be spread” (CA-01/14), followed by some explanations as to what this may mean (CA-01/15). In terms of understanding of technology, Mrs. Lange was providing guidance to her students through attempting to highlight issues for which student learning was expected to occur.

In relation to identifying what the task is about, the initial statement made by Mrs. Lange was very broad (“some one has accidentally, or however it happened, we’re not sure, has let go something that is disastrous, a germ, a virus. We’re not too sure what it is, it’s been let go here in the town” (CA-01/13)), and must be clarified through the process of identifying how the students may undertake the exercise. This may be seen as an interactive process that allowed both teacher and students to develop their understanding of the topic. It was important that the students had a conception of exactly what it is that was expected of them, that is, the identification of the task as meaningful and realistic. In effect, this would be an appropriate design brief. It was also important, from the teacher’s point of view, that the task is limited in possible outcomes. Mrs. Lange made a point of referring to her lack of definition regarding expected outcomes in the task, something that she considered to be a
weakness in the exercise which resulted in no summative assessment of student activity being attempted. This lack of definition in the expected outcomes of the activity was also a concern to the students, who also sought clarification of what the activity entailed.

Unidentified: Does it have to be in this town?

Mrs. Lange: Let’s make it here today, because that way we know some of the places that are here don’t we? And we sort of understand here; if it was a strange place we mightn’t understand all the things that were in that town, we sort of understand here.

Unidentified: Mrs Lange, why can’t we have a person in Brisbane, ‘cos there’s a Brisbane airport.

Mrs. Lange: There’s an airport here in this town (general discussion regarding the validity of this statement) ……gets an aeroplane so often.

Unidentified: Where’s the airport?

Mrs. Lange: On the outskirts. OK, I’ll come back to that one at the end. Right off you go, write down as many different ways that (you) think it could be spread. (students start activity) (CV-01/15)

It is in this exchange that Mrs. Lange prevented the expansion of the identification of the problem, through not allowing them to utilise a situation outside the town in which they live (“there’s an airport here in this town” (CA-01/15)). The responses of the students have created a situation where Mrs. Lange has to develop her understanding of the parameters of the activity and articulate this to her students. The students then started the activity. The researcher walked around the small
working groups talking to the students about what it was that they were doing. The
groups were initially undertaking to clarify the nature of the task, as can be seen in
this exchange between Benn (Year 6), Tim (Year 6) and the researcher.

Interviewer: So what are we thinking about guys? So which one
are you going to look at first do you think?

Benn: Air-borne.

Tim: Water, water.

Interviewer: Well you’ll have to choose one to start anyway
won’t you, I suppose?

Tim: Water then?

Interviewer: What have we got to think about then?

Benn: How it gets through the water, say if a truck’s
carrying it and it rolls over a bridge like that, it
could fall out from the back and fall in the water.

(CA-02/4)

Benn was then questioned as to what his understanding of ‘water’ was in the
context of this explanation.

Benn: Like in the creek, like you know the local dam,
where we get our water from, say the truck…

Interviewer: What do you mean from the local dam? How do
you get the water from the local dam, what do you
mean?

Benn: It’s from the water services and the pumps and
everything that gets it to your houses. (CA-02/5)
In this interaction the boys initially had to decide which of the transmission methods they would choose to utilise as the basis of their activity. In the end it is hard to identify any particular method that was employed in the selection. The researcher’s initial response was to get them to make a decision (“well you’ll have to choose one to start anyway won’t you, I suppose?” (CA-02/4)), and then to consider some of the issues that would flow from this (“what have we got to think about then?”(CA-02/4)). The interactions that occur between Benn and the researcher then largely revolve around clarifying the language that is being used. What the researcher was trying to do in this instance was to ensure that Benn, and his group, were not making assumptions with regard to the system of water distribution that are not warranted, for the understanding of the system is the key idea in this particular section of the unit. Without giving the group feedback that is too specific, the researcher then tried to suggest parameters, or a framework, that they might use to guide their thinking, and Benn demonstrated his own understanding through his identification of a key issue associated with the problem.

A further example of this style of guidance provided to the students can be seen in the following exchange that occurred while the students (Sarah and Rebecca) were undertaking initial development of their ideas regarding the second activity on disaster management in small groups. In such exchanges the development of student understanding is evident in their attempts to clarify the problems and technological issues they are tackling.

Sarah: Where is it coming from (the infective agent), is it the showers or the drinking water or can it be either?

Mrs. Lange: I don’t know where it’s coming from, so what are you going to do, what do you recommend we do?
Sarah: I reckon we should turn it off and get the Brisbane water.

Mrs. Lange: How long would that take?

Sarah: About 20 hours.

Mrs. Lange: How do they get the water from Brisbane to our town?

Sarah: Pump.

Mrs. Lange: Inside what?

Sarah: Pipes.

Mrs. Lange: Are the pipes there already?

Sarah: No.

Mrs. Lange: So you’re going to have to lay the pipes?

Rebecca: There could be (pipes already there).

Mrs. Lange: It could take a couple of years to lay the pipes. In the mean time we’ve got people still being infected. What else could you do? Think of other things you could do.

Sarah: We could get the council to truck some up?

Mrs. Lange: That isn’t going to clean the household water is it?

(CA-05/3)

The students are clearly coming to terms with the meaning of the activity, and it may be that they cannot fully identify what it is that they are expected to do until such time that they are able to attempt the task themselves. As an example of such identification of the KLA, some key ideas with regard to transmission of disease are, quite naturally at this stage, not so well understood by certain groups of students in the class, as shown by the response of Kristal, where she was asked by the researcher
to imagine the chances of contracting a disease when comparing being in a paddock or being at a shopping centre.

Kristal: The paddock, because it’s more open to air-borne 
(sic). (CA-05/4)

The researcher then had a discussion with Kristal and her group (including Helen) regarding this conception, and how being in a contained area was more conducive to the transmission of disease. To do so, the researcher drew their attention to their immediate environment, and the possibilities for disease transmission that this entails.

Interviewer: I like that idea you’ve come up with the shopping centre, that’s an interesting idea isn’t it? Say how may people have we got in here now, 23 of you guys, Mrs. Lange and me, so 25 people. So we’ve got 25 people in one room here haven’t we? A lot of people breathing in and out.

Helen: Yeah, and this room (connects) onto the next room.

Interviewer: How many more classes are there?

Kristal: There’s 2 grade 6s and then there’s a door, and then there’s 2 or three ....

Helen: There’s a door that’s normally open and the there’s 2 others.

Interviewer: So there might be even a hundred people in this one building here mightn’t there? All sort of breathing the same air in one way or another isn’t it? So have a think, are those places like that, like you said, that
are really enclosed, that people have to go fairly often. Have a think about some of the places that you go to where there’s lots of people. (CA-05/5)

It may be that the feedback the researcher gave to this particular group was very directed, seeking to guide them to a particular outcome. It is evident, however, that the students had an important misconception regarding a key idea involved in the exercise, that being exposure to air being a primary risk, rather than the location and circumstances of that exposure. The students in this group, had they continued with this line of thought, may have wasted considerable time, and achieve little of the intent of the unit of work. It is, however, evident that teachers can identify aspects of conceptual development by students in technology classes, and that this can form the basis for appropriate guidance, as demonstrated by Mrs. Lange through her classroom interaction with students (e.g., providing direction for students through use of visual examples). It is also evident that Mrs. Lange developed her own understanding of certain topics (e.g., transmission of diseases through contact), and that this assisted her in providing her students with appropriate guidance.

5.8.1 Summary

It is possible to observe the development of student and teacher understanding in the technology classroom through scrutiny of the discourse that is taking place as the nature of the activities are clarified and issues that are raised in association with activities are explored. The discourse provided one avenue for teachers to assess the progress of students towards the development of the desired outcomes.
5.9 Assertion 9 (Objective 3-Curriculum)

The expectations embedded in the technology syllabus proved difficult for the teacher to enact in this classroom

No attempts to utilise the syllabus beyond initial planning were undertaken by the teacher in this study. No use of the syllabus in classroom implementation (beyond its use in planning documentation (see Appendix 4) or assessment was observed. The actual activities that students undertook tended to be the dominant concern for Mrs Lange and, in light of this, the syllabus elaborations (QSCC, 2000b) tended to be the source for ideas regarding technology activities. In an interview with Mrs. Lange during the early stages of implementation of classroom activities in relation to systems, these themes were discussed:

Interviewer: One thing you said to me last week was how (technology) is so different to every other subject, I just wonder if you could tell me why?
Mrs Lange: I’m still finding it hard understanding what the syllabus is about, exactly what you’ve got to teach, I think it because it is sort of, it is so different, I mean, I try to identify what the content actually is, and I think that’s what I’m finding hard. I sort of traditionally know what should be in a science, the sort of core content we’re used to covering, with this core content is just so different from what we’ve done before, so I think I’m still struggling with what this syllabus looks like, as a big picture,
what’s the sort of things that we’ll be doing. (IA-01/3)

It is of note that Mrs. Lange makes the distinction between the Technology syllabus and other KLAs with the comment regarding “traditionally know(ing)” what should be in a subject. In this regard she is acknowledging the differences that are inherent between Technology and, for example, Science. Mrs. Lange was then asked whether the lack of specified content created difficulties for her when making classroom planning decisions, to which she replied:

I think just getting used to the whole idea of outcomes-based education too, because it is so broad, trying to focus back on to “what does that outcome mean?”(IA-01/4)

It can be seen that not only does Mrs. Lange find difficulty with the conceptualisation of the technology syllabus, but also with the format in which it is presented. She then again expressed her reliance on the elaborations, and was asked whether this was because they were concrete examples:

Yes, they’re concrete, and if it wasn’t for those I wouldn’t understand what the syllabus was actually saying. So I really need those exact examples, it wasn’t until I got to those that I really understood what the outcomes meant. (IA-01/5)

This comment tied together the twin problems of content and format explored above. Conceptualising content through the outcome statements had proven very difficult for her in this regard. Mrs. Lange also discussed how the specifics of the activity that the class was undertaking were assisting in the development of what the
strands in the syllabus meant, and how they could be interpreted in a classroom environment.

I understand now what the syllabus is talking about when it talks about systems, and I can see that link now. Some of the other strands, ... (e.g., information, materials) ... I’m still coming to terms with what the other ones mean. (IA-01/6)

Mrs. Lange contends that her experience with the systems strand through her teaching of a unit of work had been developed. This issue relates back to that of “traditionally” understanding a KLA through experience, and the lack of exposure that teachers have with the technology syllabus. The factors that were under consideration by Mrs. Lange early in the implementation of the systems section of her technology unit were also elaborated on:

Well, we started to talk before about some summative assessment because at this stage yet I haven’t thought in depth about the assessment, only because I’ve been really busy trying to get the rest of the unit together, and this is added on to what we were doing, whereas we’ve got all the assessment for the rest of the unit worked out we haven’t done it with this one, because it’s evolving. (IA-06/13)

Mrs. Lange also discussed how she was viewing the technology teaching program as experimental, or exploratory in nature, and how the role of assessment was not clearly defined in her thinking and, significantly, was following rather than leading the classroom activities.
I’m still treating it as just a trial, so that’s why I’m not stressing out about having all the assessment sorted out in my own mind, but I can see now, having seen that work together today, that we could do a summative assessment of what we’ve done so far, sort of look at understanding of water treatment, the water cycle in this town if I get them to go away individually, now that they’ve got everyone else’s knowledge built onto their knowledge, get them to go away and draw the system individually, and I think that would be a good assessment. (IA-06/14)

5.9.1 Summary

The teacher in this research program lacked the conceptual basis and experience with which to interpret the technology syllabus, including the outcome statements, in a meaningful way that could enable its translation into classroom implementation. This affected the impact that the syllabus had on her classroom practice, including assessment, and led to other concerns predominating over those of how to appropriately assess the student outcomes being achieved in the activity.

It was clear that Mrs. Lange saw the need for assessment of the outcomes in the syllabus, but was unable to develop an assessment program to cope with the open ended nature of the activities.

5.10 Chapter Summary

Chapter 5 has identified a number of recurring themes that have been developed into assertions that attempt to explain the behaviour observed in the classroom. These
assertions have been broadly grouped into categories relating to design and practice of technology in the classroom, assessment and curriculum. These assertions form the basis of discussions that will be presented in Chapter 6.
Chapter VI

Discussion

6.0 Introduction

Having presented assertions and supporting data, this chapter relates the findings to previous research, as well as presenting a discussion of issues that have arisen from them. In this section, the data are discussed in terms of the objectives of the research. While all of the assertions contribute to the overall aim of the research and are interrelated, the discussion, as with the findings, will be categorised to reflect the three areas identified in the objectives; design and practice of technology in classroom, assessment and curriculum. The implications with regard to each of these areas are discussed, and an emerging model that synthesises key aspects of the research findings is developed. A final chapter summary is also presented.

6.1 Design and Practice in Technology Classrooms (Relates principally to Objectives 1 & 4)

6.1.1 Contingent design

The students in the classroom expressed quite clearly the contingent nature of the design work (identified in Assertion 1, relating to design processes) they had undertaken (“But I couldn’t find a propeller so I just made it a road vehicle”). This is in accord with previous research and models of technology design processes that have recorded the ‘messyness,’ or chaotic nature of design (DeVries, 1997) and has also emerged from the experiences of students actually struggling with a new KLA. The work of Fleer (2000a) also supports this assertion in that she found “the materials
themselves suggested what they (students) should make” (p. 56) (parentheses added). Fleer (2000b) also found that “children do have design questions that they are interested in investigating” (p. 251) and that these “questions and design briefs can emerge at any point throughout the technological process” (p. 251). Similarities can also be seen with the work of Henderson (1998) who, in a study of designing cultures, found that the mechanical engineers she studied did not follow any design protocols, but worked back and forth from the general to the specific, working on a number of different features of a design simultaneously. The Assessment of Performance Unit’s (1994) interaction of mind and hand model (Figure 2.3, Section 2.1.10) perhaps comes closest to what is concluded in this research although the nature of contingent design, it will be argued, is distinguished through being utilised to cope with broader contextual circumstances (e.g., different resources, assistance from parents), and will not always be apparent in design activities. It also appears that such a conceptualisation of design is to be found in a range of age groups although, clearly, this needs to be further tested in terms of the broader school community. For example, Roth (1995), when reporting his research relating to students of a similar age to the students in this study undertaking technological problem solving, asserted that the problems and solutions in such situations are complexes that are transformed or translated as individuals engage in problem-related activity and that “both problems and related solutions may change as they are continually negotiated and renegotiated between individuals and the setting” (p. 376). Furthermore, the teacher involved in the study reported here was able to recognise some of the facilitating and restricting elements that impinge on the design process (“We assume that their knowledge is what we know, but it’s not”).

Contingent design arises because of a lack of knowledge and experience on the part of the designer in relation to the design task. This should not be seen as an aberration as much technological advance has been made in the same manner, where
understanding of phenomena follows the creation of artefacts (DeBono, 1974; Gardner, 1995; Raizen et al., 1995; Sobel, 1996). Plucker (2002) also reported on adolescent inventing through ‘tinkering,’ whereby one student commented “sometimes tinkering will let you accidentally discover things” (p. 154). The lack of directedness in tinkering distinguishes it from contingent design, which is aimed at solving a specific problem and is not merely exploratory in nature. It may be concluded that the students in this class, though utilising contingent design, were acting in accord with the nature of much technological activity where unknowns are being encountered for the first time.

The context in which designing takes place also clearly affects what is produced by designers. The students’ access to materials and their previous experiences, among other contextual influences, determined to a large degree what was possible in the activities they worked on. In this research the role of community members, particularly the fathers of the students, was an important contextual feature. This is confirmed by other research where it has been found that the contextual variables in the classroom affect what students achieve (Anning, 1994). It is also in accord with models of non-traditional assessment which acknowledge that knowledge is situated (Eisner, 1993; Wiggins, 1989), and points to a model of technological activity that should, in the manner of contingent design, be flexible enough to allow for such contextual variables to be integrated into a conceptualisation of student activity.

It can be concluded, in relation to contingent design, that there is a design process occurring in this classroom that does not necessarily follow present idealised models of design but, rather, is contingent on a multitude of situational factors, such as interactions between materials available for use in construction, identification of the task by participants and the ability of participants to ascertain the important elements in a successful design. These factors cannot be determined a priori, but must
be ascertained from the context of the exercise, the participants and the environment in which they occur. As noted by Roth (2001), “each design decision arises as a contingent from the constraints of the moment and from the dialectic of resistance and accommodation” (p. 786).

The concept of contingent design encompasses a range of previous research and allows for a conceptualisation of design processes that are not dependent on a single model of activity (see Section 2.1.10). It will be argued here that it is necessary to come to an understanding as to how students investigate technological problems, and that without such an understanding it will be difficult for teachers to develop the necessary skills to productively implement and assess the KLA. It is clear that the potential of the KLA may be diminished without such understanding. Contingency as a concept is based on what students actually do, rather than what they are expected to do according to models of design used by professionals, and this must lead to more informed teaching and assessment practice through the incorporation of student activity into classroom considerations.

An analogy regarding contingency, and the indeterminate nature of outcomes for design situations, may be drawn from the study of biological evolution. Stephen Jay Gould (1991, p. 69) in discussing historical events (in both technological and biological contexts) asserted that:

We call a historical event … contingent when it occurs as the chancy result of a long string of unpredictable antecedents, rather than a necessary outcome of nature’s laws. Such contingent events often depend crucially upon choices from a distant past that seemed tiny and trivial at the time. Minor perturbations early in the game can nudge a
process into a new pathway, with cascading consequences that produce an outcome vastly different from any alternative.

While appreciating that such an analogy is limited in its application to technology, and noting that the author clearly did not intend to imply conscious design in the natural world, the conceptual understanding of contingent design and its dependence on the unpredictable and/or unknowable may be enhanced by the use of this analogy. Furthermore, it may be asserted that the evidence presented in this research does not support the concept of an artefact being the necessary outcome of the application of a particular design process, and in this regard the analogy is also informative. The analogy may also be applicable to this research through the concept of early choices nudging the design process down completely different pathways. The choices the students made ‘early in the game’ clearly affected what they finally produced.

An understanding of the contingent nature of design would be reflected in the formative assessment to be found in the classroom. Contingent design is allied with such assessment in that effective formative assessment guides the design process through stages of uncertainty. This uncertainty would appear to be a condition related to the creation of new artefacts and, as such, must be an accepted part of classroom practice in design technology. The corollary of this contention is a deterministic approach to design that considers uncertainty as an impediment to design rather than a necessary feature. In such circumstances the role of formative assessment is different: it is to show correct procedures and methods to achieve a particular outcome.
Teachers encountering technology for the first time may also be tempted to template conceptions of what constitutes ‘correct’ designing that are inappropriate in a classroom setting. Exemplars of design are most often found to be that of professionals who have created exceptional work, for example, Christopher Cockerell and the invention of the hovercraft. It must be questioned as to whether this a realistic means of identifying design processes that are appropriate for students in primary school. The ‘messyness’ of design is removed and a somewhat idealised process presented to students. The vulcanisation of rubber, a process developed by Charles Goodyear, was not the result of systematic application of principles. He did not, in fact, “have the faintest idea what he was doing” (Bryson, 1994, p. 107), and his invention was the result of a lucky accident. Entries in texts may gloss over this fact, such as in DeBono (1974, p. 88), which describes the accident as occurring during one of his ‘experiments,’ clearly implying a more structured approach than actually occurred.

What must also be recognised is that many classic designs were created by a contingent design process. For example, the Sydney Opera House design was contingent on the development of a roof that was suitable for engineering. The original shell shaped roofs as conceived by architect Jørn Utzon “were not viable as structures” (Drew, 1999, p. 188), and a rather convoluted process was enacted to design the shell shaped roof structure. In light of this, teachers should be aware that design does not follow well known paths all the time and that, as a consequence, students need to be able to design in a manner that is most appropriate to their skills and experience.

The assessment of student activity should not, similarly, be based on deficit models of student behaviour, such as may be found in more traditional assessments (Duschl & Gitomer, 1993; Jones et al., 1999; Wiggins, 1989), for it is apparent that
design through a contingent approach is a strategy utilised to deal with incomplete knowledge and skills. Its use by students should, rather, be recognised as a realistic means to deal with the situation (or situations) they find themselves in, much as more mature designers often do.

### 6.1.2 Design Approaches

It is evident that in this particular classroom, what were perceived to be necessary conditions of the act of designing were possibly inappropriate, as identified in Assertion 2 (relating to implementation of certain design approaches: Section 5.2). Of particular note was the idea that students would have to make a drawn design before they commenced the actual building of the artefact. This may be described as consistent with the ‘design, make, appraise’ model of technology activity, an approach that is not supported by the literature (DeVries & Tamir, 1997; Davies, 1996; Donnelly, 1992; Hill, 1998; McCormick, 1997). The requirement of initially drawing a design was seen by the students involved as an artificial imposition of little or no use in the completion of the activity (“because you asked us to” (IA-05/3)). Findings by Rogers and Wallace (2000) would appear to support some of the findings in this research, where they reported that “the children…..did not exhibit a strong connection between their drawn designs and the other two stages of the DMA (design, make and appraise) process” (p. 133) (parentheses added). It is perhaps, as has been discussed previously, an indication of expectations of a ‘proper’ design process that may not, in fact, exist in either workplace or school setting.

Design is, it will be contended here, evident through a creative process. The literature emphasises the importance of the design process in the characterisation of technology (Eggleston, 1994; Lewis & Gagel, 1992; Medway, 1989; Mioduser, 1998; Pendergast, 1999; Rennie et al., 1992), but importantly there does not appear to be a
single design process, what was termed by Johnsey (1995) as a ‘holy grail.’ What appears to be happening in the instance of the teacher (in conjunction with the researcher) in this study, was the application of a particular conception of ‘design, make appraise’ that was not seen as useful by the students in the class. This has led to the conceptualisation of contingent design proposed in earlier sections of this research (Assertion 1, Section 5.1 & 6.1.1).

To consider design as a separate entity from manufacture through first drawing, then doing, particularly in a classroom environment, may be a misleading interpretation that leads to the sort of exchanges cited previously where students might do what they think is required by their teacher, not what is required by them and the process that they are undertaking. In this regard the distinction between school and real world technology should be acknowledged (Hennessy & McCormick, 1994; Hennessy et al., 1993). Mayo (1993) also poses questions related to school technology when discussing the profession of design. He questions whether design is an identifiable field of endeavour, that the understanding of the design process is simplistic and doubtful in its extent and that the concept of the designer as sole creator of a product is a myth. Findings by DeVries (1997) and Henderson (1998) regarding the ‘chaotic’ nature of design in the real world would seem to support such assertions. In such circumstance the imposition of conceptions of design that have little basis in reality would seem to be problematic. As Mrs Lange noted, the source of ideas for the students did not come from following a prescribed pattern of behaviour but rather “emerged from the activity.” Research by Hill and Anning (2001) would also seem to support a contextual approach to the development of technology activities where they note that “this research brings into question the utility of a generic approach to teaching design in the elementary/primary schools, without translation into context and without close examination of skills required for different fields” (p. 133).
Furthermore, researchers such as Welch et al. (2000) have reported the limited skills that students have in relation to sketching. They noted that “Pupils….are of necessity likely to have limited skills and insufficient experience of sketching to be fluent” (p. 144). They “resolve this problem by moving to three dimensional modeling when this is possible” (p. 144). This is in accord with findings already made in this research in relation to contingent design. Students in this research program, it would appear, did not have such experience or skills to produce designs of realistic production proposals, a finding consistent with that of Welch, Barlex, and Lim (2000). Research into conceptual trajectories may provide insights into an appropriate skill development program in this regard. Driver, Leach, Scott, and Wood-Robinson (1994), in their review of research on the understandings of science concepts of students in the age range 5-16 years, proposed that “learning within a particular domain can be characterised in terms of progress through a sequence of conceptualisations which portray significant steps in the way knowledge within the given domain is represented.” They used the phrase “conceptual trajectory” to label this sequence of conceptualisations across the age levels, the trajectory being evident in the progression towards more scientifically abstract views of the relevant concept. The identification of such progressions, such as has been reported by Ginns, Davis, and McRobbie (2001), has already been undertaken to a limited degree. As such, it may be that more structured lessons that address these progressions of skill may be appropriate. This is consistent with the findings of Doornekamp (2001), who found that highly structured teaching produced large learning gains for students inexperienced with construction materials.

At issue, therefore, is teacher education and the means by which teachers will attain sufficient skills to address student development in their classrooms. Gustafson, Rowell, and Rose (2001), for example, argue that “in order to promote children’s’
understanding of structural strength, teachers need programs that clearly identify technology concepts and professional support to help develop an understanding of these concepts” (p. 121).

It may be more productive in these circumstances to suggest that students are not professional designers, and that there needs to be an implementation of classroom practice that more accurately reflects their abilities and understanding of the design process. In other words, it is necessary to acknowledge that schools are not the ‘real world’ as such, and implement developmental programs that are suitable to the students who are in them (e.g., develop drawing/design skills), while still ensuring that such programs have a basis in the wider technological context. A question that needs to be asked is when, developmentally, students are ready to productively engage in technical drawing.

A fundamental issue that flows from this understanding, as well as from previous discussions on ‘contingent’ design, is that the drawn design, in professional terms, is an expression of what is already known to the designer. The idea that students can draw a design that may be realised is, to a large degree, dependent on them having a range of knowledge and skills regarding materials and material interaction that they do not necessarily possess. It should also be remembered that even conceptions of such sophisticated design processes are probably flawed. It has previously been noted that such conceptions are unrealistic and that even professional designers operate in a manner that is frequently ‘chaotic’ or unstructured to the observer (DeVries, 1997; Henderson, 1998; Rowell et al., 1999). Furthermore there should not be some sort of idealised conception of written design as having a universal quality as this clearly is not the case (Brown, 2000), and all designs must be interpreted through the context in which they are framed (De Vries & Tamir, 1997; Hennessy & McCormick, 1994; McCormick, 1997; Norman, 1998).
What must be asked is the degree to which the KLA should reflect broader professional conceptions of a hypothetical design process, and what are the expectations that should be placed on the students in this regard. Until such issues are resolved, as has been discussed in previous chapters, there will continue to be a problem with the identification of the KLA that leads to practices that may not be in the interest of either students or the development of the KLA. It would seem to be essential that a teacher be aware of a number of different features of the design process to effectively implement a technology program. Firstly, he/she needs to be aware of the ability level of the students in his/her class and how this relates to the expectations that are to be placed on them. In particular, it should be noted that formal designing on paper can only express what is already known, and that students should not be asked to do this outside of a structured framework that allows for them to create a realistic design. This problem needs to be addressed if the KLA is not to become an artificial representation of a discipline that is not reflected in reality.

What may be stated at this stage is that the practice of asking students to make drawn designs for novel situations needs to be reevaluated. In proposing this argument, the emphasis needs to be placed on the novel aspect for, as has been discussed, it may be appropriate to utilise a written design where students have sufficient skill and knowledge of the elements attached to their design problem to propose designs that are a reflection of their knowledge of these elements. This needs to be taken into account by teachers when assessing student activity.

6.1.3 The physical environment of the classroom

It is also evident that the primary school classroom in which this research took place is not necessarily conducive to the effective conduct of technological activities.
The physical make up of the room (previously described) is intended largely for two purposes; that of teacher directed lessons focused on the blackboard, and discussions with the whole class at the back of the room. While these activities may form part of activities related to technology, clearly there is a need for a physical environment that can accommodate the types of group activities that are common to technology lessons, particularly those where the students are required to use tools and/or manipulate materials (“because you might have needed a lot of space”).

In terms of the research it is pertinent to consider the role of various KLAs and their value in the school curriculum for an insight into the physical makeup of classrooms. As has been noted, the manual arts KLAs in the school curriculum have traditionally occupied a lower status within education (Allsop & Woolnough, 1990; Archer, 1989; Banks, 1994; Down, 1989; Eggleston, 1994; Lewis, 1991). Augustinian/Platonic models of liberal arts have exerted a strong influence on school curricula, as discussed by Custer (1990). The result of this has been to draw a line between ‘pure’ and ‘practical’ knowledge (Custer, 1995), what is termed by Barnett (1995) as the ‘fractured inheritance.’ As such, the design of the classroom in this research would seem to fit into the emphasis given to the intellectual traditions outlined in Augustine’s trivium and quadrivium. The layout of the classroom is designed for teacher directed lessons without any consideration to the space or equipment required for practical work in the field of technology.

Another issue that the students commented on was the lack of resources available at school (“You wouldn’t really have much stuff that you need for your design or building as you would at home”). While this may seem to be a simple issue to rectify, schools will require guidance regarding what are the appropriate purchases they should make to enhance their technology programs. This will require teachers to
be clear as to the type of technology programs they wish to implement. At the moment, this is not a straightforward issue, and clarification of what technology as a KLA encompasses must predate any significant purchasing. The identification of what technology is by teachers is clearly an issue. As has been noted by a number of authors (Jarvis & Rennie, 1996a; Jarvis & Rennie, 1996b; Jones, 1997a; Jones & Carr, 1992; Newton & Hurn, 1996), there is a lack of identity within the KLA area, perhaps most notably by teachers. This is a recurring theme for, “almost any text on the technology curriculum offers a definition” (Donnelly, 1992, p. 125). Similarly, Medway (1989) notes, “the term ‘technology’ itself is unhelpfully fluid and, unlike terms for many other disciplines, is not shared across languages” (pp. 3-4).

Medway (1989) and Lindblad’s (1990) observations regarding the conceptions of technology that are held by teachers would also support this theme. The style and scope of presentation of technology classes and, consequently, the materials required, can also be heavily influenced by the teacher’s KLA background. This is noted by Barak et al. (1995), and Rennie et al. (1992), the latter authors commenting on the narrow view of technology held by teachers of science, and further confirmed by Lewis and Gagel (1992) who conclude that conceptions of technology are value-based positions consonant with the academic position to which one ascribes. The values brought to the definitions of technology will “influence the way its content is defined, what goes in the curriculum, and how the subject is taught” (Lewis, 1991, p. 144).

In such circumstances it is imperative that teachers as a staff develop realistic and informed conceptions of the KLA before schools commit to monetary outlays. To do otherwise would be to buy materials and tools that will not be used as teachers’ enthusiasms change, staffing changes occur or different activities are engaged in.
The students also discussed where technology should take place; is a general classroom the best place to do technology? Technology may have specialist rooms set aside for the KLA where artefacts in progress may be stored and where specialist tools and materials could be used. This issue needs to be clarified by practitioners before resources are utilised one way or the other. It may be that technology is best integrated into classrooms, and this may preclude some technological activities requiring, for example, certain machine tools. On the other hand, the utilisation of specialist rooms may prove to be a mechanism to remove technology from the everyday experiences of students. School communities, therefore, will have to develop a strong identification of what technology means to them in the very near future to ensure that they establish a technology infrastructure that best suits what they wish to achieve. As noted by Jones (1997b), an appropriate classroom setting is crucial for the development of student learning, a view reinforced by evidence that pupil performance is more effective when located in a real or contextual framework (Kimbell, 1994a).

The issue of where technology takes place, once again encompasses views that may be attributed to various conceptions of the KLA, discussed above. While there are acknowledgements that technology is different (Stein, 1998), issues associated with the respectability of the KLA will only be addressed through not marginalising the KLA. It may be that schools will need to rethink the physical locales in which they teach so that technology is taught on equal terms with other areas of the curriculum. The classroom set up in this study was identified by the students as being somewhat inappropriate, but this does not mean that technology cannot take place there. It may imply that teachers will develop technology activities that are more appropriate to their environment, rather than try to enact programs that they realise will not work. This recognition, it may be speculated, will come as experience with the KLA grows amongst the teaching profession.
It has also been recognized that parental and community support plays an important role for students in their technology activities, and that this may be underutilised in the classroom. When planning, teachers need to take into account these important contextual influences on student activity and encourage the use of these influences in the development of student technological understanding.

6.1.4 Fields of possibility

It is evident from the data presented in this research that teachers need to be able to cope with a multitude of possible directions that a classroom activity may take. It is therefore essential that clarity of purpose in relation to assessment of technology be developed and that the basis of any assessment must be an understanding of what the students in the class are actually doing. Assertions in this research have dealt with this issue as it relates to contingent design, as well as through the concept of artefacts as narrative. In the fourth assertion, identifying ‘field of possibility,’ these two concepts are brought together through highlighting how predictions of what a student may attempt is possible, but only within certain parameters (the field of possibility). Such predictive ability is necessary for teachers to be able to make reasonable planning choices. For example, it would be expected that, with experience, teachers would be able to forecast likely avenues of students’ work and/or what they should draw their attention to, in a similar manner to science teachers knowing possible misunderstandings of science concepts.

The literature supports such an assertion through a number of means. Firstly, it is evident that the development of technological models of student activity is an attempt to characterise what students are doing in the classroom. It is clear from the body of technology research that practical activity is central to any understanding of technology (Anning, 1994; Allsop & Woolnough, 1990; Custer, 1990; Idhe, 1997;
Lewis, 1991; Lewis & Gagel, 1992). Therefore, it is vital that an understanding of such activity precedes any assessment of student activity. Furthermore, teachers need to be able to make reasonable predictions of the scope and direction of the activities that students undertake, and this requires that they are able to understand the practical component of classroom technology. From the data presented in this research, it appears that an inability to reconcile the apparent indeterminate nature of technology affected the ability of the teacher involved to effectively implement the intended program (I don’t know, I’m not really sure where to go from here with it, it’s hard).

Secondly, historical precedents affirm that utilising fields of possibility is a feasible means to undertake technological progressions. The example of the Sydney Opera House (see Section 6.4) indicates how a project may progress providing that its development stays within the boundaries identified for its final form and function, what is termed in this research a field of possibility. The utilisation of plans for cargo ships in the manner of the British (Brown, 2000), where much detail was left to the actual craftsmen who were to build the article, further indicates an approach that utilised fields of possibility. The plans created the parameters for the final form and function, and not the final article in its fine detail.

Finally the manual arts and technology divide provides insight into how student activity may be viewed and planned for. Manual arts, in its traditional forms, provided training for specific skill development (McCormick, 1990). The distinction in this regard has been made by Allsop and Woolnough (1990) through the identification of traditional manual arts KLA’s which trained students as technicians. It is, therefore, imperative that technology as a KLA recognises the difference between specific skill development, and a more broad ranging approach that should be the hallmark of the discipline. With this idea in mind the application of the notion of a field of possibility to conceptions of what is possible in the KLA will allow for
the development of a curriculum that does not delimit the KLA to specific occupational skill development, but to a broader intellectual base. Without such an approach, the KLA may be condemned to marginalisation through what this author has termed the ‘workshop factor.’

It is clear that clarification of what are the fields of possibility for a particular activity may assist in the appropriate assessment of student technology programs. It may be that certain programs have a broad field of possibility, a situation that allows for process driven formative assessment. In such assessment, it would be necessary for the students to display how the conclusion they have reached reflects an understanding of the issues involved. This has a clear parallel with the concept of artefacts as narratives, previously discussed. In the case of outcome driven summative assessment, where the possible legitimate outcomes are very well defined, the students would be expected to utilise methods that have been identified to them as necessary for the successful completion of a particular task. In one instance presented in the data, where students discussed the cleaning of pipes to bring water to an affected town, if the students ended up utilising the cleaning of pipes as a means to control the spread of disease, then it would be expected that the use of experts would appear somewhere in their completed plan (“You’ve got plumbers, you’ve got Henry’s Dad who works at the sewerage treatment, what do you call these sorts of people? ………..(waits for response) could I say experts?”).

It was suggested in this research that students would not be able to define the two styles of formative assessment, it being noted that the interaction cited was quite natural but, rather, that they would recognise suggestions that require an affirmative response, such as the example above. This is an issue that needs to be investigated further. The difficulty for teachers may lie in managing to balance that which is required for a successful outcome with the creativity that they would wish to have in
the classroom. In order to investigate this it may be necessary to examine extremes of
the proposed spectrum of open endedness that may be identified in the following
examples.

1. An activity that is process driven may include the development of a solution
to a problem, the outcome of which is not stipulated. The process, therefore,
directs activity not in a particular pathway, but towards multiple possible
solutions that may address the needs of the situation. An example may include
asking students to design a piece of playground equipment for a set price. It is
not necessary in this example to arrive at a particular outcome, but that the
needs and constraints are identified and addressed. The value of the product
must be negotiated with the users, as it will not necessarily be self-evident.

2. An activity that is product driven may include the development of a stipulated
item that meets identified criteria. The process therefore, is directed by the
need to meet these criteria. An example may include asking students to
manufacture a piece of playground equipment from a set of given plans. It is
necessary to arrive at a particular outcome and the value of that product is not
negotiable.

It is suggested that there needs to be a recognition before activity commences as
to where on this spectrum the activity may lie. Without such recognition
inappropriate assessment may be utilised. In terms of formative assessment, the
activity being undertaken will determine the style of feedback required, whether it is
the more reactive style of a process driven activity, or the directed style of a product
driven activity. To utilise inappropriate feedback alters the meaning of the activity
being undertaken.
6.1.5 Summary

This section of the discussion has highlighted issues associated with the design element of technology and the practice of technology in the primary classroom, and has developed ideas that have emerged from the experiences of this research program. A means of viewing student design (contingent design) was developed, as was the concept of a field of possibility to enhance teacher planning and implementation. The physical environment in which technology occurs was discussed, and suggestions as to the appropriateness of certain design approaches have been made. This section has, therefore, enhanced the understanding of technology as it pertains to the primary classroom.

6.2 Assessment (Relates principally to Objectives 2 & 4)

6.2.1 Artefacts as part of a narrative

The fifth assertion (Section 5.5), relating to the manner in which artefacts are interpreted, contended that the roles of creator and user (who they are designed for) of technology are not as clear as it might first appear and has implications for assessment. The creator of artefacts is not necessarily only the student who may present it to the class. Their parents, siblings, teacher or peers may have contributed to its creation, and yet be unacknowledged as such (“but then Dad pointed out that the glider wouldn’t work”). Such knowledge is, however, necessary to any meaningful interpretation of the item, particularly if one is to assess it. The artefact in isolation is difficult to define and may lead to the situation termed an artefact focus (Jones, 1994) that is the result of emphasis on end products. Barlex (1994, p. 78) likewise contends that:
Although pupils produce outcomes (artefacts, systems and environments) as the most obvious end product of design and technology in schools in trying to meet the needs and grasp opportunities it is the intentions (meeting the need or grasping the opportunity) and the procedural competencies developed and utilised in response to those intentions which are.

Similarly, as noted by Davies and Elmer (2001), students expect teachers to recognise their “effort and imagination” (p. 167), not just the final artefacts.

The students in the interviews recognised this, where they commented on the development of understanding (“you can’t really say theirs is better, because you don’t really know how well they’ve thought of it”), although not, perhaps, in regard to their own items. This is not to argue that such contributions are to be utilised to limit academic reward by, say, reducing a student’s marks. Rather, such sharing of experience should be considered a worthy aim and valued as such. This would be in accord with the findings of Davies (1996), Hennessy et al. (1993) and Rowell, Gustafson, and Guilbert (1999) in relation to the need to characterise technology as a social activity that is rarely the result of purely individual endeavour. Furthermore, without an acknowledgement of such contributions a deceit, often innocently, is fostered upon the learning environment of the class. In these circumstances the meaningful interpretation of any artefact is difficult, if not impossible. It can be argued that an individual assessment regime in classrooms encourages such behaviour through the grading of students with a resulting need to assign worth to individual contributions only. This implies a notion of individual creativity that may not be a true reflection of what actually occurs in the creation of artefacts.
The research in relation to outcomes-based assessment would also support notions such as cooperation in a school setting, as well as reflecting the intellectual community from which tasks are derived (Eisner, 1993), or what might be considered ‘real’ problems (Duschl & Gitomer, 1993). The discussion above highlights that real technologists work in a social manner, and it may be beneficial for students to be expected to do likewise. Knowledge is thus considered to be situated (Eisner, 1993; Wiggins, 1989), the actual circumstances in which a designer works, including the social setting, affecting design possibilities. The fifth assertion is, therefore, in accord with the assertion regarding contingent design whereby the context of the problem frames, to a large degree, what the problem actually is.

The relationship between the creator and the artefact must, therefore, be established before any object may be meaningfully interpreted. This sort of activity is often the province of historians or archaeologists. What, for example, is the meaning of Stonehenge? To attempt to understand such an artefact requires an understanding of the people who built it, to what purpose they built it and the processes they employed to create it. The mystery is in the relationship of the participants and processes to their creation, not solely in the object itself. This conundrum is recognised by the class teacher, who identified assessment techniques that would be appropriate for the activities her class undertook would be reliant on an active interplay between the creator of the artefact and his/her interpretation of it to others and themselves (“the only way to assess it would be look at your observations, but also discuss it with the kids”) as well as the students (“so you just really have to look at how well they’ve done and thought of it”). The class teacher in this activity was clearly having difficulty coming to terms with how this would actually occur, as can be noted in the above quotations.
It is apparent that a dialogue must be developed to interpret the relationships that develop around the creation of an artefact for, as has been noted, the key to utilising the subjective nature of alternative assessments is seen to be in developing communication channels between teachers (Baron et al., 1998; Duschl & Gitomer, 1993; Jones & Compton, 1998; Jones et al., 1999; Kimbell, 1994a; Wiggins, 1989), and, importantly in this regard, between students and teachers (Daws & Singh, 1999; Hodgeman, 1997; Wiggins, 1987). It must be questioned as to whether such communication channels would be possible in an environment where tests are ‘secret’ (Wiggins, 1989), or where teachers ‘own’ the assessment material (Popham, 2002; Anderson, 1996). One clear implication of this assertion would thus be that effective assessment would require changes to the power structures within a classroom to allow for the development of technology programs that reflect what technology actually is in the real world. Baron et al. (1998), Duschl and Gitomer (1993), Kulieke et al. (1990) and Robinson (1998) identify such features as being part of non-traditional assessment in the classroom. It may, therefore, be considered that less hierarchical relationships are essential to the effective implementation and assessment of a technology program in the classroom.

Traditional assessment methods have relied on the interpretation of artefacts, often in the form of written documents, as having a direct relationship to the competence, or otherwise, of participants. Through these artefacts, it is argued, an independent assessment of students may be made. The artefact is not interpreted in a contextual framework that includes the student, and is considered to be an entity in itself. The relationships between the student, assessor and artefact are assumed to be inconsequential. This is not possible with technology as has been outlined above. The conclusion must therefore be that traditional assessment methods that rely on the independent nature of artefacts should not be utilised for design technology. This conclusion is acknowledged by the students in the study (“but the person might have...
gone out and bought really flash stuff….and paid a heap of money”), a response that reflects concern with fairness in assessment, as well as the inappropriateness of assessment methods that rely on too little information, such as only the finished artefact.

The study by Brown (2000), previously cited, illustrates this very point. While the issues discussed were broad ranging, the key talking point in the paper revolved around the inability of American shipyards to interpret the engineering drawings supplied to them by the British for a 10 000 ton cargo carrier. The difficulty arose because of the differing contexts, processes and participants. In Great Britain engineering designers left much to the actual craftsmen who were to build the article, with the consequence that much detail was omitted from technical drawings. In America the technical drawing is seen more as a management tool, with the result that all possible detail is included, the individual craftsman not being permitted to ‘interpret’ the drawing as they see fit. When the British supplied the Americans with plans for these ships, the “plans proved essentially meaningless to managers and workers at the American yards” (p. 195). While eighty working drawings were considered sufficient by the British for a conventional steam engine to power the ships, the Americans believed they needed 550 for the same item. It is essential then, that the interpretation of technological artefacts and activity takes place within a contextual framework that accounts for the human participants. Without such a framework, it is difficult to interpret the meaning of created artefacts.

Another example of interpretation of artefacts within a particular context may be demonstrated where a pharmaceutical company must show that a new drug has applicability within defined contexts. Ultimately the usefulness of such drugs is not static, and depends on varying uses, understandings and social restraints. For example, thalidomide, a drug that caused devastating results when used to treat
morning sickness, has proven to an effective treatment against leprosy (American Academy of Pediatrics (AAP), 2003). Its effectiveness was dependent of the context in which it was used. In the case of thalidomide it means that the AAP (p. 1) considers that “clinical data submitted to the FDA (U.S. Food and Drug Administration) has shown that, under tightly controlled medical supervision, benefits outweigh risks of thalidomide therapy for leprosy.” Clearly the effectiveness of this particular substance must be assessed within the context in which it is used.

Within the classroom it may be seen that there are a number of users of technological artefacts, and it is necessary to understand these relationships as well. The users of artefacts could be, for example, teachers who require them to complete their assessment role, students who need them to succeed in school or school administrators who may need them to demonstrate a certain proficiency or innovation in their school. Is it well established for whom the artefacts are intended, for this plays an important role in how they will be perceived? For example, a technological artefact such as a motorcar may be perceived in a host of different ways depending on who the intended recipients or users are. Even a single model that comes from a particular factory, for example, may be intended for private use, police use, hire company work or racing. Each of these recipients or users will interpret the artefact differently according to their needs or expectations. The artefact, once again, does not stand-alone but must be interpreted through the people who have a relationship with it.

It is important, it will be contended here, that the relationships inherent in any technology activity be further examined for they, to a large degree, determine the meaning of technological artefacts. To assess a technological artefact without considering such relationships is to focus on a single aspect that may be of little consequence. The class teacher attached similar importance to the relationships,
although, it should be noted, a hierarchical classroom structure whereby the teacher who largely determined classroom activity was still delineating any assessment that may be undertaken (“What was important for me was the children’s understanding of what was happening with their particular creation”) In this quotation the teacher is still emphasising the pre-eminence of her perspective in any assessment, and although the reader will still note that peer and self-assessment are acknowledged as playing a role, they appear to be marginal to the key aspects discussed. Furthermore, there was little evidence of this occurring in the classroom.

If assessment is a reflection of that which is valued in the classroom, what then must we value in technology, and how will we determine this value? It is clear that assessment methods must be inclusive of participants, process and products and that such assessment will, in light of this, be lacking the ‘independence’ of traditional methods, through the incorporation of more interpretive forms of data. This problem presented itself very clearly to the classroom teacher involved in this study. Despite this, she appeared to be trying to contain technology within methodologies of assessment with which she was most comfortable (“I would have had to leave assessment to the end, because I can’t think of any other way we could have done it, now that I’ve done it”). Within this quotation is an acknowledgement of two key issues. Firstly that assessment is most often left until the end, following curriculum, an issue that has already been explored in the literature review.

The appropriateness of such an approach in technology education is under question and, it may be argued, will perpetuate an emphasis on artefact-based assessment. The necessity for teacher education on the importance of process and participants is also an issue that then arises from such approaches and is clearly implied in the remark that “I can’t think of any other way we could have done it.” Teachers will, in the face of such challenges, naturally revert to teaching, planning
and assessment practices that have demonstrated utility in the classroom. If so, the prospect of a viable implementation of a curriculum such as technology will be seriously diminished.

6.2.2 Understandings of assessment

In this research the concept of assessment was understood by participants on a number of different levels, as identified in Assertion 6. Several questions arose from the research that were certainly applicable to the classroom studied, and may be applicable to broader contexts. For example, can methods be developed for the assessment of students who are undertaking group work that are a fair representation of student achievement? Also, can the culture of schools, dependent for generations on the individual assessment methodologies, accommodate such changes? What teaching methodologies will allow for a cooperative approach to learning to be developed and implemented is also an important question that must be addressed. Finally, is it possible, or even desirable, to determine an assessment of the individual contribution from work that may have been undertaken in a group situation?

While a counter to these problems may be to undertake technology programs as individual exercises, as was undertaken with one of the activities in this teaching unit, it is always worth remembering the power that comes from collaborative activity within the classroom. Johnson (1997) for example, in his paper on learning technological concepts argues, “the basic message is that learning will be enhanced when students reflect on and collaborate with others to solve technological problems that occur in rich contexts” (p. 175). Research on non-traditional assessment would also support such an assertion, where the individual focus of traditional assessment shifts to a more cooperative focus (Eisner, 1993). The contention of the students,
particularly with regard to their ideas on plagiarism, reflected a more traditional approach to conceptions of assessment being reward based on individual endeavour.

Embedded in such dilemmas is the debate regarding assessment of a product, which would be considered a more traditional approach, versus the assessment of process. It is evident that the assessment of products, in the context of technology, does not constitute an assessment of the process (Jones, 1994). Barlex (1994) likewise argues for an emphasis on the procedural competencies developed and utilised in response to the intention of meeting a need, rather than the obvious physical products.

It must be acknowledged that there are embedded systemic difficulties that may impede the effective implementation of appropriate assessment for technology. Mrs Lange recognised that certain practices would be inappropriate (“all I could have done is write an anecdotal note about that child’s understanding”), while at the same time looking for familiar practices (“if I get them to go away individually, now that they’ve got everyone else’s knowledge built onto their knowledge, get them to go away and draw the system individually, and I think that would be a good assessment”). This response indicates a reliance on conceptions of assessment based on individual performance. Whether this is acceptable in the context of technology is debatable. Research indicates that such approaches are not reflective of real world practices in the field of technology. Mayo (1993), for example, considered that the understanding of the design process is simplistic and doubtful in its extent and that the concept of the designer as sole creator of a product is a myth. Hennessy, et al. (1993) would also seem to concur with this conclusion regarding individual endeavour of a designer, for although school is usually characterised by individual work and assessment, this is not the case outside school where sharing and negotiated meaning is the norm. The students in many ways expected such a traditional approach (“I’d give one plane about 100 out of 100”). What remains to be seen is
how schools reconcile generational expectations (from teacher/students/parents) with newer understandings of appropriate assessment practices. If this task is not accomplished, and classroom technology does not utilise meaningful assessment practices, there is a risk that the KLA will become, “just a chance for every kid to do something.”

Difficulties with the identification of technology by the teacher (see Assertion 7, relating to planning methodologies) involved led to the complete lack of summative assessment of the students’ work. Technology, in Mrs. Lange’s teaching program, had become, in effect, something that the students could enjoy. The intellectual worth attached to it, therefore, would seem on this basis to be minimal. This is in accord with the research on two broad fronts. Firstly, it may be possible to question the status that technology has within the observed classroom and whether this is evidence of the Platonic divide seen in traditional schooling models. The activity may have been “fun to do” but whether it rates the same as, say, learning an operation in mathematics would seem to be problematic.

Secondly, the difficulties associated with outcomes-based assessment are apparent. Expense in terms of time may have been an issue, a situation that is consistent with the findings of Baron et al. (1998), Popham (2002), Sudweeks and Clay (1995) and Wiggins (1989). However, from the evidence in this research it is more likely that the absence of summative assessment represents a lack of familiarity with the use of alternative assessments, particularly in relation to the interpretation of criteria (Popham, 2002; Khattri et al., 1995; Norman, 1995). The issue is clearly one of professional development (Mitchell, 1995), whereby teachers need training to develop their skills in the use of unfamiliar assessment techniques. The teacher’s unfamiliarity with how the KLA might progress (“I’m not really sure where to go from here with it, it’s hard”), coupled with the difficulties associated with assessment,
has created a situation where no summative assessment at all took place. The outcomes that defined the activity in planning documents were not utilised by Mrs. Lange at any stage during the activity in relation to assessment of students’ work. They were used to contextualise the activity, but not assess it. The statement by Mrs. Lange outlining the teacher’s view of activities as quite informal (“it was just a chance for every kid to do something”), may explain the lack of reference to outcome statements in any assessment program.

The assessment of contingent designing (as identified in Assertion 1, relating to design processes) is dependent on understanding what students are doing when they are designing and providing appropriate guidance. Contingent design is in accordance with previous research in that is does not envisage a linear approach to designing (DeVries & Tamir, 1997; Davies, 1996; Donnelly, 1992; Hill, 1998; McCormick, 1997). Furthermore, it encompasses the concepts of cyclic, iterative or recursive designing (Queensland School Curriculum Council, 2000a), interrelated processes involving several planning-making-testing loops (Ritchie & Hampson, 1996) and interacting design loops (Kimbell, 1997).

It is argued here that contingent design is consistent with these models while providing a more realistic means of allowing teachers to access what the students in their classes are doing. As such, it provides a means for the teacher to give more appropriate formative assessment, while informing any summative assessment that requires teachers to make judgments of student activity. Utilising contingent design to inform assessment is consistent with the research that suggests that non-traditional assessments should acknowledge non-textbook knowledge (Slater et al., 1995) such as can be seen in the student activity in this research (e.g., knowledge attained through personal interaction with others). Similarly, ‘real problems’ (Duschl &
6.2.3 Summary

The assessment of technology requires teachers to take into account the role of artefacts in any assessment. It is suggested by this research that utilising a conception of artefacts as being part of a narrative may have positive implications for the primary school technology classroom. It must also be recognised that understandings of assessment within the classroom may differ, and that the effective implementation of technology requires a more coherent understanding of assessment by students and teachers. Teachers, to be able to make effective judgments, need to be aware of some of the contextual issues that may or may not arise in the classroom activity. For example, the availability of resources, both material and personnel that students may have access to is important information for teachers making assessments.

6.3 Curriculum (Relates principally to Objectives 3 & 4)

6.3.1 Planning methodologies

In Assertion 7 relating to planning methodologies (Section 5.7), it is evident that the implementation of any teacher planning was determined to a large degree by the reactions of the students, seen particularly in relation to the disaster management scenario (see Table 4.1), for example, where a wide range of student directions were possible (i.e., open ended or ill structured problem solving). What the students develop in the classroom is shaping the ongoing thinking of the teacher, and thus planning in such circumstances must necessarily be less directed than that with which teachers might be familiar. This is certainly consistent with a KLA that is ill defined,
as discussed in Section 2.1 of the literature review where, it may be surmised, the lack of a solid conceptual understanding by teachers of technology is a common feature identified by research in the technology KLA (e.g., Lindblad, 1990).

Secondly, the discussions between the teacher and the researcher illustrate the manner in which a negotiated meaning of technology may be developed between practitioners. Teaching in a single classroom can be a very isolating experience, and it is vital that teachers are able to discuss what they are doing in technology lessons to develop ideas that they may have regarding how the KLA is implemented in their classrooms. In one exchange, for example, Mrs. Lange did not feel confident to undertake a change in direction relating to the activity on water systems. A collaborative approach with other, more experienced, technology teachers may have allowed her to undertake the lesson in a less threatening environment. Importantly, there was not such collaboration between teachers with regard to technology in the context in which this research occurred.

Such collaborative approaches would also mitigate, to a degree, the situations found by Lindblad (1990) and Medway (1989) where technology became a manifestation of teachers’ own personal experiences rather than a shared approach between schools. The work of Lewis and Gagel (1992), Lewis (1991), Barak et al. (1995), and Rennie et al. (1992) also discusses the influence of teacher background on conceptions of technology that may narrow conceptualisations of the KLA detrimentally, but certainly affect technology in the classroom in an important way.

It is also clear that the development of effective planning is dependent on a conceptualisation of technology that may be realised in a classroom environment. Mrs. Lange made mention of her frustration with not being able to envisage where the students in her class would take the activities and that, for this reason, she terminated
the first activity early. It would seem that the conceptualisation of technology held by this teacher was unable to deal with the multitude of outcomes that were possible. This is consistent with findings regarding technology teachers where Ritchie and Hampson (1996) argue that the success of implementing design technology programs may be correlated to teacher background. Jane and Jobling (1995) also contend that teachers are lacking in confidence to introduce design technology into their classrooms because of limited conceptions of how to teach and learn the KLA. Similarly, the lack of common identity within the KLA by teachers (Jarvis & Rennie, 1996a; Jarvis & Rennie, 1996b; Jones, 1997a; Jones & Carr, 1992; Newton & Hurn, 1996) has been identified previously.

Teachers of technology need to be aware that their planning must reflect certain elements of uncertainty that are necessarily attached to the KLA. It would be beneficial for teachers to allow for such uncertainty in their planning, and visualise what possibilities may occur, as well as develop the confidence to handle unexpected outcomes. For example, teachers may undertake, in conjunction with colleagues, a discussion regarding the range of directions that students might take to determine what are the parameters that they will consider to be acceptable for the problem. In this manner, planning need not be prescriptive but can allow for a range of possible end points that are all valid, within certain manageable boundaries. Furthermore, it is entirely possible that students may take directions that were not envisaged yet are within the parameters of the exercise. A degree of flexibility and negotiation must be enacted in such circumstances.

The end result of any professional development in this regard must be the development of an effective and meaningful conceptualisation of the KLA by teachers. It is apparent from this study and previous research that this is essential to the implementation of a viable technology program in the classroom.
A lack of absolute certainty is a feature of outcomes-based education, and it is clear that a degree of negotiation must be undertaken between student and teachers regarding any assessment that may be made. As has already been noted by the teacher involved, coming to terms with outcome statements is not necessarily easy (“I’m not too sure (about) the outcomes…how they fit in to what we’re doing”) and that expecting students to deal with outcomes will require a considerable amount of discussion between all participants. It is evident that technology in the primary classroom must be developed by participants into appropriate forms that reflect the nature of the KLA and the context in which it occurs, rather than prescribe templates of classroom activity that may be inappropriate.

6.3.2 Development of understanding of technology

While the assertion relating to fields of possibility (Assertion 4) contends that it is possible to delineate the boundaries of technological activity such that an appropriate response from teachers in terms of program development and assessment may be developed, the eighth assertion addresses the issue of whether student understanding of issues can be observed. This is particularly important if teachers are to make continuous evaluations of their intended programs as they are implemented in the classroom.

This has been problematic in the past from a number of differing perspectives. Firstly, authors such as Lindblad (1990), Medway (1989) Barak et al. (1995), and Rennie et al. (1992) and Lewis and Gagel (1992) have discussed how teacher values in relation to technology are very personalised. It is therefore imperative that there be identified progressions within technology that are more universally recognised than at the present. To do so would require the ability to see what students are doing in a
more uniform manner, leading to the second problem identified in this regard, that the observer has great difficulty in identifying the specific processes that are occurring (McCormick et al., 1994). This is compounded by observations such as those by Mayo (1993) that no design works unless it embodies the ideas that are held in common with the people for whom the design is intended. The obvious concern that must arise from this is the validity of assessments regarding such processes.

This research asserts that it is possible to see progression in the thinking of students (and teacher) within a classroom environment, and that as such many concern regarding the assessment of technology education may be addressed through further research. Work such as that by Ginns et al. (2001) on conceptual trajectories in technology may prove to be fruitful avenues in this regard, through defining more clearly how student understanding develops

6.3.3 Difficulties with the syllabus

It has been identified in Assertion 9, relating to difficulties associated with the Technology Syllabus, that the teacher involved regarded the ancillary syllabus documents (e.g., Syllabus Elaborations) as being more useful in term of developing conceptions as to what technology is, and how it may be enacted in the classroom. It would seem that the immediacy of the situation that required Mrs. Lange to develop a technology program led to a situation where concrete examples were seen as being more useful to her as a teacher. What remains to be seen is how this situation will resolve itself in the broader teaching community.

It can be noted, once again, that issues associated with the identification of the KLA by teachers is central to the effective enactment of syllabi. This has been discussed above in relation to the work of many authors (Barak et al., 1995;
Donnelly, 1992; Jarvis & Rennie, 1996a; Jarvis & Rennie, 1996b; Jones, 1997a; Jones & Carr, 1992; Lewis, 1991; Lewis & Gagel, 1992; Lindblad, 1990; Medway, 1989; Newton & Hurn, 1996; Rennie et al., 1992). The circumstances of this research point to a need to allow teachers time to come to terms with the syllabus, the context in which they are to teach it (see Assertion 3, relating to the physical environment of the classroom), the nature of student activity within a technology classroom (see Assertions 1, 4, 5 & 6), how to plan within a technology framework (see Assertion 7) and the nature of the KLA itself.

The issue of assessment within an outcomes-based framework has also been discussed broadly within this research, and it is clear that effective assessment is critical to the implementation of a technology syllabus. The work of Glover and Thomas (1999), Baron and Boschee (1996), Willis and Kissane (1997) and Marzano (1994) have addressed the issue of teachers utilising outcome statements, where they point to the need for teachers to develop proficiency at utilising this type of assessment. This is a recurring theme, particularly as it applies to teacher interpretation of criteria (Khattri et al., 1995; Norman, 1995; Popham, 2002). The critique of the language of outcomes-based education by Schwartz (1994) is also of relevance in that it appears that the teacher in this research did have difficulty accessing the outcome statements because of the language used.

What can be said with a degree of confidence is that teachers will need both time and assistance to develop a working knowledge of the syllabus document and the associated outcomes-based issues. It has been written in this research that teachers undertake planning, implementation and assessment as part of a teaching cycle. What might be further added to these three activities is the process of conceiving the nature of technology, the field of possibility and the syllabus before undertaking planning.
Curriculum planners need to be aware that all teachers require support in terms of interpreting curriculum documents. It may be of benefit to provide, in conjunction with statements of students outcomes, a more comprehensive addressing of issues associated with formative assessment. In particular, it would be useful for teachers to have an indication of how they might determine student understanding, as well as strategies to assist them in guiding themselves and their student through new or unknown subject matter.

As well as the provision of example activities, such as those in the elaboration document, it would be useful to provide resources to background activities that may be undertaken. Such documentation is now available for teachers through the Queensland Studies Authority website (http://www.qsa.qld.edu.au/), where teachers can access the Technology Syllabus, Sourcebook Guidelines, Sourcebook Modules, and Initial In-Service Materials (as of 24/6/04). It must be acknowledged that the scope of technological activities would preclude a comprehensive approach from a single provider, but an electronic means for teachers to communicate their experiences in developing an understanding of technology would appear to be one avenue that could be explored.

It would be of benefit to teachers to receive guidance from curriculum bodies as to what requirements should be in place in schools to achieve particular goals. Any suggested activities would need to acknowledge that all schools are differently resourced in terms of personnel, resources and infrastructure, and that technology activities may need to be suitable modified. Of more importance, however, would be those associated with the identification of the KLA, outlined above. This must be done effectively and comprehensively at a very early phase of any implementation cycle.
Current curriculum documents used in this state are based on broad outcome statements that require interpretation by teachers. This interpretation will always be influenced by beliefs and experiences of individual teachers. It is therefore necessary that documentation of skill and knowledge levels be developed that may be applied to the progression of students through school. To do otherwise is to risk that students may be asked to perform tasks that are unreasonable or unrewarding. A key means to the consistent interpretation of the syllabus documents is that of defined skill and knowledge levels that students may reasonably be expected to attempt, or teachers may reasonably be expected to implement.

This is not to say that there will be mandated skills or knowledge that will end up driving classroom activity. Rather, it would cover a range of outcomes that may or may not be applicable to a particular activity and would assist teachers in interpret the implementation of their class programs. Mrs Lange noted this in an interview with the researcher, where she suggested on more than one occasion that it was practical examples of activities that would best allow teachers to implement a reasonable technology program. However, while this may appear to be a situation in common with other KLAs, the lack of understanding of technology by teachers may make this a particular problem in that it could stifle innovation in the classroom. This cannot be beneficial at a time when such exploration of the KLA is necessary to facilitate discussion of what the KLA means to educators and the communities in which they work.

6.3.4 Summary

This section highlighted a number of issues associated with teaching practice associated with technology. Planning methodologies are examined, as are the development of technological understanding by classroom participants. Difficulties
with the use of the technology syllabus were also discussed. Recommendations regarding the improvement of classroom practice are made in regard of these issues.

6.4 A Model for Interpreting Technology Activity

The model below is intended to provide a means for the consistent interpretation of student activity, as seen within the classroom studies for this research program. It is intended that this model would be for use by teachers and researchers in technology education to interpret and plan for student activity in classrooms. A pictorial representation of the model is presented in Figure 6.1, followed by a description of the model, and some examples of how it may be used to interpret classroom behaviour.

6.4.1 Description of the model

The model consists of two main areas. The first of these is labelled all possible outcomes. From this area, the teacher involved needs to select a field of possibility in which classroom activity is intended to occur, that is, delineate the parameters of the exercise. Activity within this field is described in term of four factors. The first of these is pedagogy, or teaching practice. This includes considerations such as the management of the classroom, planning and curriculum. Pedagogy is thus a central feature of the model which is then connected with three other factors; participants, artefacts and design process. The participants feature would include considerations of the knowledge and experience of students, teachers and the community, while the artefacts feature would include an understanding of the role of artefacts, the use of real world problems and the design intentions of the activity. The design process feature would consider contingent design, openness and design experience. All four of these features are connected by double headed arrows.
indicating that interaction occurs between them during the classroom technology activity.

![Figure 6.1 A model of classroom technology.](image)

This model of activity is not linear, nor does it have a specified end point for activity. Activity occurs through the interaction between the four key features until such time that a solution that fits with the field of possibility is reached. Implicit in
the model, therefore, is the understanding that assessment of this activity must occur through the consideration of all of these four key features in conjunction with the field of possibility. Assessment may be seen to overlay these four features, as indicated by the shaded area.

Interactions between the features of the model indicate that each informs and shapes the other. For instance, access to community resources (participants) will allow for new design processes to be undertaken (design process), which will in turn allow for differing artefacts to be produced (artefacts). In each of these instances the management of the class will facilitate the effectiveness (or otherwise) of classroom activity (pedagogy). The activity is thus an interactive experience that is continually shaped by the circumstances in which it occurs. Assessment, therefore, should be informed through reflection on all four features, and not through focusing on one particular feature (most commonly the artefact).

In relation to this study the model sheds light on a number of observations made in the classroom. Mrs Lange’s comments regarding the nature of student activity, for instance, where she stated that, “I think it was changing so much in their minds, and once they got started they realised ‘oh! I could use that other thing,’” (IA-06/5), indicates two facets of the model. Firstly, the continual evolution of a design throughout an activity is shown through the comment regarding the children continually changing their minds about the possibilities they could realise. Secondly, it indicates the interaction between the key features of the model, in this case the artefacts and the design process.

The students also highlighted facets of the model. Kristal, for example, when commenting on assessment stated that, “you can’t just really say their (artefact) is better, because you don’t really know how well they’ve thought of it” (IA-02/10).
Kristal is asking for information on the participants and artefacts (through associating each with the other) and design process (through identifying a thinking process as important) to make an assessment of what has occurred in the classroom. The key features of the model are seen as inextricably linked.

The model also explains some of the difficulties that were seen in the classroom. Mrs. Lange commented on the difficulties she was encountering with assessment ("you can’t assess the kids on one thing because they’ll all be doing something different" (IA-06/7)), indicating a focus on the artefacts they were creating. Assessment, in relation to this model, overlays all four key features and, as such, should take into account a broader understanding of what the students have achieved through, for example, consideration of resources they may have had access to, how they went about achieving their design, as well as the pedagogy employed by the teacher herself to assist the students. Assessment must therefore be seen as understanding the narrative of the artefact, not the artefact in isolation.

It is suggested that this model may provide a means for educators to discuss and interpret technology within a common framework, thus facilitating the more effective implementation of the KLA.

6.5 Summary of Chapter

In this chapter the assertions and literature review have been utilised to identify a number of implications that may be of relevance to the primary school in relation to design and practice of technology, assessment and curriculum. Of importance is the contribution that this research makes to the reality of assessment of student activity in the technology classroom as well as the conceptual means to allow teachers to access student behaviour, through means such as contingent design, the use of a narrative.
approach to portfolio development, and the use of a field of possibility. All of these factors contribute in a unique manner to the understanding of technology as it may develop in classrooms.

In this research a number of assertions have dealt with facets of the design process, suggesting that contingent design may drive the design process toward a ‘field of possibility’ resulting in artefacts that need to be interpreted within a narrative framework. This is a new conceptualisation of technology design, and assists in the development of a coherent conceptualisation of technology that will assist in the effective delivery of the KLA in a primary school classroom.

The research also contributes to the understanding of the practicalities of technology in the classroom, through, for example, interpretation of syllabus documents and the physical nature of classrooms.

The research has also synthesised the findings to develop a model of classroom technology activity that may have applicability beyond the context of this research. The research is thus grounded in the classroom experience of technology, is reinforced by the literature, and presents a picture of technology that contributes to the effective implementation of technology in the primary classroom.
Chapter VII

Summary

7.0 Summary of Research project

This research has addressed a number of issues associated with the implementation of a technology program in the primary school classroom. It was developed from a review of the literature that identified areas for research that might be investigated to further understanding of the curriculum area. An initial investigation of the history of the KLA revealed a new and poorly understood curriculum area that had a number of contentious facets that required investigation. It was noted that many teachers had little knowledge or experience with the curriculum area.

Language problems with the KLA, particularly as it related to the use of terminology within the KLA, teaching profession and wider community were highlighted. The dimensions of technology were examined, revealing certain consistent features including the concepts of a multidimensional curriculum area, praxis and the centrality of process and design. These, while consistent features, appeared to be poorly understood.

Technology is a quintessentially human activity, and the role of teachers in interpreting it for students was of concern. This concern is allied to aspects of terminology outlined above, particularly as it relates to how teachers conceptualise and implement the curriculum area.
The place of technology in particular, and practical KLAs in general, was examined with regard to their status within the educational community. Historical issues associated with views of education in this regard were outlined, as were the association of technology to science and manual arts.

Design processes were examined, where it was concluded that linear models of design were inconsistent with accepted practice, and that the process was a much more complex activity than originally conceived. A number of alternative models were presented.

The role of assessment in schools was also examined where it was concluded that assessment influences perceptions of what was important in the classroom. Considering the conclusion made with regard to technology and the importance of a design process, it was concluded that alternative approaches to assessment held the key to gaining an understanding of technology practice in the classroom. Some alternative assessments, and their implications for the classroom were examined. Issues associated with the human element in assessment, communities of practice and context were discussed. The problems with alternative assessment, particularly as they relate to reliability and validity were outlined. The context in which this research was to occur in relation to assessment was also presented.

The theoretical implications of technology and assessment were discussed, and from this an aim and a number of specific objectives for the research were developed. The aim of this research was to investigate the implementation of a technology syllabus in a primary school classroom environment by a teacher with limited background in the KLA, while the specific objectives of the research were to:
1. Identify and analyse technology design processes occurring in the classroom,

2. Investigate the planning and implementation of classroom assessment in an outcomes-based technology program,

3. Investigate the development of strategies by the teacher regarding planning and implementation of an outcomes-based technology program,

4. Draw implications for the development of theory and practice of technology education in the primary classroom.

A case study methodology was presented to investigate these presented aims. This study took place in a single mixed Year 4/6 classroom in a rural primary school. Data collection was undertaken as the teacher of the class implemented a technology program. Data consisted of recordings of classroom activity, formal and informal interviews with participants, artefact collection, stills photography and field notes made by the researcher. Data analysis proceeded during and after data collection and resulted in the development of nine assertions that were presented in chapter five, and discussed in chapter 6. A model to synthesise findings was also presented.

7.1 Summary of Findings

Nine assertions were developed throughout the research program. These assertions addressed the aim and objectives of the research and were intended to highlight findings from the data. The broad and specific implications of these assertions were discussed in detail. These assertions covered a range of issues that pertained to the objectives of the research. They included observations on; 1) design processes undertaken by students, 2) the implementation of certain design approaches
3) the physical environment in which technology occurs, 4) fields of possibility in relation to classroom activity, 5) the interpretation of artefacts, 6) understandings of assessment in the classroom, 7) planning methodologies, 8) student and teacher development of technology understandings, and, 9) difficulties associated with the technology syllabus. Assertions 1, 2, 3 and 4 relate to the first objective (focused on technology), Assertion 5 and 6 relate to the second objective (focused on assessment), and Assertions 7, 8 and 9 relate to the third objective (focused on pedagogy).

These assertions are then discussed with reference to previous research, highlighting implications for technology in the primary school classroom. The aim of the research was met through the research program investigating a range of issues that emerged from actual classroom experience of a technology program. The objectives of the research have been addressed through the nine assertions, adding to present understandings of technology in the primary classroom, particularly as it relates to what students actually do when undertaking design tasks, and in the assessment of this activity.

The implications from the research point to a number of key issues. Firstly, there needs to be more understanding of how students undertake design tasks, allowing for a realistic classroom approach to their undertakings. Secondly, teachers need to be aware that to template certain notions of design processes from simplistic models (e.g., ‘design, make appraise’) may be inappropriate for their students, and a more sophisticated approach is required. The physical environment in which technology may occur can be inappropriate and create difficulties for participants. Teachers and other school staff need to be aware of the possible impact that this may have on technology activity.
Also, the utilisation of a field of possibility to characterise classroom activity may prove to be useful means to envision the development of technological activity. As well, the role of artefacts needs to be placed in its appropriate context, that of being part of a narrative, not the whole story itself. Next, a common understanding of what assessment is needs to be developed, not just between teachers, but also with students.

Teachers also need to be clear on their conceptualisation of the KLA, for this will affect how they plan, implement and assess the KLA. As well, it should be realised that the development of student and teacher understanding can be observed in technology activity, and that such a realisation will allow for appropriate guidance in the classroom. The technology syllabus needs to be interpreted in conjunction with other sources of information on technology, and is not a stand-alone document. It was apparent that the syllabus created difficulties for the teacher in this research when being read in this manner.

The presented model may also allow for a conceptual framework to develop teacher understanding of technology, although it must be acknowledged that this model has been derived from a single classroom, and its utility in a broader context has not been examined.

### 7.2 Further research

From the aim, objectives and assertions of this research it is possible to identify a number of areas in which further research might prove useful. These areas include:

1. The dissemination and development of ideas in the field of technology. It would be particularly important to see how teachers share their ideas on
technology and how they develop over a period of time in a natural setting. Research to date has not addressed this issue. As this will be one of the important ways in which technology develops, it would seem prudent to investigate how this happens.

2. The links between technology and other curriculum areas need to be explored. Within this research, analogies from the sciences (contingency), as well as from literature (narrative) have been used to explore the nature of the KLA. It would seem to be useful if such links are further developed so that more familiar means of thinking may be employed in teacher education practice.

3. What is good technology? The values basis of technology has not been explored in this research in any great detail. It is clear, however, that assessment is inextricably linked to values and that how participants value technology may provide new insights into the KLA.

4. Contingent design as students progress through school. It has been postulated here that the use of contingent design should diminish as students develop competencies in technology. This needs to be refuted or confirmed, as it is central to the concept of contingency.

5. Classroom settings for technology. It is important to ascertain how the physical environment in which technology occurs affects how the KLA is realised in schools. Any guidance in this regard would prove useful to schools implementing the KLA.

6. To what degree should technology reflect broader professional conceptions of the design process, and what are the expectations that should be placed on the
discipline in this regard. This is an essential component in the identification of the boundaries of the KLA.

7. How differing styles of assessment are implemented and recognised by participants in a technology classroom. This issue is applicable to concerns regarding appropriate teaching and learning strategies, as well as planning of classroom programs.

8. At what stage, developmentally, are students ready to undertake technical drawing that enables them to realistically envision possible technological outcomes?

9. The effectiveness of strategies for the development of teacher skills in the technology KLA.

10. The applicability of the presented model to a broader educational context.
Appendix 1: Data sources, codes and general interaction with research site.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
<th>Location</th>
<th>Type</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not coded</td>
<td>Informal approaches to school and teacher</td>
<td>School</td>
<td>N/A</td>
<td>February, 2001</td>
</tr>
<tr>
<td>FN-5/4/01</td>
<td>Formal meeting with principal and teacher. Education Queensland approval for research obtained.</td>
<td>School</td>
<td>N/A</td>
<td>5/4/01</td>
</tr>
<tr>
<td>FN-12/4/01</td>
<td>Meeting with teacher-discuss technology program &amp; technology generally.</td>
<td>Staff room</td>
<td>Field notes</td>
<td>12/4/01</td>
</tr>
<tr>
<td>FN-30/4/01</td>
<td>Meeting with teacher and students-send permission notes home &amp; discuss technology program. Teacher permission obtained. Familiarisation lesson. Teacher planning collected</td>
<td>classroom</td>
<td>Field notes</td>
<td>30/4/01</td>
</tr>
<tr>
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<td>Introductory lesson &amp; collect planning</td>
<td>Classroom</td>
<td>Audio</td>
<td>8/5/01</td>
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<td>Classroom</td>
<td>Audio</td>
<td>14/5/01</td>
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<td>Classroom</td>
<td>Audio</td>
<td>14/5/01</td>
</tr>
<tr>
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<td>General activity (2 lessons)</td>
<td>Classroom</td>
<td>Video</td>
<td>14/5/01</td>
</tr>
<tr>
<td>CV-02</td>
<td>General activity</td>
<td>Classroom</td>
<td>Video</td>
<td>15/5/01</td>
</tr>
<tr>
<td>CV-03</td>
<td>General activity</td>
<td>Classroom</td>
<td>Video</td>
<td>21/5/01</td>
</tr>
<tr>
<td>CA-04</td>
<td>General activity/informal interviews</td>
<td>Classroom</td>
<td>Audio</td>
<td>21/5/01</td>
</tr>
<tr>
<td>CA-05</td>
<td>General activity/informal interviews (2 lessons)</td>
<td>Classroom</td>
<td>Audio</td>
<td>4/6/01</td>
</tr>
<tr>
<td>CV-04</td>
<td>General activity (2 lessons)</td>
<td>Classroom</td>
<td>Video</td>
<td>4/6/01</td>
</tr>
<tr>
<td>CV-05</td>
<td>General activity</td>
<td>Classroom</td>
<td>Video</td>
<td>5/6/01</td>
</tr>
<tr>
<td>CV-06</td>
<td>General activity</td>
<td>Classroom</td>
<td>Video</td>
<td>12/6/01</td>
</tr>
<tr>
<td>CA-06</td>
<td>Introductory lesson &amp; general activity/informal interviews</td>
<td>Classroom</td>
<td>Audio</td>
<td>10/7/01</td>
</tr>
<tr>
<td>CV-07</td>
<td>Introductory lesson &amp; general activity</td>
<td>Classroom</td>
<td>Video</td>
<td>10/7/01</td>
</tr>
<tr>
<td>CV-08</td>
<td>General activity (2 lessons)</td>
<td>Classroom</td>
<td>Video</td>
<td>16/7/01</td>
</tr>
<tr>
<td>EV-01</td>
<td>General activity</td>
<td>Exterior</td>
<td>Video</td>
<td>17/7/01</td>
</tr>
<tr>
<td>IA-02</td>
<td>Interview- students(Kylie/Kristal/Geoff)</td>
<td>Adj. room</td>
<td>Audio</td>
<td>23/7/01</td>
</tr>
<tr>
<td>IA-03</td>
<td>Interview- students (Bella/Henry/Julie)</td>
<td>Adj. room</td>
<td>Audio</td>
<td>23/7/01</td>
</tr>
<tr>
<td>IA-04</td>
<td>Interview- students (Helen/Jenny)</td>
<td>Adj. room</td>
<td>Audio</td>
<td>24/7/01</td>
</tr>
<tr>
<td>IA-05</td>
<td>Interview- students (Tessa/Leon/Ambre/Dominic)</td>
<td>Adj. room</td>
<td>Audio</td>
<td>24/7/01</td>
</tr>
<tr>
<td>Not coded</td>
<td>Fax to teacher prior to interview (see Appendix 5)</td>
<td>N/A</td>
<td>N/A</td>
<td>27/11/01</td>
</tr>
<tr>
<td>IA-06</td>
<td>Interview-teacher</td>
<td>Classroom</td>
<td>Audio</td>
<td>29/11/01</td>
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<tr>
<td>Not coded</td>
<td>Thank you letters to principal and participating teacher</td>
<td>N/A</td>
<td>written</td>
<td>6/12/01</td>
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<tr>
<td>FN-(date)</td>
<td>Field notes</td>
<td>As applicable</td>
<td>Written</td>
<td>As stated</td>
</tr>
<tr>
<td>AFT- (number)</td>
<td>Collected artefact</td>
<td>N/A</td>
<td>Various</td>
<td>As stated</td>
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</tbody>
</table>
### Appendix 2: overview of cooperatively planned technology unit

#### Sequencing of Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>War</td>
<td>2 weeks</td>
</tr>
</tbody>
</table>
- Anzac Day: Remembering War  
- Australia's Involvement in War  
- Wars of the past  
- Reasons for conflict (economic, resources)
| Natural Disasters | 2 weeks  |
- What is a disaster?  
- Weather patterns/predictions: impact on health  
- Volcanoes: how are they formed?  
- Plate tectonics  
- Igneous Rocks  
- Properties and composition of rocks  
- Tsunamis  
- Earthquakes  
| Floods/droughts | 1 week  |
- Sedimentary rocks: erosion  
- Fossils  
- Composition of rocks  
- Layering  
- Sedimentation  
| Scales of time |  
- Geological time  
| Heath issues |  
- Epidemics, spread of diseases  
| Bush fires | 1 week  |
- Cyclones  
- Role of the SES, Bush Fire Brigade and other community groups  
| Metamorphic Rocks: faulting and folding |
Man Made Disasters
Sources of Energy
Alternative ways of obtaining energy
Designing a fossil fuel free machine
Consequences of energy use
Accidents forms of energy- oil spills, nuclear reactors

Man’s Affect on the Environment
Long term effects
- degradation
- salinity
- farming practices
- urbanisation
- waste management
- global warming
- habitat loss
- deforestation
- tourism
- ozone depletion
- sustainability

Health issues- sun exposure, smoke pollution, asthma

Culminating Activity
Risk management of a disaster
Risk assessment of the playground
Basic First Aid
Skills of working as a team
Disaster simulation
Appendix 3: Teacher planning and documentation – Year six cooperative planning

Suggested Learning Episodes

Year 6 Unit: What is a Disaster?

Challenging and Dense Culminating Task
The culminating activity involves the students in experiencing first hand a ‘disaster’ situation on the school oval. Each student will work as part of a team (first aid team, SES team, catering team) to deal with the disaster and the “victims”. At the end of the simulation children will evaluate their own effectiveness as a team member as well as reflect on the way that various teams worked as a whole and the need for coordination in an emergency situation.

Essential Culminating Outputs for Students
Each student will present in typed, written format a newspaper report of a disaster (or a biography of a famous Australian scientist). This report will then be presented as an oral news report to be video-taped for the student’s self evaluation.

Students will reflect on their ability to work co-operatively as part of a team and be able to identify the personal skills (communicating, listening, negotiating, cooperating) necessary for a good team member.

The contextualised sub-tasks engage the learner in:
- Accessing, interpreting and analysing daily weather maps using newspapers, TV, and the Bureau of Meteorology web site and applying this information to consider the direct implications for our community and other communities.
- Maintaining a news report watch of disasters happening around the world.
- Researching, discussing and recording forms of catastrophic change (earthquakes, volcanoes, tsunamis, floods/droughts and cyclones) and the reason for their occurrence.
- Identify the effects of catastrophic change on the environment both living and non-living.
- Designing a fossil fuel free car.
- Researching and analyzing the impact of introduced species of animals and plants to the Australian environment.
- Considering the development of scientific ideas over time and the contributions that science and scientists make to our world and our daily lives.
- Researching and discussing the cultural factors that influence the nature and direction of science.
- Writing a newspaper report (or news interview)
- Presenting their news report orally like a real TV interview or news bulletin so it can be video-taped. Evaluating their own and each other's oral news report when it is played back.

### Real Life/Life-like Focus

Being involved in a disaster simulation children will experience the feelings associated with a real disaster, gain an understanding of some of the demands placed on emergency workers and the skills these people need as well as the important role these groups play in the community.

Preparing and orally presenting a TV news report children will understand the skills needed to be a news reader/interviewer.

<table>
<thead>
<tr>
<th>Cultural and Social Contexts (Including Attitudes and Processes)</th>
<th>Community Links</th>
<th>Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being involved in a 'real' emergency situation the children will have the opportunity to understand the importance of co-operation and coordination between individuals and community groups and services.</td>
<td>A member of the State Emergency Service will be invited to speak to the children about their role in the community. Children will have the opportunity to learn some basic first aid for emergency situations from an ambulance officer.</td>
<td>Accessing weather information using the internet. Publishing a biography of a newspaper report using word, publisher, clip art, cutting and pasting illustrations.</td>
</tr>
</tbody>
</table>
- Researching, compiling and presenting a biography on a famous Australian scientist.
- Identify the sources of energy available to us including fossil fuels, sun, hydroelectric, wind and nuclear and ways the energy is utilised.
- Researching and investigating alternative ways of obtaining energy including solar cells and wind turbines.
- Analysing and discussing the consequences of energy use both in the short term (pollution) and the long term (non-renewable sources and the greenhouse effect on the environment).
- Identifying health risks related to social, biological and environmental factors like pollution and high UV levels.
- Discussing and recommending activities to promote students own health in response to the environment.
- Identifying manmade disasters and analyse the impact of this type of disaster on the environment in both the short term and long term.
- Comparing wars throughout the ages and investigating, researching and analysing the reasons for war.
- Discussing the social and environmental impacts of war.
- Predicting and hypothesizing the impact of future wars.
- Investigating and discussing solid, liquid, gas, plasma and crystals.
- Investigating, discussing and recording details of igneous, metamorphic and sedimentary rocks and their formation.
- Observing rock samples and recording details of underlying structure.
- Discussing the ecological and economic factors involved in the production and consumption of familiar resource like cotton (or uranium mining in Kakadu).
- Researching and discussing the impacts of changes that have occurred to Australia's environment with European settlement including deforestation and erosion.
- Observing and analysing safety issues of our new playground identifying actions we can take to prevent harmful or risky situations or equipment.
- Discussing the role of individuals and community groups in a disaster situation. Identifying these groups within our own community.
- Listening to a talk from a member of the SES and recording the five most important facts about the role of the SES in our community.
- Listening to and practising basic first aid procedures as explained by an ambulance man.
- Participating in a disaster simulation day. Evaluating their own role in terms of their ability to co-operate and work as part of a team.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Publishing</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.4.1 Students plan, create, evaluate, edit and publish a multipage complex document on the computer containing graphics, texts and tables. (in particular use of columns, inserting pictures, justifying, changing font, size, style)</td>
<td>RW.4.1 Students locate and reference information from CD ROMs and the Internet using advanced search strategies (reference <a href="http://fureau">http://fureau</a> of Meteorology weather maps)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Observation- Informal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>English/Genres</th>
<th>Written</th>
<th>Spoken</th>
<th>The Arts</th>
<th>Visual Arts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biography: Children write a biography of a famous Australian scientist</td>
<td>Newspaper Report: of a disaster situation</td>
<td>News Bulletin/ Interview: Video taping of the newspaper report read as a news bulletin or video taping of a news interview</td>
<td>M.4.3: Draws upon a range of skills to present media productions for a variety of audiences and purposes (video-taping of news report bulletin)</td>
</tr>
<tr>
<td></td>
<td>Focused Analysis- Biography</td>
<td>Focused Analysis- Report</td>
<td>Focused Analysis- Report</td>
<td>Observation- Teacher checklist during replay of video tape of news report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Observation- Informal discussion with children about their work and the techniques used.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Think</th>
<th>Investigate</th>
<th>Create</th>
<th>Participate</th>
<th>Communicate</th>
<th>Reflect</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am thinking when I use facts about past wars to predict what I believe might happen in the future.</td>
<td>I am investigating when I use scientific processes to understand the structure of rocks.</td>
<td>I am creating when I design a fossil fuel free engine.</td>
<td>I am participating when I work cooperatively with others to solve the problems presented to us within the disaster simulation.</td>
<td>I am communicating when I present my TV news report.</td>
<td>I am reflecting when I express my views on war and when I evaluate my role in the culminating activity.</td>
</tr>
<tr>
<td>Technology</td>
<td>Publishing P 3.1 Students effectively plan, create, evaluate, edit and publish a multipage complex document on a word processor with draw features. (In particular use of columns, inserting pictures, justifying, changing font, size, style)</td>
<td>Focused Analysis- Newspaper Report</td>
<td></td>
<td></td>
<td></td>
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<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Research RW 3.2 Students locate information from CD ROMs and Intranet. Researching information on volcanoes and other natural disasters RW 3.4 Students copy and paste text or graphics from the Intranet to another document. Copying a picture from clip art to newspaper article.</td>
<td>Observation- Informal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English/Genres Written Biography Children write a biography of a famous Australian scientist</td>
<td>Focused Analysis- Biography</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoken Newspaper Report: of a disaster situation</td>
<td>Focused Analysis- Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoken News Bulletin/ Interview Video taping of the newspaper report read as a news bulletin or video taping of a news interview</td>
<td>Peer Evaluation Self evaluation of taped report Teacher Checklist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Arts Media M 3.3 Plans and presents media productions for a particular audience or purpose. Video- taping of news report bulletin.</td>
<td>Observation- Teacher checklist during replay of video tape of news report.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Visual Arts VA 3.2 Explores and uses several art elements and uses specific skills and techniques appropriate to the medium.</td>
<td>Observation- Informal discussion with children about their work and the techniques used</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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<th>Reflect</th>
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<td>I am investigating when I use scientific processes to understand the structure of rocks.</td>
<td>I am creating when I design a fossil fuel free engine.</td>
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<td>I am communicating when I present my TV news report.</td>
<td>I am reflecting when I express my views on war and when I evaluate my role in the culminating activity.</td>
</tr>
</tbody>
</table>
Appendix 4: Technology unit planning

Technology Syllabus Component – What is a Disaster?

SN 3 Students explain the relationship between elements of a system and identify how they contribute to the input, process or output of the system and identify subsystems within systems.
SN 4 Students identify and explain the principles and logic of systems and subsystems within systems.

Activity 1 Identify a scenario where biological warfare (or the release of a toxic virus) has occurred in a town. Using our own town as an example children identify ways in which the people of the town could become infected. Children are broken into small groups to decide on the ways the virus could spread (within the town and into neighbouring areas) if it was
- water borne (river system, household water system)
- air borne (weather patterns for the town, air conditioning units)
- human contact (sneezing, touching others)
Discuss the systems involved in the spread of the virus eg municipal systems eg town water supplies and supply systems eg commuting between towns for work, delivery routes for trucks.

SN 3 Students explain the relationship between elements of a system and identify how they contribute to the input, process or output of the system and identify subsystems within systems.
SN 4 Students identify and explain the principles and logic of systems and subsystems within systems.

PE 3 Students use real-life and life-like situations to make judgments about the effectiveness of products, key design features and how they can be modified.
PE 4 Students gather feedback from users to evaluate how design ideas, production processes or products could be modified to meet original needs and wants.

Activity 2 Children in small groups devise a Disaster Management Plan for Warwick. In the event of a similar disaster happening within our town eg blue green algae outbreak or contamination of the water supply, children work in small groups to design a Disaster Plan that could be put into place for our town to control the disaster eg restricting movement to and from the town, turning off water supply from the dam. Children present their plan to the class for consideration explaining why they would instigate each strategy. Children vote on the most important aspects of each plan. Children share their plan with parents and ask for feedback on any issues they may have overlooked or any that would not be feasible.

Activity 3 Children design a fossil fuel free car.
ST 3 Students use techniques to assemble, disassemble, trial and modify systems and systems with subsystems.

ST 4 Students select and use techniques to organize, assemble, disassemble, trial and refine systems for specific users.

Activity 4 After being involved in a Disaster simulation children evaluate the effectiveness of the teams and the coordination systems that were in place. Children participate in a real-life disaster scenario where they are required to work as part of a team. Each team has a specific task and is required to work with other teams. Children attempt to map the systems and sub systems that operated on the day.

Activity 5 Play ground safety checklist. In order to avoid disasters in our own playground children conduct their own safety audit of our new playground and school grounds to identify dangerous situations and the need for rules/procedures to be put in place.
## Integrated Activities- What is a Disaster? Year 4/6 H

<table>
<thead>
<tr>
<th>Week</th>
<th>Year 4</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Handwriting: “For the Fallen” p 89 Disaster and Survival</td>
<td>Discuss wars of the past and reasons for conflict (economic, religious)</td>
</tr>
<tr>
<td></td>
<td>Design title page in Theme Book</td>
<td>Identify countries who fought in the Gallipoli Peninsula p 8 Anzac Tradition</td>
</tr>
<tr>
<td></td>
<td>ANZAC slang activity in pairs p 13 ANZAC Traditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discuss significance of ANZAC Day and Remembrance Day. See p 254 TR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brainstorm wars that children know Australians fought in. Identify wars family members fought in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research in library and intranet wars Australians fought in, time of the war and reasons for the war. List these in theme book.</td>
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</tr>
<tr>
<td></td>
<td>Start a word bank of war words.</td>
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<tr>
<td></td>
<td>List ways by which people and nations remember those killed in war time. Why do people wish to remember the dead, especially those who died in wars? Why do we establish and maintain memorials and their importance to our heritage. List monuments in our local area. (Read p 34 Australian Readers)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Art- continue working on art gallery piece.</td>
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</tr>
<tr>
<td></td>
<td>Writing description of explanation for art gallery piece.</td>
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<tr>
<td></td>
<td>ANZAC biscuits comprehension sheet (See Lisa)</td>
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</tr>
<tr>
<td>2</td>
<td>Pair research on Adolf Hitler and dictators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explore the drama medium of a frozen effigy as an introduction to “Fish and Chip Night” Tales of Survival. Year 6 to read the story to Year 4. List problems chin would expect to encounter if they went to live in a country with a strange culture. Number the items according to the degree of inconvenience, stress/concern p. 259 TR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Art- Read “Australian Artists at War” p 10 4-105 Disaster and Survival</td>
<td></td>
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<tr>
<td></td>
<td>-Play dough exploring symbolism. What is war?</td>
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<td></td>
<td>-Origami making paper cranes</td>
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<td></td>
<td>-Mother’s Day making photo frame</td>
<td></td>
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<tr>
<td></td>
<td>-Crepe paper poppies</td>
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<td></td>
<td>Music- listen to “And the Band Played Waltzing Matilda” and “Sadako Song” (ABC tapes)</td>
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<tr>
<td></td>
<td>Story- Listen to “A Big Boy’s Adventure” (own copy) and discuss feelings</td>
<td></td>
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<tr>
<td></td>
<td>Changing ideas in science read p 3,4,5,10 “Our Best Guess”</td>
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</tr>
<tr>
<td></td>
<td>Class discussion “Was the US justified in dropping the Atomic bomb on Hiroshima?”</td>
<td></td>
</tr>
</tbody>
</table>
| 3 | Natural Disasters  
Weather patterns,  
Volcanoes,  
Earthquakes | - Brainstorm various disasters the class know. Classify into natural or man-made.  
- Establish a newspaper watch to collect data on recent disasters. Locate on a world map constructed by chn.  
- Continue to build up a word bank about disasters.  
- Art- magazine distortions of a picture (mosaics and epicenter pictures)  
- Start a weather watch. Read p. 11-15 “Our Best Guess”. Look in local papers for weather maps.  
- Discuss isobars, fronts (p. 1, 12) and other features of weather maps. See p. 8 Weather and Climate. Identify wind speed and direction (p. 2). Fill in a daily weather chart (p. 17).  
- Listen to tape “A Blast from the Past”. Identifying stages of a volcanic eruption p. 8 Instruction and p. 53. p. 8 Assignment (Nancy’s Open Access Book)  
- What is a volcano? See p. 10 Instruction  
- View video on Volcanoes.  
- View video on Weather Patterns  
- Identify types of clouds p. 13 Weather and Climate |

| 4 | Igneous Rocks  
Tsunamis | - Compile a mini report on a disaster using headings p. 12-13 “Change in C20”  
- Discuss the solar system as a system- components sun, moon, planets, comets and meteors.  
- Circle electrical items in the home. P. 14 “Change in C20”  
- Changes in Farming technology p. 2 “Change in C20.”  
- After reading Famous Disasters’ pairs select one and list down hit points on palm cards to share with Year 4’s.  
- What is technology? Read p. 2 “Technology for the Environment” (together). Identify different ways of obtaining energy/different sources e.g. hydroelectric, fossil/fuels, sun, wind, nuclear. Note taking.  
- Making a model volcano. p. 17 Natural Disasters and using plasticine see Nancy’s book. See p. 43 Instruction  
- Read p. 10-13 “Our Best Guess” Discuss change in scientific ideas over time- factors that assist/hinder the development of scientific ideas.  
- Research cards. Weather recording instruments and famous people. See p. 29, 30, 34 “Weather and Climate”  
- Discuss theories on dinosaur extinction p. 16 - 21 “Our Best Guess” |
REFERENCES


249


Roth, W.-M.(1995). From “wiggly structures” to “unshaky towers”: Problem framing, solution finding, and negotiation of courses of action during a civil


255


