INDIGENOUS TECHNOLOGY AND CULTURE IN THE TECHNOLOGY CURRICULUM: STARTING THE CONVERSATION

A CASE STUDY

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ABSTRACT

Since the collapse of apartheid and the first democratic elections of 1994, education in South Africa has undergone fundamental transformation and part of this transformation was the reconstruction of the school curriculum. The new curriculum, known as Curriculum 2005 and developed in 1997, introduced Technology as a new learning area. This study is based on the inclusion of ‘indigenous technology and culture’, a new aspect introduced in a revision of Curriculum 2005. The broad goal of the study was to examine and explore pedagogic practice in relation to the inclusion of ‘indigenous technology and culture’ in the revised National Curriculum Statement for Technology.

The study was informed by an examination of literature pertaining to philosophy of technology, indigenous knowledge systems and technology education. The review of the literature highlighted the contested nature of ‘indigenous knowledge systems’. Philosophies on the nature of technological knowledge were reviewed in order to explore the meaning of ‘technology’, and a comparative review of curriculum reform in regard to technology education in various parts of the world was conducted.

This study presented an attempt to determine the rationale for the inclusion of ‘indigenous technology and culture’ in the revised National Curriculum Statement for Technology in South Africa and to explore and examine what teachers’ existing practices were in this regard. It also examined a process of participatory co-engagement with a focus group of teachers. This process was an attempt to implement ‘indigenous technology and culture’ of the curriculum in a more meaningful way. A case study approach using an in-depth, interpretive design was used. A questionnaire, document analysis, interviews and focus group discussions were used to conduct the investigation. What emerged from the data analysis was that there was unanimous support for the inclusion of ‘indigenous technology and culture’ in the technology curriculum, but implementation had been problematic. This was partly due to difficulties with the interpretation of this aspect in the curriculum as well as a lack of meaningful teaching and learning for various reasons. The study revealed that teachers face multiple dilemmas in implementing ‘indigenous technology and culture’ as an assessment standard. These dilemmas are pedagogical, political, conceptual, professional and cultural in nature.

The intentions of the study were to build a comprehensive understanding of ‘indigenous technology and culture’ and to determine how a focus group of teachers were dealing with this new inclusion. The interpretive study concluded with implications and recommendations for further studies.

DECLARATION OF ORIGINALITY

I, Sonja Margaret Vandeleur, declare that this document is my own work written in my own words. Where I have drawn on other work, these have been acknowledged using the reference practices according to the Rhodes University Education Department 'A Guide to Referencing' (2008).

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SONJA VANDELEUR
5 JANUARY 2010

This thesis is dedicated to

JESSICA,

SAM

AND

CLARE

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LIST OF ACRONYMS

AS	Assessment Standard
C2005	Curriculum 2005, the first single national curriculum for all learners
CTA	Common Tasks of Assessment
EMS	Economic and Management Sciences
GET	General Education and Training Band (Grades R - 9 of compulsory schooling)
IEB	Independent Examinations Board
ISASA	Independent Schools Association of Southern Africa
LA	Learning Area
LO	Learning Outcome
NCS	National Curriculum Statement
PATT	Pupil's Attitudes Towards Technology
SBA	School-based assessment

CHAPTER 1
AN INTRODUCTION TO THE STUDY

1.1 Introduction

This research is a case-study analysis of how a selected focus group of technology teachers were dealing, in their pedagogic practice, with the new inclusion of 'indigenous technology and culture' in the South African technology curriculum. This first chapter presents the background to the study, specifies the problem statement, describes the significance of the study and presents an overview of the methodology used in the case study. The chapter concludes by outlining the remaining chapters of the study.

1.2 Background to the study

Since the collapse of apartheid and the first democratic elections in 1994, education in South Africa has undergone fundamental transformation. One of the key strategic and symbolic changes promoted by the new government was the rapid reconstruction of the school curriculum (Harley & Wedekind, 2004). The new curriculum, known as Curriculum 2005 (C2005) and developed in 1997, was the first single curriculum for all South Africans and it was the pedagogical route out of apartheid education (Chisholm, 2003). The first nine years of schooling, known as the General Education and Training Band (GET), became compulsory and it was in this band that Technology was introduced as a new learning area. However, schools responded to C2005 in very uneven ways and there was a disjunction between policy and practice (Harley & Wedekind, 2004). The Minster of Education, Kader Asmal, called for a review of the curriculum to be headed by a substantial number of academics. The report on the review argued that the problem lay not with outcomes-based education but rather with aspects associated with its implementation (Chisholm, 2003), such as a complex curriculum policy, inadequate teacher development and limited curriculum development (Centre for Education Policy Development, 2000 [first draft]).

The review of C2005, delivered in 2000, resulted in a report which was highly controversial for many reasons. Cabinet ultimately accepted the report but rejected the recommendations which called for a reduction of some learning areas, notably Technology and Economic and Management Sciences (EMS). According to Chisholm (2003), the rejections were highly symbolic and by reinforcing the inclusion of these learning areas, Cabinet sent out two messages: first, its pragmatism on issues of educational reform and second, its alignment with symbols of modernity. Cabinet argued not only for the retention of these two learning areas but for their strengthening in the curriculum. As a result of this review, the revised National Curriculum Statements (RNCS) for grades R – 9 were developed in 2002 to strengthen and streamline the original curriculum statements (C2005). These were later developed into the National Curriculum Statements (NCS).

The new inclusion to the technology curriculum in the National Curriculum Statement was the first assessment standard in Learning Outcome 3 of 'indigenous technology and culture' and it appeared in both the Intermediate and Senior Phases for Grade 4 through to Grade 9 learners. This was a seemingly unique inclusion and it appeared only in the latest revision of the curriculum, the National Curriculum Statement. Other countries, such as Canada and New Zealand, include indigenous knowledge in curricula for indigenous students, but it is not specifically stated in any curricula for general education purposes. This inclusion in the South African curriculum means that every student from Grade 4 to Grade 9 has 'indigenous technology and culture' as an assessment standard. With the inclusion of 'indigenous technology and culture', technology teachers and learning material developers had to contend with issues such as:

- what is meant by the interrelationship between science, technology, society and environment;
- what is 'indigenous technology'?;
- the meaning of culture;
- the link between technology and culture;
- what this means in terms of 'technological literacy';
- how to teach this part of the curriculum so that it is meaningful to learners.

There was not much meaningful engagement in classroom situations with ‘indigenous technology and culture’ and there was little in the way of discussion as to why and how these technologies are used. This could partly be due to the fact that indigenous knowledge is an oral tradition and therefore it appeared that there was little in the way of examples for teachers and learning material developers to recontextualise into learning materials. It became apparent, for various reasons, that little in the way of learning materials were available for teachers to use in the classroom.

1.3 Research goal and questions

With the inclusion of ‘indigenous technology and culture’ being a new and unique addition to the technology curriculum (NCS), teachers were grappling with what to do in their classrooms so that learners could achieve this assessment standard in a meaningful way. This study set out to examine and explore what selected teachers were making of this assessment standard. The overall goal of the research was:

- to examine and explore, through a process of participatory co-engagement, pedagogic practice in relation to ‘indigenous technology and culture’ in the technology curriculum of the National Curriculum Statements (NCS) for South Africa.

The research attempted to answer the following questions:

- How is the aspect of ‘indigenous technology and culture’ being proposed for Technology Education processes in policy documents?
- What is the existing pedagogical practice in regard to this aspect of the curriculum?
- Does a process of participatory co-engagement with selected teachers, with reference to ‘indigenous technology and culture’ in the technology curriculum, impact on teaching practice?

1.4 Research methodology and methods

The primary goal of this study was to examine and explore pedagogic practice in relation to ‘indigenous technology and culture’ as an assessment standard in the technology curriculum. To realise this goal, a qualitative method using an interpretative case study was used. Bascia and Hargreaves (2000) explained that the best way to examine the subjective experiences of teachers is through an in-depth, contextual, interpretive design. Multiple sources of evidence, such as questionnaires, documents, interviews and focus groups, were used and the case study benefited from the prior development of theoretical propositions (Yin, 2003).

The research was conducted in three interconnected, non-linear phases. Phase 1 analysed policy documents to explore how the aspect of 'indigenous technology and culture' was being proposed for Technology Education and to explore the rationale for its inclusion in the curriculum. It consisted of two parts. The first part explored and analysed the rationale for the seemingly unique and new inclusion of 'indigenous technology and culture' as an assessment standard under Learning Outcome 3 (LO3 AS1). Learning Outcome 3 (LO3) requires that learners demonstrate an understanding of the interrelationship between science, technology, society and the environment. Questionnaires were sent to the curriculum developers of the National Curriculum Statement: Technology so that the rationale for the inclusion could be explored. The second part of this phase examined how this assessment standard was proposed for Technology Education processes in policy documents and learning materials. Content analysis was used as a research technique for this part of Phase 1.

Phase 2 started by examining existing pedagogical practices in regard to the implementation of 'indigenous technology and culture'. The purpose of this phase of the research was to explore the issues and problems that arose from the implementation of 'indigenous technology and culture' for a selected group of technology teachers. Phase 3 of the research consisted of analysing a process of participatory co-engagement around an area of shared concern. The shared concern in this study was how to implement 'indigenous technology and culture' in the technology classroom in a meaningful way. A school based intervention was meant to be developed by the teachers for this purpose. Phase 2 and Phase 3 used interviews and focus group sessions as the data sources.

The participants selected for the focus group of technology teachers were chosen for two reasons: convenience due to their proximity to each other which allowed for good attendance at focus group sessions, and purposeful, as they are all Grade 9 technology teachers. They were chosen to provide information-rich cases. Four of the participants for the focus group belong to the same cluster group (see pg 79 for description of 'cluster group') and so they meet three or four times a year to discuss assessment matters relating to their learning area. The fifth participant was a willing participant. All except one of the participants held a first degree, but significantly, not one of the participants had been formally trained as a technology teacher.

The other focus group that was used for the study was one that was convened at the PATT-18 conference held at the University of Glasgow, Scotland in June, 2007. The purpose of this focus group session was for the participants to engage in discussion on the implications of using a philosophy of technology in Technology Education. Andrew Feenberg led the discussion chaired by Steven Keirl. Andrew Feenberg holds the Chair in Philosophy of Technology at Simon Fraser University, Canada.

There was no single theory that guided the research, but rather different perspectives guided different aspects of the study. Feenberg's critical theory of technology guided the direction of the focus group sessions in Phase 3 of the research as well as the document analysis. The data collection methods were based on a 'constructivist philosophy that assumes reality as multilayer, interactive and a shared social experience interpreted by individuals' (McMillan & Schumacher, 2001).

1.5 Significance of the study

The purpose of this study is to contribute to a deeper understanding of 'indigenous technology and culture' so as to enable a more meaningful implementation of 'indigenous technology and culture' by technology teachers in their classrooms. The results of this study will hopefully impact positively on teachers' practices and contribute to a better quality of teaching and learning in technology. Furthermore, findings from this study could inform curriculum developers in other countries around the issues that need attention in the design and implementation of a new curriculum. The study will also hopefully contribute to the wider use of knowledge in learning materials and in our classrooms. Including indigenous knowledge in our curriculum could also address the context-specific needs of the learners, an important aspect in Technology Education.

This study will contribute to the relatively new area of research in Technology Education. In 1997, Hoepfl stated that there was a dearth of research in this field. Zuga (1997) in her review of research in Technology Education, found that only a few researchers critically examined curriculum issues, such as how teachers implement curriculum. More recently, Johnson and Daugherty (2008) found that the majority of research in the Technology Education field was quantitative. This study addresses these areas of concern as it is qualitative and an in-depth study on how technology teachers implement a certain aspect of the curriculum.

According to Jones (2001), in all the reviews conducted on research in Technology Education, there seems to be a need to define technological literacy. This study explored the issue around the attempts of this definition. This research is therefore significant as it adds to the field of research in Technology Education, both nationally and internationally, as well as exploring issues surrounding implementation of a new curriculum and issues around definitions. The following personal communication with Kurt Seemann (2008, March 23, personal communication) confirmed the significance of this study:

> Statement of an issue given in the e-mail from me to Kurt Seemann:
>
> There are many problems in terms of implementing this assessment standard – lack of available learning materials as most so-called indigenous technologies are from an oral tradition, lack of trained teachers, technology not having a high status in our schools, etc.
>
> Response given by Kurt Seemann:
>
> There is the double whammy that world wide mainstream technology education is not healthy either, and is still confused in many education systems about whether or not it can be a scholarly discipline...I am very clear it is, but most in the field do not come from such a background of expertise, most come from what may be described as task focussed trades like orientation, or some pseudo-technical curriculum ideology borne from long established in-schooling traditions rather than from a wider tested scholarship. A common signpost of these traditions is in how much of the assessment is focussed on ‘tool user skilling’ rather than studying technology itself and its contexts of validation. What is missing is a culture of scholarship in technacy and innovation education. What all this means is that you are a pioneer in the field that is desperate for scholarship.

1.6 Limitations of this study

This explorative research included a case study of a focus group consisting of five participants. The findings and results might therefore not be transferable, although this was not an aim of the study. However, the insights gained from the case study could offer valuable lessons for similar contexts, such as implementation of a new aspect of the curriculum.

The conceptual framework of the study is another limitation. Although the teachers in the focus group are more aware of introducing a critical technological literacy approach in their classrooms, which includes ‘indigenous technology and culture’, it is too soon to expect a deep change in the teachers. Another limitation to the study is that domains outside the focus group might have influenced the direction of the discussions, and as such, findings from a broader perspective will not come to light.

In retrospect, this study would probably have benefited from using indigenous theories and methodologies more extensively, as this would have provided more inclusive and broader research methods. Another limitation was that the issue of culture and its relationship with indigenous technology could have been dealt with in sufficient depth. Future research would benefit from a more in-depth exploration of the relationship between culture and technology.

1.7 The structure of the thesis

This section provides an overview of the chapters in this research.

Chapter 1: An introduction to the study

Chapter 1 provides an introduction to the thesis. The purpose of this chapter is to outline the context of the research. The research goal and methodology are given and it outlines the structure of the thesis.

Chapter 2: Technology, indigenous technology and Technology Education

This chapter explores the meaning of 'technology' and the resulting implications for Technology Education. Issues around defining the concept 'technology' are stated and an overview of the different approaches to philosophy of technology is given. The chapter continues by discussing the ambiguities surrounding the various definitions of 'indigenous', 'indigenous knowledge' and 'indigenous knowledge systems'. The theories of modernism, postmodernism and post-colonialism are described as their stance on knowledge and knowledge production are significant to this study. The final part of this chapter examines the development of Technology Education both internationally and in South Africa. The notion of technological literacy is explored.

Chapter 3: Goals of the research and profile of the research site and participants

This chapter explains the factors that led to the study. It also gives the impetus for the study. The chapter provides a contextual profile of the schools and teachers involved in the focus group. A profile of the participants in the focus group session led by Andrew Feenberg at the PATT-18 conference in Glasgow, Scotland is given in this chapter.

Chapter 4: Research design and methods

Chapter 4 provides a detailed discussion of the qualitative research design used in the study. A descriptive analysis of the methods used is then given and validity issues are described. Methods of data collection, such as document and text analysis, interviews and focus group interviews are covered. The chapter concludes by explaining the data analysis methods.

Chapter 5: Data analysis and findings

In Chapter 5, analysis and interpretation of the data is undertaken and reported on. The chapter starts by analysing the results from the questionnaires sent to the curriculum developers. It then provides an in-depth document analysis of policy documents, including the various documents relating to the curriculum and learning materials. Content analysis of the interviews with teachers and the focus group sessions is undertaken. Issues surrounding definition and implementation of the curriculum are explored.

Chapter 6: Recommendations and conclusions

A reflection on the research goals and questions, the theoretical framework, the research methods and a summary of the findings is provided in this final chapter. Issues, challenges and implications are provided and reflected upon. Recommendations resulting from the study are proposed. This final provides a synopsis and summary of the findings of the study, makes recommendations and reflects on the research process. The significance of the study and possibilities for future research are commented on.

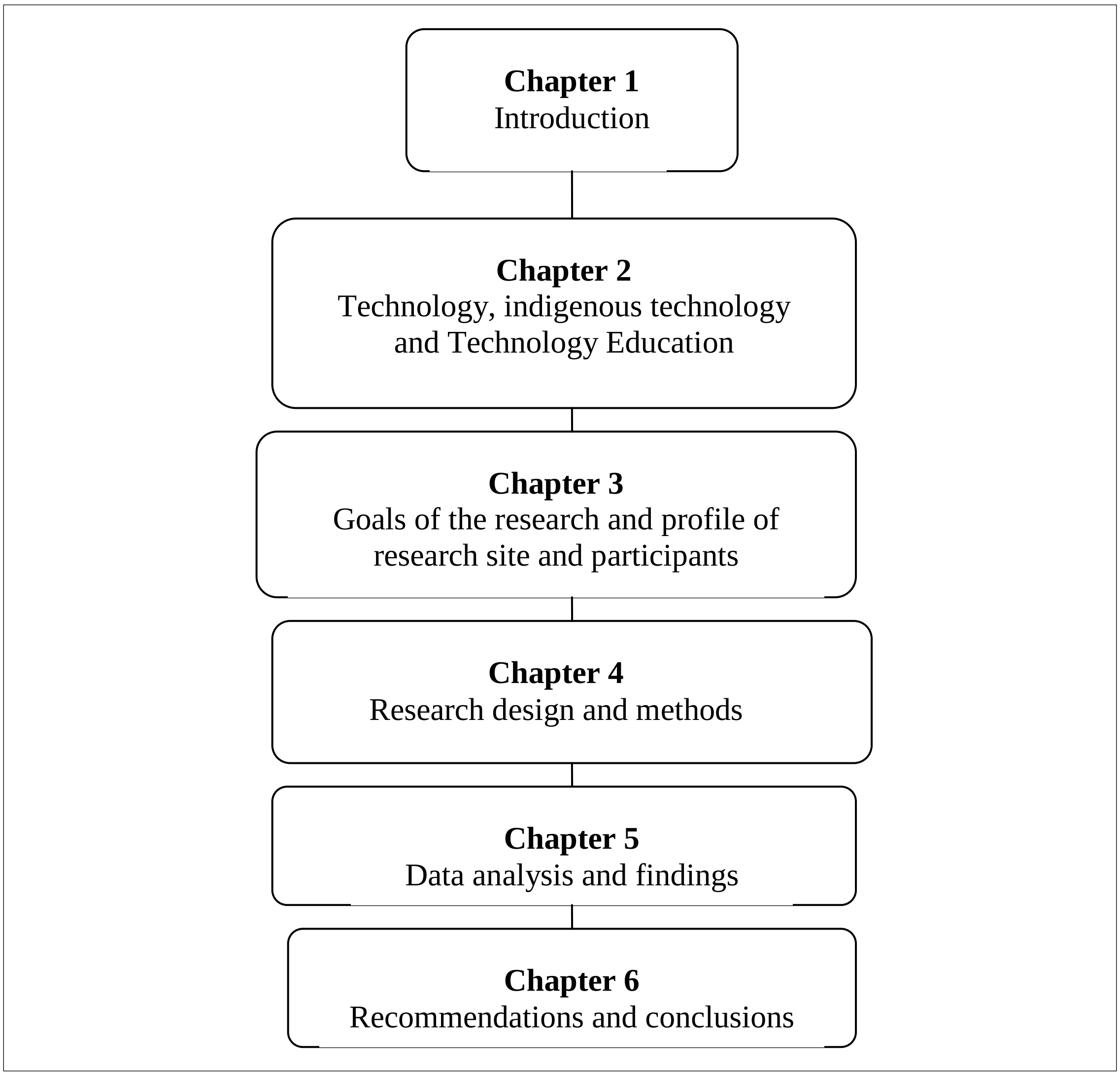

Figure 1.1: Overview of the chapters in the study

CHAPTER 2

TECHNOLOGY, INDIGENOUS TECHNOLOGY AND TECHNOLOGY EDUCATION

2.1 Introduction

This research, as outlined in the previous chapter, is a case-study analysis of the implementation of 'indigenous technology and culture' in the South African Technology curriculum. The purpose of this second chapter is to explore the meaning of technology, to examine some of the definitions of 'indigenous' and 'knowledge', to examine the development in Technology Education since the 1980s and finally to explore what is meant by 'technological literacy'. The chapter concludes by discussing some of the pedagogical implications for Technology Education.

The first section of this chapter explores the difficulties with defining the concept of technology. It does this by examining different definitions of technology. It then explores the relationship between science and technology. Technology is often perceived as applied science. By understanding the differences between these two domains, one can gain an appreciation of the nature of each at a more philosophical level, and this part of the chapter set out to clarify the relationship between the two domains. As Rowell, Gustafson and Guilbert (1999) stated, pedagogical implications for Technology Education arise from the epistemological debate about the nature of technological knowledge, so it was necessary to explore the various approaches in the field of philosophy of technology. The link between Technology Education and philosophy of technology is a recent one, and this link is explored here.

The inclusion of 'indigenous technology and culture' in the South African Technology curriculum is noteworthy. It comes at a time when questions are being asked on the formation of knowledge production, the gap between formal institutions and society, and the vacuum in theorisation (Odora Hoppers, 2002a). The second section of this chapter examines some of the definitions of 'knowledge', 'indigenous' and 'indigenous knowledge systems' and the ambiguities surrounding these concepts. The theories of modernism, postmodernism and post-colonialism are discussed as their stance on knowledge, knowledge production and indigenous knowledge is relevant to this study.

The third section of this chapter examines Technology Education and its development since the 1980s. It begins by examining Technology Education in an international context and continues by exploring the notion of ‘technological literacy’. This section concludes by suggesting a way forward for Technology Education by developing in our students a ‘critical technological literacy’, which should give them a better understanding of the concept of technology and its interrelationship with science, society and the environment, as required by the South African technology curriculum.

2.2 The nature of ‘technology’

Technology is a complex phenomenon and according to Lawson (2008) there has been a general failure to reach consensus about the meaning of technology. Bijker, Hughes and Pinch (1987) suggested that it is unnecessary to devote much effort to working out precise definitions of technology as a precise definition is bound to fail as technology has no single meaning. Lawson (2008) suggested that attempts to provide definitions of technology are generally accepted as either pointless or dangerous. A similar attitude is demonstrated in the introduction to a book of essays in the philosophy of technology written by Fellows (1995), in which he stated ‘the contributors to this volume do not concern themselves with the essentialist exercise of defining technology; they more or less take it for granted that the reader is familiar with a variety of technologies, such as Information Technology and proceed from there’ (p. 1). However, in documents such as curriculum policy documents, definitions do have to be given. These definitions are explained in this section of the chapter.

2.2.1 Defining ‘technology’

In etymology, the Greek root ‘techné’ of the word ‘technology’ means belonging to the arts, crafts or skill. It was this sense, in which ‘technology’ refers to a body of knowledge about the useful arts, that prevailed from Renaissance times well into the industrial era (Misa, 2003). At the beginning of the last century, achievement, progress and purpose were all part of the public meaning of technology (Adams, 1991; Pacey, 2001). In 1865, Bigelow told his audience at the newly founded and aptly named Massachusetts Institute of Technology (MIT) that ‘Technology in the present century and almost under our eyes … has advanced with greater strides than any other agent of civilization’ (Misa, 2003, pp. 7-8). Our contemporary understanding of the term ‘technology’ has a tangled history with the concept of modernity (Misa, 2003). What it means to be ‘modern’, though, is by no means clear, as the term is embedded with controversial notions such as progress and change, rationality and universal norms. The concept of modernity is explored in greater detail further on in this chapter. The word ‘technology’ took on something like its present meaning midway through the last century. According to Misa (2003), this meaning is that technology is a set of devices or an abstract form in itself.

Definitions deal with meanings and so, according to Dusek (2006), are semantic in nature. But they are hardly trivial and substantive disagreements often stem from the disputants having two different definitions of what is being discussed. She suggests that in the case of defining ‘technology’, even if a final definition is not agreed on, an investigation of the definition will show us the range of things that can count as technology and some of the borderline cases where people differ on whether something should be counted as technology or not.

Misa (2003) stated that technology cannot be defined statically as its nature and meaning have changed over time and continue to change. According to Keirl (2006), disciplines such as economics, sociology, anthropology and politics offer perspectives on technology but they fail to locate potential for real understanding of technology. In the discipline of Economics, ‘technology is simply anything that is important in constraining the feasible combinations of certain inputs to produce certain outputs’ (Lawson, 2008, p. 48). Keirl (2006) suggested, however, that the complexity of the concept does not make it impenetrable and it is possible to identify some key attributes. Some of these key attributes are that technologies are central to our lives and cultures; all technologies are created by a manufacturing process resulting from human intention and design; and technology cannot ‘be’ in any functional sense without a relational human engagement. There is thus consensus that technology is irreducibly social.

According to Rooney (2008), technology can be better understood and defined if we see technology and things such as politics, aesthetics, institutions and economics as ‘indissoluble partners in an assemblage of technologies’ (p. 4). He examines Foucault’s four types of technology – technologies of production, technologies of sign systems, technologies of power and technologies of the self. For Foucault, technologies of the self is an approach to study the ethics of the individual (Peters, 2003); technologies of production allow us to produce, transform or manipulate things; technologies of sign systems permit us to use symbols, signs or meanings; and technologies of power determine individual behaviour (Foucault, 1988). According to Foucault, these four types of technologies always function together but they are not reducible to one another as each type is associated with a certain domination (Burkitt, 2002). Rooney (2008) suggested that this ‘assemblage of technologies’ view reinforces the socio-technical systems approach and it provides a definitional framework for understanding the rich contexts in which technology is situated. It is a framework that enables researchers to better identify patterns, structures and relationships in a socio-technical system. Burkitt (2002), in his article on ‘Technologies of the self: habitus and capacities’, gave the following definition of technology:

> Technology is a form of practical action accompanied by practical reason, which aims to instil in the body certain habitual actions—either moral virtues (that is, right ways of acting in a situation) or technical skills—and, later, to give people the reflexive powers to reason about their virtues or skills, providing them with the capacity to refine, modify or change them. In other words, technology is a means through which humans produce not only products and works, but also themselves as human selves in both their reflexive and non-reflexive aspects. It is through various technologies that humans develop the habits, capacities, skills, identity, and knowledge that mark them out as individual members of a social and cultural group. (p. 224)

The definitions given in Technology Education documents, such as curriculum policy documents, focus on the practical nature of technology and the relationship between technology and humans as being one in which technology is there to satisfy human needs and wants. In the Standards for Technological Literacy (International Technology Education Association, 2002), technology is defined as:

> how people modify the natural world to suit their own purposes. From the Greek word *techné*, meaning art or artifice or craft, technology literally means the act of making or crafting, but more generally it refers to the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants. (p. 2)

The National Curriculum Statement: Technology (South Africa. Department of Education, 2002c) has a similar definition, although there is an emphasis on social and environmental factors:

> The use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration. (p. 4)

The definitions and key attributes of technology given in this section all have a focus on humans and their engagement with technology. This includes the influence and impact of society and culture, as well as the environment, on the emergence, development and use of technologies. In the context of this study, the above definition by Burkitt is relevant as it recognises the interrelationship between technology, society and culture as well as humans' reflexive powers which give them the capacity to adapt and change technologies. The next section examines the complex relationship between science and technology which should further clarify the meaning of technology.

2.2.2 The link between science and technology

An examination of the relationship between science and technology will enable a better understanding of the meaning of technology, as it will clarify the similarities and differences between these two domains. The relationship between the two is a complex one, but due to the contemporary world we live in, it has never been stronger. When they first became related, science followed technology: for example, thermodynamics followed the invention of the steam engine. However, more recently, scientific discoveries have been the basis for technological developments, such as lasers, and nuclear fission and fusion (Adams, 1991). So the notion that science leads to technology is a relatively young one.

Much has been written about the nature of the relationship between science and technology, for example Chant (1989), Adams (1991), Layton (1993), Gardner (1994), Williams, P.J. (2002a) and Compton (2004). Both domains are key forms of human activity alongside the arts and social sciences. According to Compton (2004), the acknowledgement that neither of these domains holds a subservient position is key to recognising the strength of the relationship between the two. In order to understand this relationship it is important to establish how the two domains differ, and it is this difference that gives their alliance strength. Compton (2004) suggested that their differentiation is characterised by three key factors: their purpose, their ontological stance and their epistemology. She stated that the role of scientists is to interrogate the 'real things' of the natural world in order to construct explanations of them. This interrogation is embedded in the sociocultural world and will therefore be human-mediated representations of these 'real things'. In this context, new knowledge must be validated by adhering to logical reasoning and be coherent within the dominant paradigm. Scientific knowledge must withstand peer review in order to be represented as a 'truth'. Truth is therefore not viewed as an absolute in science, but rather scientific 'truths' are knowledge gained by the consensus of experts in the domain (Compton, 2004). Latour (1987) suggested that science is a sum of results that hold under certain conditions, such as repeated experimental tests. Technologists, on the other hand, intervene in the world to produce something 'other' to that which currently exists. This is done through iterative intellectual and design-based processes with many different forms of input, such as conceptual, imagined, material and simulated sources. It has a 'process ontology' stance. Technological knowledge does not make claims to truth in the way that science does, as it has the process of function as its referent and technological knowledge is generally validated by success (Compton, 2004).

Feenberg (2006) is in agreement with Compton (2004) as to the two domains being different. He suggested that philosophy of technology is not closely related to philosophy of science. Philosophy of science is about the scientific method and how truth is established, whereas philosophy of technology is concerned with usefulness and control. These two philosophies share the same sort of rationality based on empirical observation and knowledge of natural causality. Feenberg stated that one of the differences between these two domains is in their purpose: the purpose of technology is to intervene in the world whereas the purpose of science is to explain the world.

Even with these differences, there is a strong link between science and technology. These two domains have different ways of viewing the world as well as fundamentally different purposes, but they work to mutually benefit each other. Scientific knowledge and methodologies provide a major source of input into technological development and outcomes. Science also has key tools for determining the success of technological interventions. Technological practices, knowledge and outcomes, on the other hand, provide mechanisms for science to gain a better view of its defined world (Compton, 2004). In terms of education, scientific knowledge is important to students engaged in technological activities and vice versa. Technological practices can provide authentic contexts for students to develop a more meaningful understanding of scientific knowledge and methodologies.

The view that technology is a subset of science has been challenged by theorists in the field of philosophy of technology and those working in Technology Education. It is evident that technology is not applied science. The ‘technology as a subset of science’ approach has been replaced by a view that science and technology are two autonomous and distinctive fields (Gardner, 1994; Compton & France, 2007). It is, however, the links between the two that are beneficial to both domains.

The following section explores the field of philosophy of technology. An understanding of philosophy of technology is central to analysing different views of the nature of technology, and knowledge of these different views would be beneficial to anyone wishing to develop a critical understanding of the technological world we live in.

2.2.3 Philosophy of technology

Philosophy of technology is a relatively new field compared to other branches of philosophy. The Society for Philosophy and Technology began in 1975. In 1995, in a twenty-year review, Ihde (1995) asserted that the Society remained marginal in dynamic and size, even with its pluralistic approach and international context. More than a decade later, Borgmann (2006) suggested that after half a century of surveying and sorting, trial and error, there was now a body of coherent and illuminating theories of technology, and some of these theories are given in the discussion on Durbin's essay later on in this section. Brey (2003) stated that major progress has been made in our understanding of technology and technological change, although Dusek (2006) did not agree with this viewpoint as she stated that the field was hardly consolidated.

It seems that Dusek, however, was seeking some kind of consensus. She claimed that the reason for the difficulty in consolidating the field is that philosophy of technology involves the interaction of a number of different fields of knowledge, such as philosophy of science, political and social philosophy, ethics, and philosophy of religion. Durbin (2006) questioned the value of working towards a consensus in philosophy of technology. In 2006, he wrote 'In Search of Discourse Synthesis' in which he reviewed thirty years of work for the Society of Philosophy and Technology. The purpose of his lengthy essay was to focus on disagreements with other philosophers. Durbin stated:

> I mention briefly McInnis's key idea, that knowledge communities—preeminently science communities but others as well—work toward a *consensus* on what constitutes genuine knowledge in (and the goals of) a given field. This includes not only key concepts but methods and values, respect for the community, and so on. And knowledge communities, according to McInnis, have since the seventeenth century assumed that valid knowledge, especially scientific knowledge, is *cumulative.* … *How* knowledge becomes cumulative or progressive (at least internally, within the disciplines) is what synthesizing amounts to. (p. 4)

He further stated:

> Returning to the question of a consensus or not within the field, since Thomas Kuhn's *Structure of Scientific Revolutions* (1962), the supposed

> cumulativeness even of science has come under attack. … Critics, indeed, pointed to how they were making the world, including the environment, worse. All of this has culminated in so-called postmodernist or social-constructionist attacks on the hegemony of science in modern culture. … What I offer in this booklength essay may not be exactly constructionism, but it is definitely a pluralism. I wouldn't even dream of saying at this point what the consensus is among philosophers of technology—I leave the question open for the moment whether there is a consensus—within the field in general or within any particular group of philosophers of technology. (pp. 4-5)

In his essay, Durbin reviewed the body of work of the central contributors in the first thirty years of the Society of Philosophy and Technology. The review is significant as it demonstrates the plurality of the field. In the first part of his essay, headed 'Philosophers of Technology Move Away from Philosophy of Science' (pp. 16-86), Durbin reviewed Mitcham's 'Thinking through Technology' (1994), suggesting that it was a premature attempt at synthesis. However, Durbin acknowledged that Mitcham contributed to the field by giving a detailed summary of major contributions.

The second part of Durbin's essay was headed 'The Field Refuses to Jell' (pp. 87-167) and it is in this section that he reviewed and gave an opinion on the works of philosophers, such as Pitt and his attempt to establish 'a professional discipline in the academic sense' (p. 87). Pitt, according to Durbin, wanted philosophy of technology to be more like philosophy of science, as is evidenced in his book 'Thinking about Technology' (2000). Durbin goes on to review Ihde and his phenomenological philosophy of technology, and then Winner with his notion of 'epistemological Luddism' which is articulated in his books 'Autonomous Technology' (1977) and 'The Whale and the Reactor' (1986). Winner's 'epistemological Luddism' does not involve the systematic dismantling of particular machines but is rather an intellectual task of bringing us to our collective senses. Durbin then discusses Feenberg's neo-Marxist critique of technology, and Ferré and Verene's metaphysical approaches.

In 'Part 3: Attempts to Establish an Academic Discipline' (pp. 167-288), Durbin begins with Higgs, Light and Strong and their argument in 'Technology and the Good Life' (2000) of the need for a new discipline. The rest of the book deals with the work of some philosophers of technology working in other fields, such as Light and his work with environmental philosophy, Krimsky with biotechnology and Thompson with agriculture. Durbin’s essay is useful in that it demonstrates the many different fields of knowledge evident in philosophy of technology, and therefore the difficulty of arriving at a consensus, if a consensus is what is required.

The link between Technology Education and the philosophy of technology is very recent. The PATT-18 conference held in 2007 at the University of Glasgow, Scotland, was the first conference in which these two fields met formally and shared ideas. Evident from this conference was that most philosophers of technology have adopted a critical sociocultural perspective of technology but the dominant thinking in formal educational institutions has been rooted in instrumental and deterministic frameworks (see 2.2.5). These different approaches are probably the reason for this lack of communication between the two fields. However, this ever-strengthening sense of a philosophy of technology as beneficial to Technology Education is because it enables those working in the Technology Education field to draw on deeper discourses and debates (Keirl, 2006). Important to this study is that philosophy of technology enables a critical evaluation to be made of the different approaches to the issues involving the influence of technology on society and culture as well as the influence of society and culture on technological development.

2.2.4 The nature of technological knowledge

Philosophical and sociological perspectives have prompted an extensive debate about the nature of technology. Part of developing a philosophical understanding of technology is the development of an understanding of the nature of technological knowledge. This study uses an adaptation of Feenberg’s (2006) table of ‘Theories of technology’ to explore this nature (see Figure 2.1). Of particular interest to this study is the way in which Feenberg uses the relationship between human agency and the values attributed to technology in which to situate the different theories of technology.

The figure (see Figure 2.1) has two axes that reflect technology’s relation to values and agency. The intersection of the axes defines four theories: instrumentalism, technological determinism, substantivism and critical theory. It is these four theories that will be explored in depth for the purposes of this study. The horizontal axis reflects technology’s relation to human powers, in other words the extent to which human beings have the freedom to decide how a technology will be applied and developed. According to Feenberg (2006), the question being asked here is ‘Is the next step in the evolution of the technical system up to human decision-makers, or is the next step determined by a logic inscribed in the technology itself?’. The vertical axis offers two alternatives: technology perceived as value-laden or technology perceived as neutral.

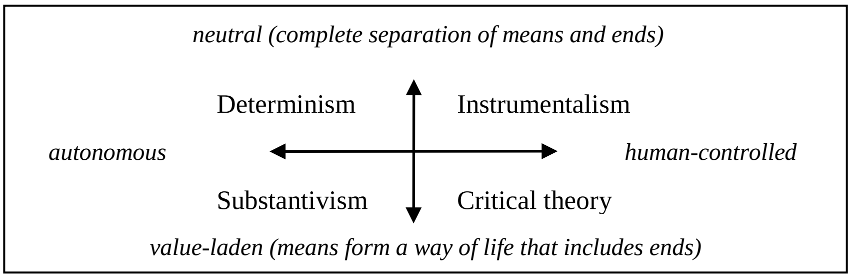

Figure 2.1: Theories of technology (adapted from Feenberg(2006))

Durbin (2006) has cautioned against oversimplifying theories by using bipolar spectra to explain them. He stated ‘Nearly everyone recognizes the limitations of overly simple bipolar spectra in all sorts of educational settings’ (p. 270), but going beyond this standard complaint, he further stated ‘even within a four-pole system, there are many, many variations within each of the resulting four quadrants’ (p. 271). So these two axes do not act as delimiters as there are many similarities between the four different theories, and these are discussed later on in this chapter. The four theories of instrumentalism, technological determinism, substantivism and critical theory of technology are now explored in detail.

2.2.5 The ‘technology as neutral’ approaches

The two theories of technological determinism and instrumentalism perceive technology as a set of neutral products detached from values. Both these theories are based on the idea of progress, be it social or technological, and both separate means from ends.

Instrumentalism

Instrumentalism is the most widely accepted view of technology. It is based on the idea that technologies are tools that are used to provide the means for the realisation of independently chosen ends (Feenberg, 1991). Technology is viewed merely as an instrument of progress and it appears as value-free; in other words it is deemed 'neutral'. Heidegger (1977) defined 'means' as 'that whereby something is effected and thus attained' (p. 313). In his discussion on 'What is the instrumental itself?' he emphasised the notion of causality as being central to this approach to technology. He stated 'Wherever instrumentality reigns, there reigns causality' (p. 313).

Instrumentalism is the standard modern view to which technology is a tool or instrument of the human species (Feenberg, 2006). This view on the nature of technology encounters raw materials as passive; in other words, raw materials are waiting to be transformed into whatever it is that human beings desire. This world is to be controlled and used. The West has made huge technological advances on this basis and our means have become ever more efficient and powerful. In the nineteenth century it was commonplace to view modernity as an unending progress towards fulfilment of human needs through technological advance. This view corresponds to the liberal faith in progress that was such a prominent feature of mainstream Western thought until fairly recently (Feenberg, 2006).

In the modern context, technology appears as purely instrumental. Means and ends are independent of each other. The statement 'Guns don't kill people, people kill people' is typical of this viewpoint. Guns are a means independent of the user's ends, whether it is to rob a bank or to enforce the law. The instrumental view is a spontaneous product of our civilization and it is assumed unreflectively by most people. Technology encounters nature as raw materials waiting to be transformed into whatever it is that we desire – the world is there to be controlled. Instrumental theory treats technology as subservient to values established in other social spheres, such as politics or culture (Feenberg, 1991).

Technological determinism

According to Dusek (2006), ‘technological determinism is the claim that technology causes or determines the structure of the rest of society and culture’ (p. 84). In other words, technology is autonomous and is not in human control; it develops with a logic of its own. Technological determinism implies diminished human choice and responsibility in controlling technology. As technology develops and changes, so do the institutions of society. This view, according to Marx and Smith (1994), developed out of social impact theories.

Definitions of technological determinism get very technical, but a good starting point is, similarly to instrumentalism, the notion of universal causality. Heilbroner (1967), in his essay ‘Do machines make history?’, noted that models of science as being linear and cumulative, and of technology as applied science, support the idea of technological determinism. If there is a single necessary path for science, and technology is applied science, then there must be a single, linear path for technology. The direction of technology is therefore not swayed by cultural factors (Dusek, 2006). Technological determinists believe that technology controls humans and in doing so, it shapes society to the requirements of efficiency and progress, as in classical Marxism (Feenberg, 1991). Marx developed an historical teleology of social progress in which ‘the working class would ultimately own and control machinery as the means of production’ (Hansen, 1997, p. 51). This view of technology has reinforced the idea that technology is an autonomous entity developed according to an internal logic which has determinate impacts on society (Williams & Edge, 1996; Russell & Williams, 2002). So, unlike instrumentalism, technological determinism implies diminished human choice and responsibility in controlling technology.

Technological determinism involves predictability: it has the notion of ‘same cause, same effect’. It holds that everything is caused by a sequence of previous conditions and events, operating with regularity and, in principle, with predictability. It presents technological systems as ‘ordered accordingly to materials, processes and laws that can be understood from an objective standpoint’ (Pannabecker, 1991, p. 2) and casts technology in a perspective of cause and effect relationships. Pannabecker (1991) stated that the notion of technological impacts is simple to understand and it has enabled the field to interpret technology in the context of society and culture, something which technology studies has long struggled to do (Russell & Williams, 2002). However, the deterministic view of technology has contributed to a simplistic and inflexible view of the relationship between technology and society (Pannabecker, 1991) and it has reinforced the idea that technology is an autonomous entity. Another criticism of this view is that studying impacts places the emphasis on a restricted point of the sequence of technological development which then gives a partial perspective of that technological development. The deterministic approach therefore is not sufficient as an explanation for the development of technology.

2.2.6 The 'technology as value-laden' approaches

Theorists such as Feenberg (1999) and Ihde (1990) claim that technology can never be removed from a context and therefore can never be neutral. The non-neutral approaches suggest that attention be given to relationships as well as objects. While the scientific principles used in the design and production of technologies are deemed to be value-neutral by some (although this is debatable), the development, emergence, implementation and impact of these technologies are embedded in historical, aesthetic, political and cultural meaning. Substantivism and a critical theory of technology are the two theories discussed here that support the view that values are embedded in every aspect of the development, emergence, implementation and subsequent changes of a technology.

Substantivism

Substantive theory views means and ends as inseparable. In other words, our tools form our environment and therefore who and what we are. Substantivists claim that the values embodied by technology are the pursuit of power and domination; they view technology as a culture of universal control from which there is no escape. It is the embodiment of these values that differentiate it from instrumentalism. According to Feenberg (1999), substantivist theories of technology draw attention away from the practical question of what technology *does* to the hermeneutic question of what it *means*. These theories suggest that once society goes down the path of technological development, it will be dedicated to values such as efficiency and power, and traditional values will not survive this challenge.

Substantive theory is best known through the writings of Heidegger and Ellul. Heidegger (1889 – 1976) was one of the most influential German philosophers of the twentieth century and the most famous substantive theorist. In his attempt to characterise the human condition, he contrasted language as the realm of meaning with the technological realm. For Heidegger, technology is the primary characteristic of our modern age, replacing the notion of biological growth, artistic creation or divine creation that characterised previous eras (Dusek, 2006). He argued that the essence of modernity is the triumph of technology over every other value. Heidegger suggested that although we control the world through our technology, we do not control our own obsession with control (Feenberg, 2007). Heidegger (1977) stated:

> Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it. But we are delivered over to it in the worst possible way, when we regard it as something neutral; for this conception of it … makes us utterly blind to the essence of technology. (p. 311)

In his last interview, with Augstein and Wolff of Der Spiegel, Heidegger (1966) famously stated: “Only a God can save us now”. The following is an extract from this interview:

> SPIEGEL: Why should we be so overpowered by technology ... ?
>
> HEIDEGGER: I do not say overpowered. I say we have no path that corresponds to the essence of technology as of yet.
>
> SPIEGEL: One could naïvely object: What do we have to come to terms with here? Everything functions. More and more electric power plants are being built. Production is flourishing. People in the highly technological parts of the earth are well provided for. We live in prosperity. What is really missing here?
>
> HEIDEGGER: Everything functions. That is exactly what is uncanny. Everything functions and the functioning drives us further and further to more functioning, and technology tears people away and uproots them from the earth more and more. I don’t know if you are scared; I was certainly scared when I recently saw the photographs of the earth taken from the moon. We don’t need an atom bomb at all; the uprooting of human beings is already taking place. We only have purely technological conditions left. It is no longer an earth on which human beings live today.

Ellul (1967) suggested that the technologists and engineers who develop technology lack understanding of its social impact and are often naïve about the means of controlling it. He also claimed that the public is ignorant of both the technical and social aspects of technology (Dusek, 2006). Ellul wrote his major work 'The Technological Society' in the 1950s in which he 'floated the notion of a boundless, omnipotent, and deterministic 'technique'' (Misa, 2003, p. 8). Ellul's viewpoint was deterministic as he saw efficiency as the only value in technological development: 'The multiplicity of means is reduced to one: the most efficient' (1967, p. 21). However, unlike the technological determinist's view of technology as an instrument of progress, Ellul's concern, as was Heidegger's, was the emergence of a technological tyranny over humanity. He (1967) stated: 'Technique has taken over the whole of civilization. Death, procreation, birth, all must submit to technical efficiency and systematization' (p. 128).

Substantive theory purports that technology constitutes a new type of cultural system characterised by 'an expansive dynamic which ultimately overtakes every pretechnological enclave and shapes the whole of society' (Feenberg, 1991, p. 8). This theory attempts to make us aware of the arbitrariness of the claim that the transition from tradition to modernity is judged to be progress by a standard of efficiency that is intrinsic to modernity. The substantive approach has been criticised for it's apocalyptic and dystopian view by critical theorists such as Marcuse (1991) and Feenberg (1991). Feenberg suggested that it is true that many technological projects supported by political and economic interests can steamroller grassroots opposition, but nevertheless, it is not always clear that they succeed. An example is the prominence given in the last few years to the concern over environmental impacts.

A critical theory of technology

The fourth theory to be explored in this study is a critical theory of technology. Critical theory represents a body of work produced by the so-called 'Frankfurt School' associated in large part by Horkheimer, Adorno, Fromm, Benjamin, Marcuse and Habermas (Willinsky, 2007). It 'amounts to a philosophical take on social theory, informed by Marx and Freud. During the middle decades of the last century it offered an unrelenting critique of contemporary sources' (Willinsky, 2007, p. 1). Marshall

(2003) defined critical theory ‘in an ecumenical sense, as a research program … which includes metatheoretical reflection, a substantive and historical theory of society, and normative critique’ (p. 111). Critical theory is a theory about taking a critical stance and a critical theory of technology attempts to explain how technology can be redesigned to adapt it to the needs of a freer society. Feenberg (2005) explained this notion of a ‘freer society’ as:

> In a free society the universal element involved in all perception, the “concept” under which a “manifold” is unified, would incorporate an immediate awareness of the potentialities of the object. The object would be perceived through its concept, as it is today, but that concept would include a sense of “where the object is going”, what it can become. The object to which these qualities are attributed is not the object of science. It is the lived experience of the world in which the perceived incompleteness and imperfection of things drives action forward (p. 131).

According to Marshall (2003), critical theory can be broadly conceptualised to include a variety of postpositivist and reconstructivist approaches. It is not a theory in the sense of traditional philosophical theories, such as Platoism, as it has not set out to explain how it is we know the world and should act within that knowledge. Rather it is far more a theory in ‘the sense of constantly bringing forward a speculative set of ideas about, in this case, what lies behind this seemingly given reality. It is the theoretical product of imagination, insight, and thoughtfulness. It is a theory that does not seek its fulfillment in practice. … Critical Theory is a theory about the value of taking a critical stance, of finding contradictions, of recording losses, as to the economic conditions, aesthetic qualities, and individual expression of our lives’ (Willinsky, 2007, p. 11). Calhoun (1995) suggested that it is an ‘interpenetrating body of work which demands and produces critique’ (p. 11). He stressed the significance of understanding historically the social conditions that permit specific forms of practice.

A critical theory of technology shares certain traits with instrumentalism and substantivism. One of the traits it shares with substantivism is the view that technology is value-laden, and, similarly to instrumentalism, it argues that technology is in some sense controllable (Feenberg, 2007). But critical theory views the values embodied in technology as socially specific; in other words, values emerge from a culture and can be interpreted as a cultural phenomenon (Hansen, 1997). Like substantivism, critical theory argues that the technical order is more than the sum of tools, but it rejects their dystopian view (Feenberg, 1991). A critical theory of technology replaces the conventional distinction between artefacts and ideas held by technological determinism and instrumentalism, with a holistic view in which technology reflects the dominant ideologies of the culture in which the technology emerges. Hansen (1997) stated:

> Critical theory differs from Marxian ideas by locating ideologies not only in the heads of human beings but also in the gestalt of the material world. Ideologies represent hegemonic systems, not as books or schools of thought, but as socially designed machinery that determines the power relationships underpinning, for example, how work is organized or how we deal with nature. Technology thereby becomes a socio-cultural phenomenon that belongs to base and superstructure alike. (p. 54)

A critical theory of technology argues that ‘technology is not a thing in the ordinary sense of the term, but an ‘ambivalent’ process of development suspended between different possibilities’ (Feenberg, 1991, p. 14). Feenberg argued that existing society contains the ‘suppressed potentiality for a *coherent civilizational alternative* based on a system of mutually supporting transformations of social institutions, culture, and technology’ (p. 17).

Marcuse (1898-1979), a student of Heidegger and one of the first generation of critical theorists, was deeply influenced by classical philosophy. He was ‘concerned about the triumph of apparently normless means over ends, of domination of every other value’ (Feenberg, 1998, n.p.). His book, *One-Dimensional Man* written in 1964, takes up these issues. He started by declaring ‘A comfortable, smooth, reasonable, democratic *unfreedom* prevails in advanced industrial civilization, a token of technical progress’ (1991, p. 1, own italics). In this book, Marcuse critically analyzed new forms of technology and technological rationality which he claimed produced a totally administered society. Marcuse’s critique of value-neutrality is similar to Heidegger’s, but the difference between them was that Marcuse responded by suggesting an alternative (Feenberg, 1998). This is evident in his third and final part in *One-Dimensional Man* titled ‘The Chances of the Alternative’. This commitment to a better future is a defining feature of Marcuse’s work. In *One-Dimensional Man*, Marcuse argued that it is not knowledge or technical devices that are primary but the technological relation to reality that makes progress in science and technology possible in the first place.

The criticism leveled against some critical theorists, such as Adorno and Horkheimer, is their disinclination to move beyond a theory of critique to provide suggestions for alternatives. They refused to step beyond the questioning and give a way forward (Willinsky, 2007). This criticism seems to be leveled against the so-called first generation of critical theorists, as more recently, Feenberg (2006) has suggested that there is a trend towards greater participation by the public in decisions about the development of technology. It is his hope that citizenship will include exercise of human control over the technical framework. He stated:

> The public sphere appears to be opening slowly to encompass technical issues that were formerly viewed as the exclusive preserve of experts. Can this trend continue to the point at which citizenship will include the exercise of human control over the technical framework? We must hope so, for the alternative is likely to be the eventual failure of the experiment in industrial society under the pressure of untrammeled competition and national rivalries. If people are able to conceive and pursue their intrinsic interest in peace and fulfillment through the political process, they will inevitably address the question of technology along with many other questions that hang in suspense today. We can only hope this will happen sooner rather than later. (p. 15)

2.2.7 A social-constructivist approach

Social-constructivism can inform a theory of technology. Social constructivists argue that technology is largely socially determined. It has recently sharpened reflection on *who* makes the technology and *why* and *how*. Like substantivism, constructivism attempts to understand more than the technical function by exploring the construction of networks of people and things within which functions emerge. It confirms the link between means and ends and contingent development (Feenberg, 1999).

Faulkner and Runde (2005), Klein and Kleinman (2002) and Williams, R. (2002b), emphasise the role of human agency as central to the process of technological advance. Faulkner and Runde (2005) propose that the technological identity of an object emerges jointly from that object's physical characteristics and the function collectively assigned to that object by society. This identity is internal to those communities in which those identities have currency. All technological artifacts have 'interpretive flexibility', in other words they are understood differently by different participants (Brey, 2003). Brey stated:

> When social negotiations surrounding technological change come to a close, interpretive flexibility is held to diminish because the technology stabilizes, along with concomitant (co-produced) meanings and social relations. Stabilization implies the embedding of the technology in a stable network consisting of humans and other technologies, and the acceptance of a dominant view on how to interpret and use the technology. Stabilization of a technology implies that its contents are "black-boxed" and are no longer a subject of controversy. (pp. 51 – 52)

Advocates of social constructivism claim that it liberates technology from objectivist determinism and uncovers the tacit assumptions that are part of technological development, whereas critics of social constructivism say that it often ignores the socio-political imperatives that influence technological development (Hansen, 1997). Hansen contended that social constructivism 'contributes to a critical epistemology of technology, and supports an emphasis on an active role of the learner in Technology Education. This does not imply abandoning the internal dimensions of science and technology but rather a *shift* from perceiving technology as a set of value-free activities or outcomes to understanding it in terms of social relationships embedded in cultural norms and values' (p. 56).

2.2.8 Reflections on the theories of technology

According to Hansen (1997), most approaches in the debate about the nature of technology, are based on the idea of progress: for example, in the case of Marx it is social progress, in the case of systems theory it is technological progress. By imposing a teleology, these approaches 'separate technology as material artifact from technology as idea, volition, or knowledge' (Hansen, 1997, p. 51). The neutrality thesis to which the instrumentalists and the determinists subscribe admits that technology embodies a value, but this is a merely formal value: that of efficiency (Feenberg, 2007). Hansen (1997), in his criticism of technological determinism stated:

> An ontology directed towards the technological artefact tends to be reductionist, it excludes the complex dialectic of individual and cultural

> meanings. The historicity of technology is neglected, leaving ontological interpretations to reflect technological determinism rather than the possibility of human choice. (p. 52)

The above criticism also applies to instrumentalism. Theorists such as Feenberg (1999) and Ihde (1990) claim that technology can never be removed from a context and therefore can never be neutral. Theories based on a neutrality thesis ignore the influence of contexts, including indigenous knowledge practices (Vandeleur & Schäfer, in press).

In the past, many theorists took a dichotomous view focusing on either the social impact of technology or the social shaping of technology. Technological determinism developed out of social impact theories where, after it has been introduced into society, technology takes on a life of its own (Marx & Roe Smith, 1994). But this does not provide the full picture of technological development. As has already been discussed (see 2.2.5), studying the impact of technology on society places the emphasis on a restricted point of the sequence of technological development (Pannabecker, 1991) and it ignores the role of human agency. The implications for Technology Education are that the focus on studying the impact of technology on society leads to a domination of dichotomies, such as 'advantages and disadvantages' or 'uses and abuses' (Hansen, 1997), and oversimplifies the human-tehcnology relationship.

According to Feenberg and Bakardijieva (2002), technologies do not start out clearly defined. This is what is known as interpretive flexibility (see 2.2.7). In the early stages of the development of a technology it is easy to uncover the role of human agency. As the technology stabilises, its design tends to dictate users' behaviour more successfully and agency recedes into the background until new demands emerge. Reciprocity, and not one-sided determinism, best describe the human-technology relationship. So the reaction against technological determinism was due to its inadequacy as explanation. It seems that the limitations of technology-as-neutral approaches have been addressed by a reconceptualisation of technology as situated human activity that influences and is influenced by the social, cultural, political and environmental aspects of our world.

The pedagogical implications of a social constructivist or critical theory of technology approach include a shift from teaching content separate from cultural, social and environmental influences and considerations towards a dialectic engagement with these aspects in order to make Technology Education meaningful to students. Hansen (1997) stated:

> The educational implications of social constructivism are radical since socio-technological understanding is not added as a separate dimension to technological activity but is an integral part of it. Viewing technology as a sequence of social choices set within a framework of technical possibilities creates space for discussing the cultural relationships and values that are part of design decisions. It may lead to pedagogy in which Technology Education integrates role models and social interaction with the acquisition of skills and theoretical knowledge. (p. 57)

2.3 Indigenous technology and culture

The inclusion of 'indigenous technology and culture' in the South African National Curriculum Statement: Technology (South Africa. Department of Education, 2002b) is noteworthy. It comes at a time when questions are being asked on the formation of knowledge production, the gap between formal institutions and society, and the vacuum in theorisation (Odora Hoppers, 2002a). This chapter examines some of the definitions of 'knowledge', 'indigenous' and 'indigenous knowledge systems' and the ambiguities surrounding these concepts. The theories of modernism, postmodernism and post-colonialism are discussed as their stance on knowledge, knowledge production and indigenous knowledge is relevant to this study.

2.3.1 Definitions

This section of the chapter deals with the definitions of 'indigenous', 'indigenous peoples', 'knowledge', 'indigenous knowledge' and 'indigenous knowledge systems' and the complexity surrounding the defining of these terms. Throughout this study, the term 'western' or 'westernised' is used and so it needs clarification. The term is used to refer to the ideas and practices whose origins can be traced to European traditions of knowledge, teaching and learning.

Defining 'indigenous' and 'indigenous peoples'

Defining the term 'indigenous' is a complex but important issue, as the term is increasingly associated with new laws and rights (Niezen, 2003) as well as being used in education policy documents in countries such as South Africa, Canada and New Zealand (Phiri, 2008). The word 'indigenous' refers to the root, something natural or innate (Odora Hoppers, 2002a). A 1987 United Nations report by Martinez Cobo (1987) stated:

> Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of societies now prevailing in those territories, or parts of them. (p. 48)

This definition is problematic as it excludes those communities living in countries that were not colonised. The Working Group on Indigenous Populations had their own view on a definition (Niezen, 2003). For their annual gathering of indigenous peoples and organizations, they maintained an open-door policy toward participation, so their definition was one of no definition. This enabled indigenous delegates to attend the gathering with little insecurity about their own status as 'indigenous' and few had doubts about the claims of others. This Working Group also completed the text of a 'Declaration on the Rights of Indigenous Peoples' in 1993 in which they did not define 'indigenous peoples' (Sanders, 1999). In this way, they avoided the controversy of exclusion and inclusion.

'Indigenous peoples' is a relatively new term. The International Labour Organisation's Convention 107 drawn up in 1957 in Geneva, Switzerland, applied to:

> (a) members of tribal or semi-tribal populations in independent countries whose social and economic conditions are at a less advanced stage than the stage reached by the other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations;
> (b) members of tribal or semi-tribal populations in independent countries which are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonisation and which, irrespective of their legal status, live more in conformity with the social, economic and cultural institutions of that time than with the institutions of the nation to which they belong. (International Labour Organisation, 1957)

The more recent Convention 169 formulated in 1989 was less paternalistic (May & Aikman, 2003). Convention 169 applied to:

> a) tribal peoples in independent countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations;
> b) peoples in independent countries who are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonisation or the establishment of present state boundaries and who, irrespective of their legal status, retain some of their own social, economic, cultural and political institutions. (International Labour Organisation, 1989)

However, according to Posey and Dutfield (1997), there are problems with defining the word 'indigenous' as it relates to 'indigenous peoples', as it appears to homogenise many distinct populations whose experiences have been very different. Another difficulty is that 'indigenous' is sometimes used interchangeably with words such as 'traditional' and 'local', as is evident in Grenier (1998), the International Institute of Rural Reconstruction (1996), Dei (2000b) and many others. The final 's' in 'indigenous peoples' has been argued by indigenous activists as it is a way of recognising that there are real differences between indigenous peoples, and it has allowed the collective voices of colonised people to be expressed in the international arena (Smith Tuhiwau, 1999). As May and Aikman (2003) stated:

> Central to these arguments is the principle that indigenous groups are not simply one of a number of ethnic minority groups, competing for the limited resources of the nation-state, and therefore entirely subject to its largesse, but are *peoples*, with the associated rights of self-determination attributable to the latter under international law. (p. 140)

Current approaches to defining 'indigenous peoples' include Sanders's (1999) definition:

> An indigenous people is a collectivity which has descent from the earliest surviving population in the part of the State where the people traditionally lived (whether still living in that area or, as a result of involuntary relocation, in another part of the State) and which has a distinct identity associated with its history. (p. 9)

There continue to be different approaches to defining 'indigenous peoples'. These range from the broader open-ended approach of the World Bank to definitions where historical descent from the earliest populations is required

(Sanders, 1999). There is lack of consensus on a definition, or even on the need for a definition. Even so, a range of non-profit and inter-governmental organisations have brought a concern for 'indigenous peoples' into discourse and practice within contemporary human rights (Sanders, 1999).

A broad definition of knowledge

The concept of 'knowledge' is important in the context of this study as the basis to understanding 'indigenous knowledge systems' lies in how 'knowledge' itself is conceptualised. Peat (1996) stated that the verb 'to know', which is of ancient Aryan origin, has to do with perception, recognition, and the ability to distinguish. In time, this view of knowledge was changed into a noun and came to mean a collection of facts that could be categorised, collected and stored. He further stated that 'In deep and subtle ways the attitude of Indigenous science to knowledge and to the process of coming-to-knowing is profoundly different from that of its Western counterpart' (p. 56). Peat suggested that the Native American's vision of 'coming-to-knowing' is close to Polyani's (1958) definition of 'tacit knowledge', a knowing that is learned by direct experience and a relationship with the thing to be known. For Polyani, tacit knowledge is personal and is based on one's own experiences and learning, but it can be made explicit in some circumstances. For him, all knowledge has a tacit component.

Battiste (2002) agreed with the notion of difference between 'western' knowledge and indigenous knowledge. She asserted that indigenous peoples have their own methods of classifying and transmitting knowledge, and therefore indigenous knowledge cannot be placed within Eurocentric frameworks and disciplines, as no Eurocentric perspective acknowledges the extent to which indigenous communities have their own knowledge holders and workers. She stated that indigenous knowledge:

> embodies a web of relationships within a specific ecological context; contains linguistic categories, rules and relationships unique to each knowledge system; has localized content and meaning; has established customs with respect to acquiring and sharing of knowledge; and implies responsibilities for possessing various kinds of knowledge. (p. 14)

This notion of difference between ways of knowing is, however, problematic and is dealt with in the section on ‘Issues with indigenous knowledge’ (see 2.3.2). Aikenhead and Ogawa (2007) stated that knowledge within a Eurocentric worldview is an entity separate from the knower, a concept that is foreign to most indigenous worldviews. It is interesting to note that Aikenhead and Ogawa stated that there is no equivalent word for knowledge in most indigenous languages, as it is such an ‘epistemic concept’.

Tompkins (2002) suggested that colonialist conceptions of knowledge equated knowledge with truth, and it coincided with the beliefs of the dominant group. Schools generally deal with knowledge in this context. Multiculturalists, however, view knowledge as ‘social construction deeply rooted in a nexus of power relations’ (McLaren, 1989, p. 169). Woodley (2003) stated that if:

> *knowledge* is understood not as an abstract information base, but resulting from a combination of dynamic and shifting variables that represent daily activity and belief, there is more reason to approach local ecological knowledge from the perspective that it is shifting and responsive to change. (p. 3)

In this instance, knowledge is conceptualized as dynamic and knowledge production as a creative process, not just transmissive. McLaren (1989) suggested that educators should go beyond technical and practical knowledge and conceive of knowledge in emancipatory ways as it is this kind of knowledge that can serve as a foundation in schools working for social justice. This notion aligns itself with the ‘critical technology literacy’ approach discussed later on in this chapter (see 2.4.3).

Defining ‘indigenous knowledge’

According to Arce and Fisher (2003), the plethora of terms surrounding the knowledge that people hold, such as ‘local knowledge’, ‘traditional knowledge’, ‘indigenous knowledge’, ‘indigenous knowledge systems’ and ‘rural people’s knowledge’, reflects the different interest groups that use these terms, such as those with research interests, those with certain theoretical stances and those interested in the practical applications of knowledge. It also reflects the influence of disciplines like ecology, anthropology and sociology, which have sought to appropriate indigenous knowledge. ‘Indigenous knowledge’ is a term which, in recent years, has become value laden, and has gained meaning beyond its mere semantics (Rouse, 1999). This is evident in the definitions discussed in the next paragraph, which all have a different focus but many common elements.

One of the more inclusive definitions of indigenous knowledge is that given by Dei, Hall and Rosenberg (2000), which stated ‘Indigenous knowledges are unique to given cultures and societies and they reflect the capabilities and values of the communities that use them’ (p. 19). The World Bank (2003) emphasized the traditional origins and the cultural aspect of indigenous knowledge as well as its interdependence on other knowledge systems:

> Local knowledge that arises from tradition and is embedded in culture is referred to as indigenous knowledge. Indigenous knowledge is not independent, and is always linked in some ways to other parts of the global knowledge system. (n.p.)

Warren, Slikkerveer and Brokensha (1991) gave a description that emphasized the difference between ‘indigenous knowledge’ and ‘international knowledge’:

> ...indigenous knowledge is an important natural resource that can facilitate the development process in cost-effective, participatory, and sustainable ways (Vanek, 1989; Hansen and Erbaugh, 1987). Indigenous knowledge (IK) is local knowledge- knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural resource management, and a host of other activities in rural communities. Such knowledge is passed down from generation to generation, in many societies by word of mouth. Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities. (p. 1)

SciDev.net (2002) contrasted indigenous knowledge with the concept of formal knowledge. They stated that formal knowledge refers to knowledge systems developed in predominantly western-based education systems and it is supported by written documents, rules and regulations. Indigenous or local knowledge refers to ‘the complete bodies of knowledge, know-how, practices and representations that are maintained and developed by peoples with long histories of close interaction with the natural environment’ (n.p.).

Battiste (2002) suggested that it is useful to focus on similarities between indigenous knowledge and so-called ‘western’ knowledge rather than on their differences. She stated:

> Indigenous knowledge comprises the complex set of technologies developed and sustained by Indigenous civilizations. Often oral and symbolic, it is transmitted through the structure of Indigenous languages and passed on to the next generation through modeling, practice and animation, rather than through the written word. (p. 2)

Flavier, de Jesus and Mavarro (1995) stated that indigenous knowledge systems are dynamic and are being continuously influenced by experimentation, internal creativity and contact with external systems. Battiste also emphasised the dynamic nature of indigenous knowledge and pointed out that using the taxonomic approach to analyse indigenous knowledge is therefore not justified. She further stated:

> Indigenous knowledge is an adaptable, dynamic system based on skills, abilities, and problem-solving techniques that change over time depending on environmental conditions. (p. 11)

Ahmed (1994) suggested that indigenous knowledge is adaptive by stating it ‘is a mixture of knowledge created endogenously within the society and knowledge acquired from outside but then absorbed and integrated within the society’ (p. 12).

Castellano (2000), in her paper on ‘Updating aboriginal traditions of knowledge’, identified different broad aspects of ‘aboriginal’ knowledge with an understanding that these categories overlap and interact with one another. She suggested that the knowledge valued in indigenous societies has been derived from multiple sources such as traditional teachings, empirical observation and revelation. Castellano categorised these different aboriginal knowledges as follows:

> *traditional knowledge* is handed down from previous generations and the wisdom of elder generations is highly respected; *empirical knowledge* is gained through careful observation over periods of time; *revealed knowledge* is acquired through dreams, visions, and intuitions that are understood to be spiritual in origin. (p. 23)

New information is interpreted in the context of existing information and the existing information is adapted when necessary. Indigenous knowledge is therefore rooted in personal experience and it lays no claim to universality (Castellano, 2000, p. 25). Castellano suggested that the ultimate test of the validity of this type of knowledge is whether it enhances the capacity of people to live well and that the validity of new formulations of old wisdom is tested in everyday life. The notion that indigenous knowledge lays no claim to universality and the way in which this type of knowledge is validated are two of the main differences cited by writers on the difference between western knowledge and indigenous knowledge, and this has important implications for the way in which 'indigenous knowledge' is taught and learnt in Technology Education. The criterion of effectiveness rather than efficiency would allow for the way in which indigenous knowledge is validated and its local nature to be considered.

The main characteristics of indigenous knowledge derived from these definitions are that it is place-based and therefore makes no claim to universality, it is transmitted (usually orally) from generation to generation, and it is dynamic in nature. However, there are issues surrounding the definition of indigenous knowledge and its inclusion in policy documents, and these are discussed in the next section.

Defining indigenous knowledge systems

Knowledge systems are taken to include both the contents and the processes of that domain of experience referred to as 'knowledge' (Odora Hoppers, 2002b). As with 'indigenous knowledge', different definitions of 'indigenous knowledge systems' exist. Rouse (1999) differentiated between indigenous knowledge and indigenous knowledge systems by stating that indigenous knowledge refers to the knowledge itself, whereas indigenous knowledge systems refer to indigenous practices such as mixed cropping systems, water management systems, pastoral cattle movement, and use of medicinal plants. Posey and Dutfield (1997) stated that indigenous knowledge systems is a general term that refers 'to the collective knowledge of an Indigenous People and it includes knowledge that is commonly known within a community as well as the specialised knowledge which may be known to certain groups of the community such as elders, a lineage group or a gender group' (p. 46). Seepe (2001) suggested that indigenous knowledge systems refer to the intricate knowledge systems acquired over generations by communities as they interact with the environment and they encompass technology, social, economic, philosophical, learning and governance systems, whilst he National Research Foundation (2002) stated that indigenous knowledge systems refer to 'the complex set of knowledge and technologies existing and developed around specific conditions of populations and communities indigenous to a particular geographic area' (p. 1).

According to Woodley (2003), indigenous knowledge systems should be studied in terms of space and time, emphasising the importance of context. He further stated that the spatial dimension of indigenous knowledge is the embedded, holistic or 'place-based' aspect of knowledge at any one point in time, and that to understand knowledge as embedded in place needs an understanding of the social norms, values, belief systems, institutions and ecological conditions that provide the basis for the 'place' where knowledge is derived. Battiste (2002) also emphasised the place-based aspect of indigenous knowledge in that it is:

> inherently tied to land – not to land in general but to particular landscapes, landforms and biomes where ceremonies are properly held, stories recited, medicines gathered and transfers of knowledge properly authenticated. (p. 13)

The whole area of 'indigenous knowledge' is a contentious and political one and issues from what constitutes 'indigenous' to whose interests are being served by the documentation of such knowledge arise. As Nakata (2002) suggested 'there lies a string of contradictions, of sectorial interests, of local and global politics, of ignorance, and of hope for the future' (p. 281) all of which add to the contentious nature of indigenous knowledge.

2.3.2 Some issues pertaining to indigenous knowledge

This section of the chapter deals with some of the issues pertaining to indigenous knowledge. One of the issues is that in the defining of 'indigenous knowledge' false dichotomies can be created. These dichotomies are discussed here. The rest of this section deals with other issues that are relevant to this study.

Dichotomies

Important for this study is the issue of the dichotomy that occurs when defining 'indigenous knowledge'. Most definitions compare 'indigenous knowledge' to ‘western knowledge’, and in doing so, separate them. This separation is important in some fields, such as horticulture, where the difference between indigenous, endemic and exotic plants is significant (Fiorotto, 2008). This separation is important as it impacts on aspects such as biodiversity, sustaining ecologically sensitive areas and positive use of land. It is my view, however, that in other fields such as technology studies, this separation creates an artificial boundary. Horsthemke and Schäfer (2007) have a concern in this regard in the field of ethnomathematics:

> … the term ‘indigenous’ has, at best, limited applicability. A similar point could be made about the prefix ‘ethno’. If ethnomathematics constitutes knowledge in the propositional or factual sense, then it is unclear what purpose the prefix is meant to serve – other than artificially severing ethnomathematics from mathematics as such. (p. 8)

In agreement with this view is Rack’s statement that ‘the terms ‘indigenous’ and ‘local’ imply a discontinuity with other forms of knowledge, such as state, official or scientific knowledge. This implicit dichotomy highlights the power differentials that exist’ (2003, p. 171). She suggested that these terms oversimplify the different ways of knowing.

Agrawal (1995b) stated that this dichotomy stops any useful dialogue around the safeguarding of this type of knowledge:

> I argue for the recognition of a basic political truism: anchored unavoidably in institutional origins and moorings, knowledge can only be useful. But it is useful to particular peoples. Specific strategies for protecting, systemizing, and disseminating knowledge will differentially benefit different groups of people. The recognition of this simple truism is obscured by the confounding labels of “indigenous” and “western”. It is only when we move away from the sterile dichotomy between indigenous and western, or traditional and scientific knowledge, that a productive dialogue can ensue for the safeguarding of the interests of those who are disadvantaged. (p. 31)

Agrawal’s notion that knowledge is useful, but useful to particular peoples is relevant to this study, and one that is important in the development of learning materials for Technology Education. In other words, not all knowledge is useful to all people at all times. I would like to suggest that this point should be used in the analysis of technologies at school level. ‘Usefulness’ and ‘effectiveness’ of a technology for particular groups of people should be central criteria in any analysis of particular technologies.

Carter (2006) suggested that there are perceptual borders between western science and indigenous knowledge, but these borders are not strict delineators. Agrawal (1995b) suggested that the border created by the differentiation between these two knowledge systems is artificial. Aikenhead and Ogawa (2007) agreed with this notion as they write about a ‘false dichotomy’. They suggested that the labelling of ‘indigenous knowledge’ and ‘science’ belies the great diversity found within each of these categories but it also hides the similarities such as empiricism, rationality and dynamic evolution. The way scientific knowledge is conceptualised has changed in recent years, especially in the field of social development, and it is now viewed by some as a type of ‘local’ knowledge rather than a ‘monolithic entity’ (Pottier, 2000). Turnbull (1997), in the abstract to his paper titled ‘Reframing science and other local knowledges’, stated:

> By recognizing science as a set of local practices it becomes possible to ‘decentre’ it and develop a framework within which all knowledge systems can be equitably compared. It is argued that all knowledge traditions are spatial in that they link people, sites and skills. In order to ensure the continued existence of the diversity of knowledge traditions rather than have them absorbed into the great imperialist archive we need to enable disparate knowledge traditions to work together through the creation of a third space in which the social organization of trust can be negotiated. (p. 551)

In this article, Turnbull argued that there is no difference between the production of local knowledge and the production of scientific knowledge as they both emanate from local knowledge that produces a knowledge space. He also argued that the production of science is not a result of universal principles of logic but a result of local contingent judgements and negotiations.

The comparison of western scientific knowledge and indigenous knowledge usually creates a dialectical opposition (Shava, 2006). Shiva (2000) points to the dichotomising impact of Western scientific research on local knowledges which, through processes of inclusion and exclusion, create boundaries of power. She points out that in colonial times, western systems of agriculture and medicine were defined as the only scientific systems. Yet the agricultural practices of most farmers in Africa rely heavily on traditional know-how and this sometimes proves to be far more productive than imported techniques (Hountondji, 2002). However, indigenous knowledge proponents can also create an oppositional logic of 'us' and 'them' – the subjugated 'us' and privileged 'them' (Dei cited in Shava, 2006).

Agrawal (1995a) suggested that there are three common themes that are used to differentiate indigenous knowledge and western science: substantive because of the differences in subject matter and characteristics; methodological and epistemological as the two forms of knowledge use different methods to investigate reality; and contextual because indigenous knowledge is more deeply embedded in its environment. He further stated that the attempt to create two categories of knowledge 'rests on the possibility that a small and finite number of characteristics define the elements contained within the categories' (p. 2). But this attempt to classify knowledge flounders as it seeks to separate and fix in time and space knowledge systems that can never be so separated or fixed in time. Nakata (2002) proffered that the duality between the two systems assumes a fixity in time and space that is false.

Agrawal (1995a) also condemned attempts to archive indigenous knowledge. He stated:

> If indigenous knowledge is inherently scattered and local in character, and gains its vitality from being deeply implicated in people's lives, then the attempt to essentialize, isolate, archive and transfer such knowledge can only seem contradictory. If Western science is to be condemned for being non-responsive to local demands, and divorced from people's lives, then centralized storage and management of indigenous knowledge lays itself open to the same criticism. (p. 4)

There is now a growing realisation that these knowledge systems are not necessarily oppositional. The attention is moving away from the dichotomous approach to a process by which different discourses, values and practices associated with the notions of 'modernity' and 'tradition' intersect and are intertwined in the everyday encounters and experiences of people from diverse socio-cultural backgrounds (Arce & Long, 2000, pp. 2-3).

According to Arce and Long (2000), interfaces of knowledge are not found between the scientific, official and local knowledges. A consensus has emerged in the development field, that knowledge production is rather a continuous, boundless, seamless process between many different forms of knowledge. This consensus emerged due to the postmodern challenge that 'bounded' needed to be replaced by 'relational', ontological categories (Arce & Fisher, 2003). Local knowledge does not exist in isolation but rather interacts with a variety of ways of knowing, so it is being continually shaped and re-shaped. Local knowledge is therefore not unquestioningly endogenous as local people interact with exogenous elements to strengthen their own ways of knowing. The binary 'endogenous/exogenous', 'us/them' view of knowledge does not apply much to everyday reality (Pottier, 2003). Agrawal (1995a) suggested that it makes sense to talk about multiple domains and types of knowledge with differing logics and epistemologies rather than creating distinctions between these domains and Nakata (2002) stated 'that the very separation of the domains – cultural and Western – or traditional and formal – lead to simplifications that obscure the very complexities of cultural practices in both domains' (p. 285).

This has implications for the ways in which these knowledge systems are recontextualised into learning materials. Students must have the opportunities to interrogate their own systems of thought by intellectually engaging with all knowledge and discourses (Nakata, 2002). The historical, political, social, cultural and environmental contexts in which a technology emerges, develops and stabilizes should therefore be explored. This needs to be done critically though, and the internal and external characteristics of all technologies should be explored and analysed. It is my view that to include 'indigenous technology and culture' in its narrowest sense in pedagogical practices would separate it from 'western' technologies, promoting the dichotomy that already exists and in the process marginalising indigenous technologies from other technologies. Arce and Fischer's (2003) notion of knowledge production as a seamless, continuous and boundless process between different forms of knowledge is important for curriculum and learning material developers to acknowledge. To get learners to define what is appropriate or useful in given contexts by asking questions on the historical, social, political, cultural and environmental influences and effects of all technologies, should encourage a critical disposition towards technology in general in our learners, thereby promoting a critical technological literacy (see 2.4.3 for discussion on technological literacy).

Other issues

Another issue is the claims that are sometimes put on the value of indigenous knowledge by some. Currently, indigenous knowledge is viewed as a valuable resource, as is evident in policy documents in South Africa and elsewhere, such as Canada. In the 1950s and 1960s this was not so – development theorists viewed this type of knowledge as hindering to the developmental needs of developing countries (Agrawal, 1995b). According to Rouse (1999), education and the transfer of western technologies was the pervading objective during colonial times. But indigenous knowledge, in time, became increasingly recognised as a valuable and under-utilised resource. Agrawal (1995b) suggested that these shifting viewpoints were due to the failure of modern science and grand narratives to improve the life chances of indigenous peoples. In the social development field, authors often refer to 'local knowledge'. The interest in 'local knowledge' in this field was a reaction to the failures of 'externally driven, transfer-of-technology focused, top-down development' (Pottier, 2003, p. 1). The externally driven attitude to development was due to some deeply rooted assumptions about local knowledge, such as it was bounded, static, consensual, non-reflective and unscientific (Howes & Chambers, 1979). The emphasis on local knowledge, in terms of social development, demanded that practitioners be receptive to the technology, skills and accumulated knowledge of people everywhere.

However, Fairhead (1993) suggested that this emphasis on local knowledge sometimes resulted in exaggerated claims about its value, such as farmers being collectively rational, even super-rational, everywhere. Under scrutiny, local knowledge began to reveal itself as 'the multifarious, contestable product of an ever-evolving syncretic process' (Pottier, 2003, p. 1). So the unitary concept of 'local knowledge' fragmented into a plurality of knowledges.

Another issue concerns the production of indigenous knowledge. Even though most agree with the dynamic aspect of indigenous knowledge, opinion is divided over the nature of the process of its development and adaptation. Many writers assert that indigenous knowledge evolves through a process of controlled experimentation whilst others support the notion that it adapts through a 'trial and error' process (Rouse, 1999). But in my view, this is not an issue if one holds the view that *all* knowledges are dynamic in nature and some of this knowledge is produced by controlled experimentation and some by ‘trial and error’. Knowledge is produced in different contexts and ways. So the issue is not with the production of indigenous knowledge but rather with the separation of indigenous knowledge from western knowledge.

According to Nakata (2002), one of the aspects that is overlooked in some definitions of indigenous knowledge is the fact that the management of this type of knowledge involves rules regarding secrecy and sacredness, and therefore the rules surrounding ownership and protection ‘are quite different from those inscribed in Western institutions’ (p. 283). One of the issues that this brings up is the contradiction that the strategy of archiving and disseminating indigenous knowledge runs contradictory to the very conceptual basis of what is seen to be ‘indigenous’ in indigenous knowledge (Agrawal, 1995a; Nakata, 2002). Nakata had the following to say about the strategies of conservation of indigenous knowledge:

> When it employs methods and instruments of Western science, which involve fragmentation across categories of information, isolation and *ex situ* storage in regional, national and international archives and networks then it begins to lay itself open to the same criticisms as ‘Western science’, which has largely failed in development contexts. It becomes not embedded in local meanings and contexts but separated from its original context – an entity to be studied, worked on, developed, integrated, transferred, and ultimately changed to fit another. (p. 283)

He further stated that he was not going to argue the extreme position that indigenous knowledge should be forever isolated or that it should not be documented, but he did suggest that:

> knowledge recovery led by Indigenous communities would not look the same as that led by scientists, developmental technologists, and conservationists (even when participatory). For without a doubt, the collection and documentation of Indigenous knowledge by the development and scientific communities is a very partial enterprise, selecting and privileging some Indigenous knowledge whilst discarding and excluding others. (p. 283)

This area of indigenous knowledge is complex but even so, and perhaps because of its complexity, it is one that should be brought into classroom discussions and debates surrounding issues such as intellectual property rights and documentation of and access to knowledge.

Dei (2000a) suggested that ‘the discursive project of ‘Indigenous knowledges’ is seen as a way to rupture the sense of comfort and complacency in conventional approaches to knowledge production, interrogation, validation and dissemination in Euro-American education settings’ (p. 111). So, perhaps in regard to the South African curriculum, it has made educators aware of different knowledge systems. Dei writes about recognizing the legitimacy of different forms of knowledge, and that the interplay of these knowledges is one of the many reasons why indigenous knowledges should be taught in the academy. He stated that it is now necessary ‘to address the emerging call for academic knowledge to speak to the diversity of histories, events, experiences and ideas that have shaped human growth and development’ (p. 113). Pottier (2003) asserted that there is no final word in the debate about power and knowledge. He suggested that the tendency is to go along with Foucault’s (1971) broad claim that the criteria of what constitutes knowledge involves acts of power as it involves issues such as ‘who is designated as qualified to know’, ‘what constitutes knowledge’ and ‘what is to be excluded’. The role of power in knowledge production remains pervasive.

There is a reference to ‘culture’ in the National Curriculum Statement: Technology. The heading for the assessment standard is ‘indigenous technology and culture’. As Nakata (2002) stated, ‘References to culture are references to a whole system of knowing, being and acting. Agrawal (1995a) suggestion that the development of knowledge systems everywhere ‘suggests contact, diversity, exchange, communication, learning and transformation among different systems of knowledge and belief’ (p. 3) seems to me to be a good approach for educational purposes. Implications of these issues for Technology Education are given later on in this chapter.

2.3.3 Modernism, postmodernism and post-colonialism

A brief examination of the theories of modernism, postmodernism and post-colonialism is conducted in this section of the chapter, as indigenous technology and the ways in which academics, policy makers and users perceive and engage with these technologies are partially explained by these theories. As Battiste (2002) in her paper ‘Indigenous knowledge and pedagogy in First Nations Education’ stated, the ‘academic effort seeks to identify relations between the two generalized perspectives of Eurocentric modernism (and postmodernism) and Indigenous knowledge and postcolonialism’ (p. 10). It is relevant to examine the basic tenets of modernism here as these were a precursor to postmodernism, and as Brey (2003) stated, it is difficult to overlook the pervasive role of technology in the making of modernity. Postmodernism, as a reaction to modernism, questions the dominance of certain knowledge systems and cultures over others, so it is an important theory to explore in terms of this study. Postcolonialism as an intellectual movement is strongly associated with postmodernism and it is strongly linked to indigenous knowledge, as acknowledged by Battiste (2002). All three of these theories have relevance to this study.

Modernism

According to Misa (2003), ‘for more than a century ‘modernity’ has been a key theoretical construct in interpreting and evaluating social and cultural formations’ (p. 5). It is the historical condition that characterises modern societies, cultures and human agents (Brey, 2003). Modernism is a consequence of the forces caused by urbanisation and industrialisation and it has a lot in common with the notions of ‘industrialism’ and ‘modernisation’ that hegemonised American society in the 1950s and 1960s (Giroux, 1997). Transport systems, electric lighting, immense constructions such as bridges and dams, and massive factory complexes, all helped to seemingly change culture. Technologies such as computers, genetic engineering and wireless communication, are all promoted as proof that society is endlessly changing and progressing. Brey (2003) stated that ‘the social systems of modernity are sociotechnical systems, with technology an integral part of the workings of social institutions’ (p. 54). The notions of change and progress are central to modernism’s agenda. As Misa (2003) stated:

> These culture-changing technologies have been at the core of modernity because their presence and their promoters’ promises have seemingly offered proof of the modernist storyline that society is incessantly changing, ever progressing, transcending frontiers without an end in sight. (p. 12)

Modernism is basically about creating order out of chaos and is defined in terms of an aspiration to reveal the essential truth of the world (Klages, 1997). Lyotard (cited in Klages, 1997) argued that this order is maintained in modern societies through the means of ‘grand narratives’ or ‘metanarratives’. Lyotard further argued that all aspects of modern societies, including science as the primary form of knowledge, depend on these grand narratives. Giroux (1996) suggested that modernism’s emphasis is on the mutually reinforcing categories of the unified, autonomous self. He also stated that the relationship among identity, culture, agency and community as defined by modernism reinforced rather than challenged the existing networks of hierarchy and exploitation. Factors that were deemed important in the industrialisation and modernisation of Northern America and Western Europe were transformed into policy targets for the developing world (Misa, 2003).

As discussed earlier in this chapter (see 2.2.5), instrumentalism is the standard modern view in which technology is viewed as a tool or instrument of progress. The world is to be controlled and used. In the nineteenth century, modernity was viewed as an unending progress toward fulfillment of human needs through technological advance (Feenberg, 2006) and the instrumentalist view prevailed. According to Misa (2003), Marx and Engels, as theorists of modernity, had a faith in the rationalisation of society. This rationalisation was in terms of technological progress as well as growing social awareness of the process of change. Feenberg (2003) stated that rationalisation was used as the key notion in modernity theory to explain the uniqueness of modern societies. Misa (2003) asserted that Marx and Engels grasped the essential point that modern societies are fundamentally about change. This insight gave rise to the division between premodern societies and modern ones, and that a ‘great divide’ forever separates the two (Feenberg, 2003). As Brey (2003) stated:

> Cultural and epistemological theories of modernity focus on the distinction between premodern and modern cultural forms and modes of knowledge. These theories usually place the transition from traditional society to modernity in the Renaissance period, in fifteenth- and sixteenth-century Europe. The transition to modernity, in this conception, is characterized by the mergence of the notion of an autonomous subject, the transition from an organic to a mechanistic world picture, and the embrace of humanistic values and objective scientific inquiry. (p. 36)

He also stated that:

> Institutional theories of modernity focus on the social and institutional structure of modern societies and tend to locate the transition … with the rise of industrial society in Europe. … Modernity … is characterized by institutional structures and processes such as, industrialism, capitalism, rationalization, and reflexivity. It is with this institutional meaning of modernity that one can correlate the notion of modernization, which is the transformation of traditional societies into industrial societies. (p. 37)

Misa (2003) argued that technologically determinist views as promoted by modernists and postmodernists alike, miss the salience of technology as they examine the macro-level abstractions and not the details of the technology. Technologies often appear as 'black boxes', as 'fixed entities that irresistibly change society and culture' (p. 2). The modernist view of technology neglects relationships. As Feenberg (2003) stated 'modernity theory goes wrong when it claims that all of society operates under values somehow specific to a science and technology differentiated from other spheres' (p. 74). He suggested that 'technology is a social phenomenon through and through, no more and no less significant than any other social phenomenon' (p. 74).

Postmodernism

The term 'postmodern' is difficult to define for a number of reasons and there is a lot of debate around the term. Docherty (1993) stated that 'The term itself hovers uncertainly in most current writings between … extremely complex and difficult philosophical senses, and … an extremely simplistic medication as a nihilistic, cynical tendency in contemporary culture' (p. 1). Hassam (as cited in Boyne & Rattansi, 1990) stated that 'the term 'postmodernism' 'has shifted from awkward neologism to derelict cliché without ever attaining the dignity of concept' (p. 9). Some of the difficulties in defining the term arise as it lacks distinctive boundaries and from the fact that it contains a range of positions across a diversity of intellectual and cultural fields, such as art, architecture, music, literature, sociology, communications, fashion and technology (Boyne & Rattansi, 1990). In each of these fields there is an antecedent practice that laid claim to a certain exclusivity of insight and it is this that postmodernism rejects (Appiah, 2000). Among the many themes of postmodernism are the fragmentation of culture, the dissolution of the self, the relativity of human values, and the role of power relations (den Ouden, 1997). Kincheloe (as cited in McGovern, 1999) stated that a foundational principle of postmodern theories is that there is no universal knowledge other than that which is developed within conditions of particular cultural and social formations. Postmodernism promotes the protection of local and marginalised cultures and it addresses universal views of reality, the prestige of modern science as a form of knowledge, and the authority of experts.

Postmodernism is a reaction to the modernists view of there being an 'essential truth' which makes out that things have to be done in one particular way and that way only. Lyotard (as cited in Boyne & Rattansi, 1990) stated that 'Postmodern knowledge is not simply a tool of the authorities; it refines our sensitivity to differences and reinforces our ability to tolerate the incommensurable' (p. 17). Postmodernism focuses on the pragmatics of social worlds and not on modernism's visions of finished worlds and its accompanying obsession with 'ends' (Lyotard, as cited in Boyne & Rattansi, 1990). The grand narrative is thus discarded in postmodern society, and social development is seen as 'a pragmatic matter of inventing new rules whose validity [resides] in their effectivity rather than in their compatibility with some legitimating discourse' (Boyne & Rattansi, 1990, p. 18). Postmodernism favours 'mini-narratives' which are stories that explain small practices and local events rather than universal or global concepts. These mini-narratives are situational, provisional, contingent and temporary and they make no claim to universality, truth, reason or stability (Klages, 1997). Even though postmodernism may or may not be a useful characterisation of the state of the world today, it is useful in showing a growing scepticism with the 'grand narratives' which have given modernism a sense of itself and its achievements.

Technologies used in traditional societies are frequently viewed by modernists as non-innovative (Boyne & Rattansi, 1990) due to their subtle nature and low cost. Local knowledge systems have often been described as 'primitive', 'unscientific' and 'backward' compared to the western system which is seen to be 'uniquely scientific and universal' (McGovern, 1999). Modernism promoted the concept that western science and technology take over the leading role of development as they were regarded as the reason for the superiority of the North and were a guarantee of the promise of development (Ullrich, 1993). In the 1970s, development became synonymous with achieving the material prosperity of the West by adopting Western technologies, but this has resulted primarily in monocultures, devastation of nature and the destruction of cultures (Ullrich, 1993). A postmodern approach questions this viewing of certain ideas and practices having dominance over others. It also addresses power relations such as the authority to create and the legitimisation of knowledge (McGovern, 1999). Shiva (cited in McGovern, 1999) asserted that there is a relationship between power, knowledge and culture in terms of the perceptions and practices associated with modern scientific knowledge. The dominance of a knowledge system 'makes alternatives disappear by erasing and destroying the reality which they attempt to represent' (McGovern, 1999, p. 27).

Postmodernism's focus is on specific local goals and local situations that are seen as 'fluid and unpredictable' although influenced by global trends. Lyotard (as cited in Boyne & Rattansi, 1990, p. 18) suggested that social development in the postmodern era, also known as post-development, can no longer be seen as fulfilling some metanarrative, but that it should be a pragmatic matter of inventing new rules whose validity will reside in their effectiveness rather than in their compatibility with some legitimising discourse. Several post-development theorists emphasize the potential variety of human experience and view development strategies as a mechanism for imposing cultural uniformity. Development has been rooted in Western economic ideology, which means increased productivity through large scale, capital-intensive enterprise. There is an assumption that a 'technological fix' can always be found, that is if we can get the technology right, then progress and development in the Third World will follow (Stamp, 1990). However, this assumption was not necessarily a correct one as, after decades of applying a variety of development theories and policies, the real per capita income in more than seventy so-called developing countries is lower than it was twenty years before (de Rivero, 2001). De Rivero (2001) suggested that the myth of development should be discarded and the 'elusive agenda of the wealth of nations' should be replaced with 'an agenda for the survival of nations (p. 186).

The mini-narratives, the notions of community and the shift from content to context of postmodernism epitomise the fundamental aspects of indigenous knowledge systems. Postmodernism questions modernisms claim of a universal truth and it promotes the protection of local cultures. Lyotard views postmodernity as a set of partially differentiated social orders, as do Foucault and Derrida (Boyne & Rattansi, 1990). Indigenous knowledge systems are rooted in personal experience and local culture, and the intrinsic value of indigenous knowledge systems is illustrated in the high use of these knowledge systems by the local communities. In a postmodern world, sensitivity to the value of indigenous knowledge systems grows and they are claiming a rightful place alongside other knowledge systems. However, Dei (2000a) cautioned that a critical stance is required and that it is important to use and challenge postmodernism that results in over-subjectivising, individualising and privileging certain narratives and subject voices. He criticised postmodernism for its neglect of larger political-economic questions and for its forming of the world into separate entities without connections.

Brayboy and Castagno (2008b) stated that they find the label of 'postmodern' problematic when addressing the needs and rights of the Indigenous peoples with whom they work, as they believe in the concepts of sovereignty and self-determination, and these concepts conflict with their understanding of postmodernity as they require boundaries to be drawn and establish what some postmodernists might call a 'grand narrative'.

Postcolonialism

Postcolonialism has coincided with the rise of postmodernism in Western society. Like postmodernism, the term is ambiguous and complex due to the many different cultural experiences it implicates. Colonialism refers to political control or rule of the people of a given territory by a foreign state (Bernstein, 2000) and so the term 'postcolonial' was first used to designate the period following the post-war decolonisations in the late 1960s and 70s. The colonial powers used education as a tool with the intention of promulgating the metanarrative form of civilizing culture perceived to be utopian at the time. Pre-colonial modes of production and livelihood were destroyed in the process of colonization as land was expropriated by settlers and colonial companies and the indigenous inhabitants were restricted to agriculturally marginal areas of land. Pre-colonial societies gained their living from the land and so changes in ownership of, access to, and uses of land had profound effects on these societies. In countries that have experienced colonization, political autonomy was removed from the indigenous inhabitants, along with land and religion. This, of course, altered the local communities worldviews over time (Bernstein, 2000).

Postcolonialism has been used as a critique of the totalising forms of Western knowledge but in this use does not imply an unchanging process of resistance but rather 'a series of linkages and articulations without which the process cannot be properly addressed' (Ashcroft, Griffiths, & Tiffin, 1995a; Slemon, 1995). Postcolonial theory discusses many types of experiences from slavery, migration, resistance, representation, race, gender and place, to the response of the master discourses of imperial Europe such as history, philosophy and linguistics. None of these are 'essentially' postcolonial, but together they form the complex fabric of the philosophy (Ashcroft et al., 1995a). Like postmodernism, postcolonialism repudiates the grand narratives of modernism. The concept of universalism is of particular interest as it is the notion of a unitary and homogenous human nature that marginalises and sometimes excludes the distinctive characteristics of postcolonial societies. Universalism is a fundamental feature of colonialism as it is the characteristics of those who have political dominance that are then viewed as the 'universal' features of humanity. If one's own worldview does not concur with this view, then it is suppressed in favour of that which is viewed as 'obvious' (Ashcroft, Griffiths, & Tiffin, 1995b). One value of postcolonial discourse, in its response to colonialism, is that it provides a methodology for considering the dialogue of similarity and difference. However, this value is repudiated further on in this section of the chapter.

Most postcolonial science and technology studies focus on three aspects: the relationship between science and technological change within projects of European-American origins; the scientific and technological traditions of non-Western cultures; and the implications of the failures of 'development' caused by the North's attempts to increase the standard of living in the South by transferring northern sciences and technologies to the South (Harding, 2000). Postcolonial science and technology studies allow us to see a different picture of the past, present and future possibilities than were visible in the European "tunnel of time" accounts and brings into focus elements that were obscured or denied in older views (Harding, 2000).

In a postcolonial discourse, both western science and indigenous knowledge would be recognised as ways of thinking that are co-existent, incommensurate and culturally valid (Aikenhead & Ogawa, 2007). A concept in one culture might not exist in another culture, and Aikenhead and Ogawa state that not viewing one concept as 'the correct one' avoids a false dichotomy associated with colonial discourse. They also suggest the importance of minimising stereotyping and superficiality.

However, as with most theories, there are cautions that one must take when considering them. Dei (2000a) stated:

> Postcolonial theory has become a meta-theory by essentializing 'difference' and thus risks idealizing and essentializing the human subject by privileging the individuation of the self and subject. Postcolonial theory dehistoricizes human identities as totally fragmented, multiple and transient. (p. 116)

Ryan (2008) has suggested that the 'post' in 'postcolonial' does not mean that colonialism has ended but rather that the resulting aftermath has been contested. She further stated that neo-colonial interventions in education are seen through the activities of organisations such as the World Bank, UNESCO and AusAID. These organisations move into small countries often with negative results as the needs and conditions in the recipient country are ignored. However, Scott (1997) has suggested that there are shifts in knowledge and in the organisation of social life and that the balance of power has been tilted away from 'western' dominance towards an incorporation of local knowledges and cultures. Cloete and Muller (1997) stated that if there has been a change in balance, 'then we are finally able to move beyond the crippling dichotomous code of postcolonial discourse' (p. 4). Scott (1997) further stated that:

> So long as the intellectual and scientific culture of the West persisted in its universalising claims, other cultures were marginalised, obliged to choose between imminent (and irreversible) redundancy and angry ideological opposition. But these claims have been eroded from 'within', in the cognitive sphere, by the radical scepticism that has always been part of the Western tradition and the epistemological doubts that have emerged more recently; and from 'without', in the wider social and economic environment, by new patterns of knowledge production. As a result, the tension between Western and 'other', elite and democratic knowledge traditions has eased. Perhaps we no longer have to choose because perhaps we can no longer clearly differentiate them." (p20).

This blurring of boundary lines resonates with my viewpoint expressed earlier (see 2.3.2) that separating 'indigenous technology and culture' from other technologies in the curriculum promotes an 'us/them' dichotomy and this could marginalise indigenous technologies. It would be more beneficial to encourage a critical technological literacy in our learners (see 2.4.3). The theories of modernism, postmodernism and postcolonialism are relevant to this study as they explain the changing viewpoints towards 'indigenous technology and culture' that have occurred and continue to change and develop in the last two centuries.

2.3.4 Indigenous knowledge and the curriculum

Most of the literature I have read concerning indigenous knowledge and curriculum, deals with 'culturally responsive schooling for Indigenous youth' (see Battiste, 2002; Lambe, 2003; Sarangapani, 2003; Neegan, 2005; Brayboy & Castagno, 2008a). Brayboy and Castagno stated:

> The literature on culturally responsive schooling for Indigenous youth… comes out of other, even broader, bodies of literature on multicultural education, cultural difference, and improving the academic achievement of youth who are not members of the dominant cultural group in the US. One of the most general but direct definitions provided is that culturally responsive schooling is that which "makes sense" to students who are not members of, or assimilated into, the dominant social group. (p. 733)

One of the purposes of 'culturally responsive schooling' is to build a bridge between a child's home culture and the school in order to effect improved learning and achievement. Brayboy and Castagno stated that this type of schooling entails 'a number of important elements that relate to curriculum, pedagogy, school policy, student expectations, standards, assessment, teacher knowledge, community involvement and many more' (p. 733). They also stated that three topics that rarely get discussed are sovereignty, racism and epistemologies.

None of the literature indicated that the youth in culturally responsive schooling should learn tribal cultures and languages at the expense of learning mainstream culture and the typical academic subjects. This is an important point as it emphasises an inclusive, both/and approach rather than an exclusive, either/or one. Brayboy and Castagno (2008b) suggested that this possibly frames this approach as postmodern.

Bishop (2003) provided an alternative model to ‘mainstream’ education that emphasised:

> empowerment, co-construction and the critical importance of cultural recognition. This model constitutes the classroom as a place where young people’s sense-making processes (cultures) are incorporated and enhanced, where the existing knowledge of young people - particularly Māori – are seen as ‘acceptable’ and ‘official’, and the teacher interacts with students in such a way that new knowledge is co-created. (p. 221)

Neegan (2005) made recommendations on how ‘Aborigianl worldviews can be introduced in the education system in a respectful and honourable way, thereby bringing about their revitalization and reclamation’ (p. 3). Neegan wrote about education for Aboriginal children before formal schooling based on the European system was enforced. This education provided young people with the skills, attitudes and knowledge that they needed to function in everyday life. It was a natural process that occurred whilst doing everyday activities. Learning happened by first observing and then doing. For example, knowledge about fish spawning was, and still is, obtained by participating in fishing, storytelling, art and other related activities, and not by studying biology. Neegan wrote about the ‘conflict’ between the two educational systems. She stated ‘There is a deeply rooted, systemic problem in the schools that needs to be challenged’ (p. 10). Neegan gave the following recommendations on redressing historical marginalisation of Aboriginals in schooling:

- Curriculum planning must always take into consideration existing power relations and the multiple centres of power involved in the process of decision-making and implementation.
- Government, schools and institutions of higher learning must be committed to meeting the rights of Aboriginal peoples.
- Full support should be offered, through curriculum reform, to addressing the specific needs of Indigenous peoples including the introduction of Aboriginal languages.
- Schools need to collaborate and consult with Elders and the community so that Aboriginal worldviews and epistemology can be integrated in producing and the transmitting of knowledge.
- Aboriginal worldviews and ways of learning should be fostered both in classroom and the community based learning.
- Courses on Aboriginal peoples as well as other marginalized groups should be incorporated into the core curriculum rather than serve as an add-on.
- View everyone as a learner/teacher, i.e. both student and teacher. (p. 13)

It is interesting to note that Neegan’s sixth recommendation is that courses on Aboriginal peoples and other marginalised groups should be incorporated into ‘mainstream’ education. This is the case in the latest curriculum revision in South Africa in which indigenous knowledge is incorporated into the general curriculum for all South African learners. ‘Indigenous technology and culture’ and its incorporation into the general curriculum for South African learners is discussed in 2.4.4.

2.4 Technology Education

It was in the late 1980s that:

> industrial educators decided to revise and update their curriculum stories and rename them Technology Education. In some places Technology Education has been constructed as a separate subject for study and in others it is seen as an emphasis to be included in all subject areas. (O'Riley, 1996, p. 30)

So as a core subject in school curricula, Technology Education is a relatively new concept (Satchwell & Dugger, 1996). Satchwell and Dugger (1996) gave the following definition of Technology Education: ‘As a core subject, Technology Education strives to help students understand, use, and evaluate the effects of current and emerging technological devices and activities’ (p. 6). There have been, however, many different approaches to Technology Education. There are some who believe that teaching the use of tools is important, others who believe that conceptual knowledge should be the goal, some who believe in vocational education purposes whilst other believe in a general education approach, some hold engineering design as important, others aesthetic design (La Porte, 2007), and so it goes on. Hansen and Lovedahl (2004) discovered in their research described in ‘Developing technology teachers: questioning the industrial tool use model’, that there was a clear dichotomy of opinion as to the purpose of Technology Education. Technology Education teachers stated technological literacy as the goal whilst industrial technology/arts teachers stated career preparation as the goal. As Wicklein (1997) commented:

> The critical issue is, to what degree should the curriculum be devoted to technical skill training? Historically, educators within Technology Education have given an exorbitant amount of instructional time to this area while slighting many of the other facets of the curriculum. An appropriate balance of tool skills with other curriculum areas is a key to a healthy curriculum. (p. 75)

There has been much in the way of curriculum reform in Technology Education as a relatively new subject in many countries and this is briefly discussed in this section of the chapter. I have focussed specifically on the aspect of technology and its interrelationship with society and the environment in these reforms as this is pertinent to this study. This section concludes with a discussion on ‘technological literacy’.

2.4.1 An international perspective

Technology Education, known variously as technics, design and technology, and technological education, is a relatively new subject in schools. It has been implemented in countries such as the United States of America, New Zealand, Australia, England, Finland, Israel and South Africa. Most of these countries have undergone curriculum revisions, for example South Africa, Australia, England, and so are at different stages in their developing of Technology Education programmes (Rasinen, 2003). In most countries, Technology Education developed from the industrial arts subjects such as woodwork, metalwork, home economics and technical drawing. According to Erekson and Shumway (2006), this transition was due to the dramatic changes that technology and technological innovations brought to all aspects of society. It is relevant to examine the development of Technology Education in other countries as these countries have undergone a process of curriculum reform, and so it is relevant to this study to examine whether the relationship between technology and society has been incorporated into the various curricula.

According to Mitcham (1994), the philosophy of technology has two traditions: the engineering philosophy tradition which emphasises analysing the internal structure of technology and the humanities philosophy tradition which is more concerned with external relations and the meaning of technology. In other words, most theories of technology distinguish between technology as artefact and technology as social ideas, values and needs. Technology Education curricula in general have focused primarily on the engineering philosophy tradition, perhaps due to the roots of the discipline being in the technical curricula of the industrial arts subjects. The humanities philosophy tradition is more recent and its influence is evident in curricula revisions in some countries, such as New Zealand (Jones, 2003), the USA (ITEA, 2002), the Netherlands (Eijkelhof, Franssen, & Houtveen, 1998) and South Africa.

‘Design and Technology’ was introduced into the National Curriculum in England and Wales as a distinct academic subject in 1990, and it is claimed that they were the first countries in the world to make Technology Education compulsory for 5 – 16 year olds (Wilson & Harris, 2004). It was recognised as a multi-disciplinary subject and as Kimbell and Perry (2001) stated: ‘It is a creative, restive, itinerant, non-discipline’ (p. 19). From the documentation prepared by a Working Group, it was clear the Technology Education in these countries should focus on design and make activities as well as develop technological capability for all students. The curriculum guidelines stressed, amongst other aspects, that students ‘should be able to make critical appraisals of the personal, social, economic, and environmental implications of artefacts and systems’ (DES/WO (1988) as quoted in Wilson & Harris, 2004, p. 48). In a study conducted in England and Wales by Mittel and Penny (1997) of teachers perceptions of Design and Technology, it was found that many teachers constructed their Design and Technology programmes within a ‘craft’ paradigm. In the survey conducted with heads of departments at schools, it was found that ‘encouraging future citizens to be technologically aware’ was ranked fourth out of five possible statements in importance of purpose for Design and Technology. Craft training and skills development were the most commonly cited reasons given for the purpose of design and technology. By examining which text books are used and the use of design folios as an indication of the use of the design process, it was evident that there was still an overriding focus on craft and skills. There was no reference to the intrinsic value of Design and Technology. This lack of implementation, even with generous provision for funding for in-service teacher education, has addressed the conceptual, epistemological and essentially theoretical dimensions within Design and Technology Education. Even though this study was conducted in England, there are certain aspects which are relevant when examining the implementation of the new curriculum in South Africa schools, such as reasons for the lack of implementation and the focus on skills development (South Africa. Department of Education, 2009).

In the past decade, much has been done in the United States of America to articulate what it is that students should know and be able to do in the technology domain. One of the purposes of the ‘Technology for All’ project (1994 – 2003) was to establish technology as a core subject in the curriculum (Satchwell & Dugger, 1996; Dugger, 2002). The ‘Standards for Technological Literacy: Content for the Study of Technology’ project (1994 – 2003), developed by the International Technology Education Association with an international reference group, was motivated by the need for technological literacy for all citizens. The goal of this project was to create standards for Technology Education for grades K – 12. The standards define what students should know and be able to do in order to be technologically literate. These standards do not prescribe a curriculum to achieve these outcomes. The standards (International Technology Education Association, 2002) are organised into five groups as follows:

Understanding of the nature of technology:

1. The characteristics and scope of technology
2. The core concepts of technology
3. The relationships among technologies and the connections between technology and other fields.

Understanding of technology and society:

4. The cultural, social, economic and political effects of technology
5. The effects of technology on the environment
6. The role of society in the development and use of technology
7. The influence of technology on history

Understanding of design:

8. The attributes of design
9. Engineering design
10. The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving

Abilities for a technological world:

11. Apply the design process
12. Use and maintain technological products and systems
13. Assess the impact of products and systems

Understanding of a designed world:

14. Medical technologies
15. Agricultural and related biotechnologies
16. Energy and power technologies
17. Information and communication technologies
18. Transportation technologies
19. Manufacturing technologies
20. Construction technologies

Despite the international agenda of the ITEA, the ‘Standards for Technological Literacy’ (International Technology Education Association, 2002) are explicit in their orientation to the USA. There are no claims to universality which is in keeping with a postmodern approach (Williams, 2006). Of relevance to this study are standards 4 – 7. Three of the standards (4, 5 and 7) take a determinist stance – that is, they promote the view that technology has impacts on society. However, standard 6 requires students to understand how society has influenced the development and use of technologies, promoting a more critical theory of technology stance.

The main aim of Technology Education in New Zealand is to develop students' technological literacy (Compton & France, 2007). Research was conducted as 'it became increasingly evident that the nature of the technological literacy being developed by students was somewhat limited in breadth and depth and lacking in the level of informed critical analysis behind decision making' (Compton & France, 2007, p. 260). The results of the research were to argue for a strong sociological focus as key to supporting students' technological practice, and to move away from a technological literacy that had a 'functional' orientation to one that was 'liberatory' in nature. The result was that Technology Education was restructured to have three strands: Technological Practice, the Nature of Technology, and Technological Knowledge. The Technological Practice strand provides for students to undertake their own technological practice and to evaluate the technological practice of others. The Nature of Technology strand aims to develop a critical understanding of how technologies intervene in the world and how historical, social and cultural events influence technological developments. The Technological Knowledge strand provides for the development of key generic concepts required for technological practices (Compton & France, 2007). It is interesting to note that these three strands correspond directly with the three Learning Outcomes in the South African technology curriculum.

Rasinen (2003), in his comparative study of Technology Education curricula in Sweden, the Netherlands, France, the United States of America, Australia and England, noted that studying the effects of technology on society are emphasized, and Sweden, in particular, emphasises the importance of the history of technology. From the examination of technology curricula in different parts of the world, it is evident that there is a greater emphasis on the relationship between technology and society. What remains an issue though is whether this policy is put into practice in technology classrooms.

2.4.2 Technology Education in South Africa

Since 1994, education in South Africa has undergone fundamental transformation. The new curriculum, known as Curriculum 2005 (C2005), was the first single curriculum for all South Africans and it was the pedagogical route out of apartheid education (Chisholm, 2003). The first nine years of schooling, known as the General Education and Training Band (GET), became compulsory and it was in this band that Technology was introduced as a new learning area. The revised National Curriculum Statements (NCS), developed in 2002 for grades R – 9, were the result of a process of revision designed to strengthen and streamline the original curriculum statements. The guiding philosophy of C2005 was 'outcomes-based education', a controversial philosophy with links to the 'competency-based' approaches found in the vocational and work-based training areas (Stevens, 2005). Each learning area has its own 'learning outcomes' achieved by attainment of specific 'assessment standards'.

Technology has three Learning Outcomes. 'Technological Processes and Skills' are covered in Learning Outcome 1, 'Technological Knowledge and Understanding' in Learning Outcome 2 and of interest to this chapter is Learning Outcome 3 (LO3), which explores the interrelationships between science, technology, society and the environment. The inclusion of this outcome is in line with curriculum revisions undertaken in other countries such as New Zealand (Jones, 2003) and the United States of America (International Technology Education Association, 2002), which acknowledge the interrelationship between science, technology and society. It is noteworthy that the South African curriculum has added the aspect of 'environment' in the exploration of the interrelationships between science, technology and society. The achievement of Learning Outcome 3 will ensure that learners are aware of indigenous technology and culture, the impacts of technology, and biases created by technology (South Africa. Department of Education, 2002c). The 'impacts of technology' and 'biases created by technology' have been consistent throughout the curricula revisions that have taken place in South Africa since 1994. 'Indigenous technology and culture', however, only appeared in the final revised National Curriculum Statements, implemented in 2006. This inclusion is seemingly unique to South Africa.

The traditional approach of C2005 required learners in Technology to explore the 'positive and negative impacts of technology'. This approach addressed the outcomes of technology and cast technology in a perspective of cause and effect relationships which presented a technologically determinist, or at best, an instrumentalist view to learners. Technological determinism holds that everything is caused by a sequence of previous conditions and events, operating with regularity and, in principle, with predictability. It presents technological systems as 'ordered accordingly to materials, processes and laws that can be understood from an objective standpoint' (Pannabecker, 1991). Pannabecker stated that this notion of technological impacts is simple to understand and it has enabled the field to interpret technology in the context of society and culture, something which technology studies has long struggled to do (Russell & Williams, 2002). But one of the problems with the deterministic view is that studying impacts places the emphasis on a restricted point of the sequence of technological development. This view of technology has contributed to a simplistic and inflexible view of the relationship between technology and society and it has reinforced the idea that technology is an autonomous entity developed according to an internal logic which has determinate impacts on society (Williams & Edge, 1996; Russell & Williams, 2002).

The curriculum revision (NCS) implicitly challenged the simplistic, deterministic approach to some extent by suggesting that socio-cultural-ecological patterns are also embedded in the content and processes of technologies. The description for Learning Outcome 3 for Technology in the National Curriculum Statement: Technology (South Africa. Department of Education, 2002c) stated that:

> All technological development takes place in an economic, political, social and environmental context. Values, beliefs and traditions shape the way people view and accept technology, and this may have a major influence on the use of technological products. (p. 9)

The first part of this description implies that technological development is influenced by factors such as economics, politics, society and the environment, suggesting human's active role in the shaping of technology. The emphasis on context encourages learners to explore the challenges and influences faced in specific situations in terms of technological development. The second part of the description emphasises the interpretation of technology in the context of social influences. However, it restricts this social influence to the ‘use’ of technological products, thereby giving a deterministic view of technology. It neglects the fact that values, beliefs and traditions influence the way a technology emerges and develops.

2.4.3 Technological literacy

One of the goals of Technology Education in most curricula in different parts of the world is to develop students that are technologically literate (O'Riley, 1996; Rasinen, 2003), and in the USA, it is *the* intended outcome (Petrina, 2000). It is also the aim of the New Zealand technology curriculum (Ministry of Education, 1995). Borgmann (2006) stated ‘If we can teach our students technological literacy, we not only enrich their education, we also enable them to see what obstacles and opportunities they face in trying to remain educated persons once they have left school and for the rest of their lives’ (p. ix). Snyder (2004) claimed that by definition technological literacy is and has always been at the very heart of Technology Education. However, as Lewis and Gagel (1992) suggested, that ‘having set forth its commitment to technological literacy so unambiguously, the field of Technology Education has had the problem of trying to communicate just what technological literacy means’ (p. 132). More recently, Kahn and Kellner (2005) wrote:

> The ongoing debate about the nature and benefits of technoliteracy is without a doubt one of the most hotly contested topics in education today. Alongside their related analyses and recommendations, the last two decades have seen a variety of state and corporate stake holders, academic disciplinary factions, cultural interests and social organizations ranging from the local to the global weigh in with competing definitions of ‘technological literacy’. (p. 238)

Defining technological literacy is a contested area and this part of the chapter will examine the issues surrounding its definition.

Petrina (2000) stated that so-called literacies, such as computer literacy, scientific literacy, ecological literacy and workplace literacy, although they are constructs that are nebulous by design,

> are *not* impotent or meaningless. These constructs serve as links between action and ideology – they serve to govern some economic, political or social

> course of action. They are socially distributed and shared ideologically across groups with contradictory articulations and meanings. They help to diffuse a range of motives with popular appeal. This is to say that these constructs are 'always already' political. (p. 181)

For most technology educators, however, the construct of technological literacy is neutral (Petrina, 2000), and for the 'Technology for all Americans' project, technological literacy is simply 'the ability to use, manage and understand technology' (International Technology Education Association, 2002, p. 7). Even though there is considerable literature on the history of technological literacy (for example Lewis & Gagel, 1992; Waetjen, 1993; Jenkins, 1997; Petrina, 2000), literature on an emancipatory approach has only begun to emerge since the mid-1990s (Kahn & Kellner, 2005).

Dakers, Dow & de Vries (2007) gave the following description of technological literacy:

> Technology Education must engage with the development of informed attitudes about the impact that existing and emerging technologies will have upon their cultural development, as well as the potential and actual consequences these technologies will have upon the environment, both locally and globally. This is known variously as 'Technological Literacy' or 'Technological Capability'. (p. 7)

Dakers et al. conflate technological literacy and technological capability. Yet Petrina (2000) suggested that technological capability is 'simply the potential for efficient, practical, quality work in design' (p. 181). The New Zealand Curriculum Draft for Consultation (as quoted by Gawith, O'Sullivan, & Grigg, 2007) claimed that a 'broad, technological literacy' is encompassed by the three strands in their curriculum – Technological Practice, Nature of Technology and Technological Knowledge. According to Dakers (2006a), a genealogy for Technology Education shows roots firmly embedded within an industrial and vocationally orientated past. As a result, much of what happens in technology classrooms today addresses only the operational dimension of technology, with the focus on 'designing and producing for 'fitness for purpose' with an overemphasis on skills and competencies' (Michael, 2006, p. 49). According to Michael, in Technology Education as a subject taught in schools, there are assumptions made about the nature of technological knowledge and the humans that engage with it. Elshof (2007) suggested that the deterministic and instrumentalist frameworks are not without merit from the perspective of the marketing and business communities, but in regards to education, it privileges artifactual knowing above all other ways of knowing technology, such as social, ecological, political and relational. Elshof (2007) further claimed that it is unreasonable to expect students to see technology today as ‘anything but an ephemeral culture of relatively disconnected and short-lived disposable artefacts’ (p. 177), as their experiences inside and outside formal educational institutions reinforce these problematic notions. The dominant thinking in most formal educational institutions remains embedded within the deterministic and instrumental frameworks, due perhaps to the influences of the business and industrial sectors. This influence has encouraged a preoccupation in technology classrooms with the evaluation of artefacts in terms of effectiveness, which then gives a partial perspective of the artefact being evaluated.

The instrumental approach to Technology Education has led to much criticism by Technology Educationists, such as Williams (1996), Michael (2006), Dakers (2006b) and Compton and France (2007), as the focus on materialist, artifactual knowledge is restrictive and develops a technological literacy in our students that is narrow. It reduces the concept of technology to that of artefacts necessary for our needs and wants. One of the problems, as Hansen (1997) suggested, is that ‘an ontology directed towards the technological artefact tends to be reductionist, it excludes the complex dialectic of individual and cultural meanings’ (p. 52). Elshof (2007) agreed with this by stating that the siren call of Technology Education for economic competitiveness, higher achievement standards and curriculum standardisation across contexts, cultures and worldviews, is symptomatic of a broader failure to see the bigger picture. Many young people do not see technology in terms of the knowledge and processes that create the artefacts, nor are they aware of the implications for society and the environment that arise from the existence of these technologies (International Technology Education Association, 2002).

Another issue in Technology Education is the ‘taken-for granted’ phenomenon of technology. This has been well documented by theorists and educationists such as Winner (1977), Feenberg (2006), Keirl (2006) and Williams (2007). Michael (2006) asserted that it is the nature of our ‘mundane technologies’ and their ‘embroilment in sociotechnical ensembles’ that make them difficult to see and understand. This ‘taken-for-granted' phenomenon is perhaps why our pupils do not engage critically with the technologically-pervasive world that surrounds them. Technology Education cannot ignore this. Teachers should guide young people's learning towards developing a critical awareness of what it is to live in a technologically pervasive world.

According to Dakers (2006b), there is a lack of discourse in the technology classroom. This lack of discourse is symptomatic of the emphasis in Technology Education on in-depth manipulative competencies rather than cognitive and attitudinal competencies (Michael, 2006). Kierl (2006) stated 'since technology constitutes such a pervasive and hegemonic part of life on the planet, it is unacceptable that Technology Education currently constitutes such a minor part of the curriculum – especially as that which does exist mostly takes on mere instrumental and/or atomized forms' (p. 81). This missing literacy in Technology Education reduces the concept of technology to that of basic raw materials that will be transformed into artefacts perceived as necessary for our needs and wants (Dakers, 2006b). In fact, a hidden curriculum has been created that debars alternative, richer understandings and in doing so, enforces this status quo (Keirl, 2006). However, this problem is not limited to the Technology Education field. Some critical theorists, such as the feminist Rothschild (1982), though providing a powerful critique of 'technology', did so by limiting the critique to the technological artefact itself. This lack of discourse has also been levelled at philosophers and their lack of robust accounts of technology in their theories of modernity (Misa, 2003). So there seems to be a general malaise in all areas in regards to developing a critical stance to technology.

There are two opposing philosophies that can be translated into models for Technology Education. One of these philosophies views technology as neutral except for the value of efficiency. This would translate into a model that is technical, empirical, and rule driven. The task of Technology Education when presenting technology as a technical discipline will be to offer the instrumental skills and theoretical knowledge regarded as essential for solving technological problems. These solutions are then assessed in terms of efficiency and cost (Hansen, 1997). The other model is based on the philosophy of technology as value-laden and this leads to a model that is more hermeneutic and interpretive in nature. This model offers a more critical approach, and it will take a socio-cultural-political stance to explore the emergence of a technology along with its development and consequent impacts. It is my view, that elements from both of these philosophies are necessary if students are to develop a meaningful and holistic understanding of technology and technological development. Most technology teachers, however, need to see technology in a broader and deeper context than is often the case. Knowledge of the different theories of technology by learning material developers would contribute to deeper understanding of technology and its interrelationships with science, society and the environment and it would enable a critical dynamic in the technology classroom. According to Keirl (2006):

> what is called for is a critical ethical consciousness, articulated through a rich technological literacy which enables societies and their members to critique *all* phases of technologies' lives. Such a proposal cannot be some kind of technology audit or checklist but must, itself, be integral to our praxis, to our being in the world. (p. 90)

One of the issues mentioned previously is that the instrumental approach, with its focus on artifactual knowledge, has led to a technological literacy that is narrow and restrictive. It is restrictive in the sense that it reduces the concept of technology to that of artefacts necessary for our needs and wants, and ignores the broader social, cultural, environmental and political influences on technological development. Borgmann (2006), in the foreword to 'Defining Technological Literacy: Towards an Epistemological Framework', claimed that there is a need 'for a penetrating understanding of contemporary life' (p. ix) and the accomplishment of this is to be found in the social theory of technology.

Petrina (2000) suggested that technological literacy as a goal of Technology Education is often interpreted in an instrumental and self-serving way. Teachers need to bring a critical technological literacy into the lives of the students they are teaching. This should become a key concept in Technology Education. Technological literacy needs to engage students with critique in technology in such areas as community life, popular and traditional cultures, the world of work and manufacturing and the political world. The challenge here is that this approach needs to be transformed into practical agendas for teachers. This became evident in the focus group held with Andrew Feenberg at the PATT-18 conference in Glasgow, 2006. He suggested that students need to start questioning aspects such as: ‘What is meant by ‘progress’?’, ‘Does the technology being developed or used allow for better quality of life?’, ‘What is meant by ‘a better quality of life’?’ (FGS). Students need to debate these issues and this should then inform their designs and evaluations of technological artifacts.

I would like to suggest that much can be learnt from the critical literacy work associated with Shor (1999), Luke (2000), Lankshear (1993) and Willinsky (2007). Their work openly acknowledged the educational influences of critical theory. The larger educational influence of critical theory extends to the broader critical pedagogy field that informed the work of Giroux, Simon and others (Kincheloe, 2004). According to Lankshear and Knobel (1998), there are distinctions to be made between critical pedagogy, which is focused on teaching, and critical literacy, which is focused on language. Critical literacy formed at the intersection of critical theory and pedagogy with literacy studies (Knobel & Lankshear, 2002). Shor (1999), when it came to the question of what critical literacy was, stated that it is a means of redefining ourselves and remaking society through alternative rhetoric and projects, by questioning power relations, discourses and identities in a world not yet finished. He (1999, n.p.) stated ‘Critical literacy … is an attitude towards history’. Critical literacy is concerned with words and how they are used as a social force. Words are one type of social force, technology is another; but it is rarely recognised as such in the technology classroom. We need to ask ourselves how we can engage our students in critical discourse surrounding the technologies that are in use as well as new and developing technologies. Shor (1999) stated ‘When we are critically literate, we examine our ongoing development, to reveal the subjective positions from which we make sense of the world and act in it’ (n.p.).

Petrina (2000) resituates technological literacy in a critical tradition. He stated that a turn to critical technological literacy ‘means working to overcome forms of power sustaining inequities in the built world’ (p. 182). Petrina gave the following as having a critical literacy towards technology:

> (a) a critical orientation to representations of technological literacy;
> (b) the sensibility or critical *intention* to engage politically with technological practices such as those that sustain high rates of capital, consumption, inequities, and unegalitarian distributions of profit and waste; and

> (c) the political or critical *agency* to mobilise and produce actions and 'texts' that work against or 'jam' the discourses and works of culturally and ecologically destructive technologies. (pp. 200 – 201)

Literacies are situated in local practice and are therefore dependent on the critical selection of 'texts by sensible and politically sagacious teachers' (p. 201). So, in my view, the success of technological literacy rests with the successful implementation by teachers, and this is where the problem lies.

2.4.4 Technology Education and indigenous knowledge

There is no doubt that the inclusion of 'indigenous technology and culture' in the National Curriculum Statement: Technology (South Africa. Department of Education, 2002b) promotes the visibility of indigenous knowledge. The challenge for Technology Education in South Africa is how to put this policy into practice. Indigenous knowledge has been exposed as an extensive and valuable knowledge system. Battiste (2002), in her paper on 'Indigenous knowledge and pedagogy in First Nations Education' stated that 'what is required in First Nations education is a research that moves beyond rule-based learning and considers life-long learning, learning how to learn in diverse contexts, and ability to apply knowledge in unfamiliar circumstances' (p. 16). Battiste's article is about First Nations education having space for the indigenous peoples in Canada, so that they do not lose their culture. Although this statement is made in the light of a different education system for 'First Nations' learners whereas the South Africa curriculum includes indigenous knowledge systems as part of the main curriculum for *all* learners, some of the aspects from Battiste's article would be useful in developing an approach to including indigenous knowledge in learning materials for Technology in South Africa.

Nakata (2002) called the intersection of western and indigenous knowledge the 'cultural interface'. This cultural interface is a place of tension that requires constant negotiation as knowledge is dynamic. Nakata suggested that indigenous peoples need metaknowledge, which is knowledge about knowledge, as 'the basis for their interactions with the multitudes of intersecting, often conflicting or competing discourses emerging from different systems of Knowledge' (p. 286 – 287). I would like to suggest that this notion of metaknowledge should be used by technology teachers to ‘enable a better view of what impacts on and gives shape to daily decisions’ (p. 287). Teachers and learning material developers need to overcome the dichotomies created between western science and indigenous knowledge by using a heterogeneous, dynamic, plural notion of knowledge and culture.

We, as technology educators, should engage our learners in exploring the diverse contexts in which technologies emerge and develop, thereby encouraging them to work in unfamiliar contexts. Learning material developers should guard against oversimplifying or mystifying indigenous knowledge systems. Only using case studies to learn about ‘indigenous technology and culture’ could promote the view that these technologies are no longer in existence. It is my view that ‘indigenous technology’ should not be separated out in learning materials as this would create an incorrect notion in our learners of differentiation. The inclusion of ‘indigenous technology and culture’ in curriculum statements should enable educators to recognise that different knowledge systems can coexist, they can complement each other and they can be in conflict. Dei (2000a) suggested guarding against ‘a falsely dichotomous thinking between ‘Indigenous’ and ‘non-Indigenous’ knowledges’ (p. 120) by understanding that knowledges are not frozen in time and space. He stated ‘There is a continuity of cultural values from past experiences that helps shape the present. Similarly, the present also influences the narration of the past’ (p. 120).

Maluleke, Wilkinson and Gumbo’s (2006) article discussed whether the inclusion of ‘indigenous technology and culture’ was still relevant for inclusion in the Technology curriculum, and their argument was that due the extensive use of indigenous knowledge in South Africa by many of its inhabitants, it is relevant. The useful aspect of this study was the confirmation of the relationship between technology and culture made by the elders in this study. However, the inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement: Technology should not be simplifies. Nakata (2002) gave the following as some of the complexities when we begin to talk about indigenous knowledge as it connects to the academic domain: in documenting indigenous knowledge it is then treated in contrast to western scientific knowledge; the risk to the integrity of indigenous knowledge in its documentation; and the implications of different approaches used in the inclusion of indigenous knowledge into formal education processes’ (p. 289). It is different knowledges, concerns and priorities that will converge to inform and develop new technologies and practices. van Wyk (2002) agreed with that a critical stance is necessary as is evident in the following excerpt:

> IKS embodies ultimately a pedagogy that fosters cultural, social and identity criticism to validate the centrality of learners' experiences and how educators could support them to understand that their realities are socially constructed , and inevitably will be reconstructed as time goes on and exposure to different contexts are enhanced. (p. 311)

In conclusion, O'Riley (1996) commented:

> Rather than privileging too narrow a range of texts through standardizing curriculum, might it not be more beneficial for students to have multiple and different tools so that they can converse in the world as coding trickster, and become actors themselves, agents in the mediation of their own knowledges and subjectivities? (p. 36)

The inclusion of indigenous knowledge systems in the curricula of the democratic South Africa, after many years of apartheid, is significant and even though overtly political, it enables a multiple literacies approach to Technology Education.

2.5 Conclusion

It is now widely accepted in the philosophy of technology field 'that the technical is social, and social is technical' (Marshall, 2003, p. 130). MacKenzie and Wacjamn (1999: p. xvi) suggested:

> If the idea of the social shaping of technology has intellectual or political merit, this lies in the details: in the particular ways technology is socially shaped, in the light these throw on the nature both of 'society' and of 'technology'; in the particular outcomes that result; and in the opportunities for action to improve these outcomes.

However, Technology Education has been slow to adopt the viewpoints of the more phenomenological theories which would bring the social and cultural aspect into the classroom. There is an overemphasis on skills and competencies without much critical engagement so that students can explore what it is that will make their designs substantially different. The operational is emphasized at the expense of the cultural-symbolic (Keirl, 2006). But designing learning activities to get students to challenge assumptions is difficult as environments in which a technology is developed and used are complex and dynamic (Michael, 2006), so this remains a substantial challenge. Burkitt's definition (see p. 13) recognises the interrelationship between technology, society and culture as well as humans' reflexive powers which give them the capacity to adapt and change technologies. I would like to suggest that if students were given opportunities in a classroom context to critically engage with technologies this would encourage their reflexive reasoning thus giving them the opportunities to improve and change existing technologies, as suggested by MacKenzie and Wacjamn (see p. 72).

Hansen (1997) stated that 'a liberal Technology Education … needs a philosophy that illuminates the meaning of technology for individuals and society and that raises our comprehension of the interaction between technological knowledge and its cultural significance' (p. 50). He further stated that a critical approach is not only a necessary tool, but must also be a 'way of being' in the technology classroom. A critical theory influence would encourage students to be actively engaged in discourses surrounding the technological world by taking historical aspects into account, to think about what they say about our world, why they say it, and whether the view they promote should be accepted. Students need to engage in debate and discussion on the issues surrounding technology, but they also then need to step beyond the critiquing and suggest alternatives and possibilities.

The view that indigenous knowledge is a valuable resource has been relevant to those involved in the fields of sustainability and development. However, the differentiation between indigenous knowledge and western science has created a problematic dichotomy. Some authors place the two 'ways of knowing' in opposition to each other, which is unhelpful. The inter-epistemological dialogue between indigenous knowledge and western science is necessary in education so that learners can consider how the science in indigenous knowledge can be explained using western science perspectives and how western science perspectives can be illuminated through indigenous ways of knowing (O'Donoghue, 2007, August 23, personal communication). The inclusion of 'indigenous technology and culture' in the South African curriculum is significant as it provides an opportunity for this inter-epistemological dialogue to take place in a classroom context, encouraging students to be actively engaged in discourses so that they, as Hansen (1997) suggested, can think about what they say about our world.

The ever-strengthening sense that a philosophy of technology is beneficial to technology education as it enables those working in the technology education field to draw on deeper discourses and debates (Keirl, 2006) is important for this study as it promotes a critical evaluation of the different approaches to the nature of technology to be made. As already stated, it was obvious from the PATT-18 conference held in Glasgow in 2007 that the philosophers of technology have adopted a critical socio-cultural perspective of technology but the dominant thinking in educational institutions is rooted in instrumental and deterministic frameworks (see p. 19). The inclusion of ‘indigenous technology and culture’ in the South African curriculum, taking into account the various issues surrounding this inclusion, could provide an opportunity for a more critical socio-cultural approach to technology.

CHAPTER 3

GOALS OF THE RESEARCH AND PROFILE OF THE RESEARCH SITE AND PARTICIPANTS

3.1 Introduction

This chapter serves to explain the factors that led to the study, and it describes the schools and teachers who participated in the study. Justification for the sample is given. The chapter concludes by giving the researcher's background.

3.2 Impetus for the study

There have been three main curriculum reforms since the first democratic elections in South Africa in 1994. The first was the cleansing of the curriculum of racist language and controversial content; the second included the launch of Curriculum 2005, a new national curriculum named after its intended implementation date; and the third was the review of C2005 which resulted in the National Curriculum Statement (NCS), implemented fully from Grade R to Grade 9 in 2006 and up to Grade 12 in 2008 (Chisholm, 2005).

C2005 introduced eight learning areas, of which technology was one. So for the first time, technology was to be part of every learner's education from Grade R to Grade 9. However, as C2005 did not emerge from a 'situational analysis', or debates about the about the most appropriate forms of pedagogy, or what was feasible in the diverse and unequal range of schools in South Africa, the new curriculum 'emerged as a *political and not pedagogical* project' (Harley & Wedekind, 2004, p. 198, original emphasis). Teachers found themselves in a new curriculum 'paradigm'. C2005 received support from teachers but this was largely due to teachers believing it would achieve equity and redress (Vally & Spreen, 1998).

Two years into the implementation of C2005, a curriculum review was conducted. The main issue was outcomes-based education and its nature and manifestation in C2005 (Chisholm, 2003). The Ministerial Review Committee, appointed in 2000 and chaired by Linda Chisholm, gave a wide-ranging critique of C2005. The resultant report identified a number of weaknesses, such as lack of alignment between curriculum and assessment policy; inadequate orientation, training and development of teachers; policy overload and limited transfer of learning into classrooms; and inadequate recognition of curriculum as the core business of education departments (Chisholm, 2003). According to Chisholm, these weaknesses were associated with implementation of the curriculum rather than with outcomes-based education.

The report by the Ministerial Review Committee was highly controversial. One of the controversies arose from the recommendation to reduce the number of learning areas by integrating science and technology into one learning area and economic and management sciences into life skills. Due to the controversy, Cabinet made the final decision on the recommendations of the report, and they rejected the proposal of the reduction of learning areas. These recommendations by Cabinet were highly symbolic and:

> by reinforcing these, Cabinet simultaneously sent out two messages: first, its pragmatism on issues of educational reform and second, its alignment with symbols of modernity. (Chisholm, p. 5)

A draft revised curriculum was developed and released for public comment in July 2001. In the draft curriculum, learning outcomes were similar but reduced. There was a strong reaction to this draft, especially from a religious constituency (Chisholm, 2003). A Public Hearing on the Curriculum was held on 12th November, 2002, to which various stakeholders were invited, such as various religious organisations and the teacher unions. A consensus was formed firstly around outcomes-based education and secondly around values oriented to a diverse and democratic South Africa. The revised curriculum was finally submitted to Cabinet. What is of note in this study is that ‘indigenous technology and culture’ appeared for the first time in the revised National Curriculum Statements. It did not appear in the draft, so there was no prior orientation for teachers that this aspect was to be a part of the curriculum. As a result, teachers and schools were not well prepared for this inclusion. One of the purposes of this study is to unravel the issues surrounding the implementation of ‘indigenous technology and culture’.

The impetus for this study arose from the dilemma I faced, as a Technology teacher in an independent school, when I had to implement the revised National Curriculum Statement: Technology. At the time of implementation, I had been teaching technology for eight years and during this time had experienced three different curricula – developing my own curriculum in the initial stages of the introduction of technology as a subject at the school in which I teach, Curriculum 2005 and the Draft Curriculum Statement. With the now revised National Curriculum Statement: Technology, I faced personal dilemmas of not knowing what to do in my lessons, not understanding fully what the Technology curriculum document meant by the word 'indigenous', not having any resources from which to draw as a teacher and having difficulty with how to link 'technology' and 'culture' when developing learning materials.

3.3 Goals of the research

The primary goals of the study were firstly to explore the rationale for the inclusion of 'indigenous technology and culture' in the Technology curriculum statements, then to find out how technology teachers were dealing with this aspect in their classrooms and finally to account for how the focus group discussions assisted a selected group of teachers' classroom practices and their understanding of policy documents. This study therefore used an interpretive qualitative inquiry approach.

The three questions that guided this study were:

- How is the aspect of 'indigenous technology and culture' being proposed for Technology Education processes in policy documents?
- What is the existing pedagogical practice in regard to this aspect of the curriculum?
- Does a process of participatory co-engagement with selected teachers, with reference to 'indigenous technology and culture' in the technology curriculum, impact on teaching practice?

These three questions targeted three main foci for data collection: policy and other texts that deal with Technology Education; curriculum developers; and a selected focus group of technology teachers. The main data sources were the curriculum statements and Learning Area policy documents; Grade 9 Technology learning materials; questionnaires sent to the curriculum developers; the interviews and discussions with the selected focus group of technology teachers; and the focus group discussion held at the PATT-18 conference in Glasgow, Scotland in 2007.

3.4 Profile of the research site

In this section, the schools that participated in the second and third phase of the research are described in terms of their location, whether they are single-sex or co-educational schools, and their histories (all three phases are discussed in detail in 4.4). The history of independent schools and the changing profiles of this sector of schooling are also described.

The five schools selected to participate in the focus group are from the independent school sector, with the exception of one school. This school is a state school but it participates in the Independent Examination Board’s assessments. Two of the schools belong to the Independent Schools Association of South Africa (ISASA), one belongs to the Catholic Schools Board (CSB) and the fifth school is an independent Jewish school. The reason that these schools were chosen is that all but one belong to the same ‘cluster group’ for the Independent Examination Board’s assessments. All the schools are in the northern suburbs of Johannesburg. Non-probability samples were selected for the study. Cohen and Manion (2000) stated that this selectivity is derived from ‘the researcher targeting a particular group, in the full knowledge that it does not represent the wider population; it simply represents itself’ (p. 102). This type of sampling was chosen as no attempt at generalising (see Chapter 4.7) was envisaged for this study, as is often the case for case study research. Both purposive and convenience sampling were the types of non-probability methods chosen. Purposive sampling is when researchers handpick typical cases to build up a sample to specific needs and convenience sampling involves choosing the nearest respondents so that the researcher can have easy access (Cohen et al., 2000, p. 103). I chose the schools from my cluster group with one additional school from another cluster region, as these schools provided easy access due to their proximity to each other. The definition and purpose of ‘cluster groups’ are given further on in this chapter (see pg. 79). This enabled the focus group to meet more easily and readily than if they were spread across Johannesburg or elsewhere. Cluster groups have to meet on a regular basis, normally three times a year. This enabled the focus group to meet regularly to discuss Independent Examinations Board matters as well as participate in focus group discussions. I have a good professional relationship with the technology teachers as most of the teachers have been working together since the ‘clustering’ of schools came into being to facilitate the moderation of the national assessment at Grade 9 level in 2003. The implementation of the National Curriculum Statement was incremental, starting with Grade R to Grade 3 in 2004, and with full implementation from Grade R to Grade 9 in 2008 (Independent Education Board, 1994), although the schools in the cluster group implemented the curriculum much earlier. The sample was also purposeful: the participants were chosen as they were all Grade 9 technology teachers.

In South Africa, there are two school sectors: independent and public. The South African Schools Act of 1996 makes provision for this. Statistics for 2006 (South Africa. Department of Education, 2008) stated that there were 12,3 million learners in the schooling system. In 2006, there were 26 269 schools of which 95,7% were state schools and 4,3% independent schools. Since the 1990s, there has been significant change to the independent school profiles in terms of their sizes, diversity and socio-economic spread (du Toit, 2004; Hofmeyr & Lee, 2004). Independent schools are diverse with a wide range of religious (for example Catholic or Jewish), ethnic (such as Greek and German) and philosophical (for example Montessori and Waldorf) orientations. The socio-economic spread has also diversified considerably. Dominating the landscape with more than half of all independent schools are smaller, predominantly ‘African low-to-average fee schools’ (du Toit, 2004). There has also been an increase in the number of learners at independent schools. Between 2001 and 2006, the percentage of learners in independent schools grew from 2.1% to 2.9% (South Africa. Department of Education, 2008). Patel (as quoted in du Toit, 2004), however, disputed the claim of significant growth in the independent sector and suggested that this growth was due to the formalisation of what had previously been unregulated growth. When the 1996 South African Schools Act (South Africa. Department of Education, 1996) enabled a legal and democratic framework for registration, many schools that had been operating for years became legally registered.

Nevertheless, 61.1% of all independent schools registered after 1990 (du Toit, 2004). It is interesting to note that religious schools are the largest sub-category of independent schools at 43%, as four of the schools in the focus group are a Catholic, Jewish, Anglican and Christian school.

The Independent Examinations Board, set up in 1988, is a non-governmental association governed by a board. It plays a professional management role by supporting, overseeing and administering curriculum policy implementation in the schools that write its Grade 9 and Grade 12 examinations. Of concern to the independent school sector, was when in 1999 Minister Asmal announced the state's wish to have greater control over this sector. The Education Laws Amendment Act No. 50 of 2002 granted the Minister regulatory powers over curricula and examinations as well as other areas for both the independent and public sectors. This Act brought to the fore the issue of 'where regulation of private education is justified, and where such intervention becomes an infringement on the right of schools to exist and retain sufficient independence to fulfil their distinctive missions' (Hofmeyr & Lee, 2004, p. 164). Independent schools are free to organise their teaching, learning and assessment in the way they believe will provide the best education for their learners, as long as the learners achieve the minimum outcomes and standards as set down in the National Curriculum Statement (NCS). Some schools, for example, choose to write the International Baccalaureate or the Cambridge International examinations. Most independent schools write the Independent Examinations Board assessments at Grade 9 and Grade 12 levels. Grade 9 and Grade 12 are the two possible exit points for learners in South Africa.

The Independent Examinations Board appoints schools to a 'cluster' in order to enable standardisation in assessment processes as well as sharing of ideas. A cluster group consists of

> teachers who teach the same LA at Grade 9 level, and who meet together on a regular basis, to support one another, to share experience and to ensure that standardisation of SBA and Continuous Assessment (CASS) occurs. Cluster groups form an extremely important part of the CASS process. (Independent Examinations Board, 1994, p. 13)

The Independent Examinations Board further stated:

> A minimum of two meetings should take place each year, after school or on Saturdays. All schools must be represented at these two meetings. The purpose of the first meeting is to standardise the type of tasks being set for the portfolio work as well as the criteria used for assessment. (p. 13)

For our cluster group, the reality is that due to the schools allocating such different times for technology (see Table 3.1), standardisation has always been impossible. One school allocates thirteen hours per year to technology whilst two other schools allocate seventy-two hours per year. The purpose of the cluster groups is to:

- provide teacher development opportunities
- develop support for teachers in LAs
- monitor progress in portfolio work
- ensure standardization of the moderation process
- help with the development of learner support material

(Independent Education Board, 1994, p. 14)

The cluster group to which I belong was therefore an ideal choice for a focus group.

Four of the schools selected for the focus group were members of the same cluster group as me, the researcher. The fifth school was chosen due to its proximity to the other schools and the willingness and desire of the technology teacher to be part study. The schools have different historical backgrounds and are therefore reasonably diverse in their approaches to curriculum implementation. A description of the schools is given in Table 3.1.

	Gender	**Grades**	**Religious/cultural affiliation**	**Time allocated to technology**
School A	Single sex (girls)	Grade R to Grade 12	Christian	72 hrs/year
School B	Single sex (boys)	Grade R to Grade 12	Anglican	18 hrs/year
School C	Mixed sex	Grade R to Grade 12	Catholic	72 hrs/year
School D	Mixed sex	Grade 8 to Grade 12	-	36 hrs/year
School E	Girls and boys are taught on different campuses for religious reasons	Grade 7 to Grade 12	Jewish	36 hrs/year

Table 3.1: Profile of the schools

Both School A and School B are independent, single sex schools. They are well-established being over 100 years old. School A has 940 pupils from Grade 0000 to Grade 12. It is a Christian school and is a member of the Independent Schools Association of South Africa (ISASA). The school writes the assessments set by the Independent Examinations Board. School B has 1300 pupils from Grade 0 to post-secondary level and is also a member of ISASA and the Independent Examinations Board. This school allocates only 18 lessons per year to technology. School C is a co-educational, Catholic school that was founded in 1889. In 1979, after a decision by the Catholic Bishop's Conference, the school opened its doors to children of all races which was against the apartheid government policy of the time. This school is proud of its diversity and the stance it took during the apartheid years. It belongs to the Catholic Schools Association and writes the Independent Examinations Board examinations. Schools A, B, C and E do not receive funding from the government. School D is a mixed sex school that receives funding from the government and draws its pupils from the diverse nationalities that reside in the flatland area of Hillbrow. It was built in 1886 as a school for white girls, and it reopened in 1993 intent on including pupils of any creed or culture. It has a 1000-strong pupil body and 11% of these pupils are refugees from Mozambique, the Democratic Republic of Congo and Zimbabwe. Only 45 % of the pupils pay fees and it therefore does not have many available teaching resources. School E is an independent, orthodox Jewish school. Boys and girls are taught separately for religious reasons. Class sizes are small, ranging from 3 to 12. In 2009, there were a total of 57 pupils in this school from Grade 7 to Grade 12. This school is not a member of ISASA but it does write the Independent Examinations Board assessments and examinations.

This section of the chapter has highlighted the diversity of the schools chosen for the focus group. All the schools participate in the Independent Examinations Board assessment processes and meet regularly for cluster group meetings.

3.5 Profile of the participants in the focus group sessions

The study used two different focus groups. The one focus group consisted of five technology teachers from independent schools in Johannesburg. This group participated in three focus group sessions as well as individual interviews. The second focus group consisted of interested participants from the PATT-18 conference held at the University of Glasgow in 2007 to discuss the interlinking of philosophy of technology with Technology Education and the implications for Technology Education. Part of this focus group discussion centered on ‘indigenous technology and culture’ and this added depth to the exploration of the meanings and interpretations of this aspect. The profile of the participants of these two focus groups is discussed in this section of the chapter.

3.5.1 Profile of the teachers participating in the study

When the focus group discussions started in 2007, there were five teachers who were prepared to be part of the study. This group remained unchanged during the two years in which the focus group met. This enabled debate and discussion to take place as well as continuity. The group, except for one participant, were already a cohesive unit due to being placed together to form a cluster group for the Independent Examinations Board for the moderation of the General Education and Training Band (GET) examinations at Grade 9 level. Table 3.2 profiles these teachers in terms of experience, qualifications and other teaching subjects. The information was obtained through interviews with the individual teachers at the start of the two years. The teachers in the focus group gave permission for their first names to be used and not pseudonyms. The names of the schools that they teach at will remain anonymous.

	Teaching experience in years	Teaching technology experience in years	Gender	Qualifications	Other subjects taught
Karen	15	4 - 5	F	BSc, HDE	Physical Science, Home Economics
Anne	28	1	F	BA, PGSCE	Geography
Vivien	26	6 - 7	F	BSc	Home Economics
Vincent	+5	+5	M	-	Arts and Culture, Natural Science
Judith	3	3	F	BFA	Arts and Culture

Table 3.2: Profile of the teachers participating in the study

All the teachers, except for one, are university graduates. Two of the teachers do not possess a professional teaching qualification, although one teacher is qualified as an Adult Education teacher. What is of note here though is that not one of the teachers is trained as a technology teacher. The extent to which this effected their implementation of 'indigenous technology and culture' is discussed in Chapter 5. Four out of the five teachers are female. The teachers are diverse in terms of teaching experience. They are also diverse in terms of their qualifications, ranging from degrees in Fine Art to Physical Science. The influence of this on their teaching of 'indigenous technology and culture' is discussed in Chapter 5. The positions that these teachers hold within the school system are varied. One technology teacher is a deputy head, two are heads of department, and the others are classroom teachers. One teacher is part-time and the others full-time.

In 1998, when Technology was introduced into schools as part of Curriculum 2005, there were few formally trained technology teachers in the system. Those that had received some training had attended courses run either by Non-governmental organisations (NGOs) or by a nationally appointed task team (Mothupi & Stevens, 2006). Now training takes place in Higher Education Institutions, where prospective teachers may enrol for a part-time, two-year Advanced Certificate in Education (Technology) or a part-time, three-year Bachelor of Education degree course. Another option for students is to enrol for a three- or four-year degree course and then to complete a one-year post-graduate certificate in education (PGCE). In this programme, technology is often offered as an option, but since very few universities offer undergraduate courses in 'technology' or any cognate course, very few technology teachers have emerged from this system (Stevens, 2005). It is interesting to note that not one of the teachers in the focus group has any formal training in technology. The differences in terms of qualifications and teaching experience of the participants, mentioned in the previous paragraph, enabled interesting discussions in the focus group sessions.

3.5.2 Profile of the participants in the focus group session at the PATT-18 conference

This focus group session was one of a few that were held at the PATT-18 conference on Friday 22nd June, 2007 at the Faculty of Education, University of Glasgow. The title of the conference was ‘Teaching and learning technological literacy in the classroom’. The purpose of this focus group session was to have a discussion led by Andrew Feenberg and chaired by Steven Keirl on the implications of a philosophy of technology for Technology Education. Two recordings were made of this focus group session: one by the Faculty of Education at University of Glasgow and another by me. Permission from the participants was obtained before the session. They were informed of my study and asked if the data could be used for this research. The names of the participants and their institutions are listed in Table 3.3.

Andrew Feenberg	Simon Fraser University, Canada
Steven Keirl	University of South Australia, Australia
Leo Elshof	Acadia University, Canada
Marion Rutland	Roehampton University, England
Vicki Compton	University of Auckland, New Zealand
Ruth Conway	Retired, England
Sugra Chunawala	Homi Bhabha Centre for Science Education, India
Sonja Vandeleur	Roedean School, South Africa

Table 3.3: Participants in the focus group session with Andrew Feenberg held at the PATT-18 conference, 22nd June 2007.

The participants come from different parts of the world and they have varying foci of speciality within Technology Education. Andrew Feenberg holds the Canada Research Chair in Philosophy of Technology in the School of Communication at Simon Fraser University, Canada. He is the author of *Transforming Technology* (Oxford University Press, 2003), *Questioning Technology* (Routledge, 1999) and *Alternative Modernity* (University of California Press, 1995) and co-editor of *Modernity and Technology* (MIT Press, 2003). Steve Keirl lectures in design and Technology Education, ethics and critical enquiry at the University of Southern Australia. He has taught design and technology in England and Australia and he was a member of a taskforce for the national investigation into the Status of Technology Education in Australian Schools. Leo Elshof lectures in Technology Education at Acadia University in Canada with a focus on ‘eco-technology’. Marion Rutland lectures at Roehampton University in England and her interest has been in food technology and creativity in Technology Education. Vicki Compton from the University of Auckland in New Zealand was part of a team that developed a draft curriculum for Technology Education with the purpose of developing a deeper, broader and more critical technological literacy in students at school level. Ruth Conway was a physics teachers and she has authored a book *Choices at the heart of technology: a Christian perspective* (Trinity Press International, 1999). She is co-founder of VALIDATE, an informal network of technology educators interested in values and ethics in design and Technology Education. Sugra Chunawala's research interests lie in attitudinal studies of students and teachers, and gender and technology. She is also involved in curriculum development at the Homi Bhabha Centre for Science, Mumbai.

3.6 Researcher's background

Patton (2002) contends that the qualitative researcher's capacity to make effective inquiry depends on his/her proximity to the programme and procedures through which he/she develop opinions as they interact with people and materials. What the researcher deems as interesting depends on his/her perceptions of meanings from the field. As Marshall and Rossman (1999) stated:

> In qualitative studies, the researcher is the instrument. Her presence in the lives of the participants invited to be part of the study is fundamental to the paradigm. Whether that presence is sustained and intensive as in long-term ethnographies, or whether relatively brief but personal as in in-depth interview studies, the researcher enters into the lives of the participants. (p. 79)

This section of the chapter gives my background and involvement in the field of Technology Education.

After I completed my B.Ed honours degree at the then Randse Afrikaans University (RAU), which recently merged with the Witwatersrand Technikon to form the University of Johannesburg (UJ), I was invited to enrol for a new masters degree in Technology Education. I completed the degree part-time within two years. During this time, I was teaching Information Technology at an independent school. Whilst I was completing my masters degree, the school built a Technology Centre and I applied for the post of technology teacher and head of department and have been in this post since then. I have been involved with the Independent Examinations Board since 2001. Initially I was part of a team to develop what was known as ‘validation’ assessments for Grade 9. These assessments intended to incorporate all eight learning areas of Curriculum 2005 in a two hour examination. They were used for research purposes to assess whether the results from the validation paper correlated with the pupils writing separate examinations in all eight learning areas. In 2004 I was invited to develop a Common Task for Assessment (CTA) for Grade 9 for Technology. This model was then adopted by the Department of Education for their national Grade 9 assessment. I was part of an initial national team which developed the first CTA for all Grade 9 learners in South Africa. The development took three weeks with many debates and discussions centring on what the essence of technology as a subject should be and how this should be assessed. Up until 2008, I was involved either as an examiner or a moderator in the development of the Technology CTAs. I have also given many presentations at the Technology Association conferences and have attended three international PATT conferences and presented at two of these. At the SAARMSTE conference in January 2009 my papers on ‘The Nature of Technology and Indigenous Technology and Culture: Some preliminary perspectives’ and ‘‘Indigenous technology and culture’ in the Technology curriculum: issues around definition’ were peer-reviewed. I am co-author of ‘All Aboard Technology’, a textbook published by Heinemann for Grade 9. I have co-authored with Marc Schäfer, a chapter for a book to be published in 2010 by Sense Publishers. The book relates the last twenty years of primary Design and Technology Education internationally and our chapter contribution is titled ‘Indigenous Technology and Culture’. I have therefore been involved in Technology Education since 1998 and consider myself a passionate and dedicated Technology teacher.

3.7 Conclusion

This chapter has profiled the participants involved in the focus group sessions and the schools in which they teach. My decision to use the Independent Examinations Board cluster group to which I belong as a focus group was justified and my background as the researcher was given.

CHAPTER 4
RESEARCH DESIGN AND METHODS

4.1 Introduction

The purpose of this chapter is to describe and justify the methodology, design and methods used in conducting this research. This chapter describes how a constructivist framing has informed the research process and its design. Chapter 4 covers data generation methods, such as document analysis, interviews, focus groups and questionnaires; and how the evidentiary base was established. It concludes by discussing the issues surrounding qualitative designs and how the study deals with these concerns.

4.2 The research orientation

Guba and Lincoln (1994) analyse four research inquiry paradigms: positivism, post positivism, critical theory and constructivism. 'Paradigm' for this study is taken to mean 'a basic orientation to theory and research' (Neuman, 1997, p. 62). Guba and Lincoln suggest that the four paradigms are the major paradigms that frame research and that these inquiry paradigms are sets of beliefs about the nature of reality. These beliefs can be summarised by the responses given to three fundamental questions. The ontological question is 'What is the form and nature of reality and, therefore, what is there that can be known about it?'; the epistemological question 'What is the nature of the relationship between the knower or would-be knower and what can be known?' is constrained by the answer given to the ontological question; and the methodological question asks 'How can the inquirer (would-be knower) go about finding out whatever he or she believes can be known?' The response to this question is once again constrained by the responses to the other two questions: the methodology has to be appropriate. Heron and Reason (1997) have added a fourth fundamental question: the axiological question, which asks 'What is intrinsically valuable in human life, in particular, what sort of knowledge, if any, is intrinsically valuable?'. Giddings and Grant (2006) suggested that it is often the axiological positioning of a researcher that is the determining factor in the research decision-making process. This chapter set out to respond to these four questions.

The first two of Guba and Lincoln's paradigms, the positivist and post-positivist paradigms, 'work from within a realist and critical realist ontology and objectivist epistemologies, and rely upon experimental, quasi-experimental, survey and rigorously defined quantitative methodologies' (Denzin & Lincoln, 1994p. 13). Critical theory paradigms, such as the feminist and Marxist models, adopt a materialist-realist ontology, subjectivist epistemologies and naturalistic settings and data and findings are examined for their emancipatory applications. This research adopted a constructivist paradigm, as according to Alexander (2008), qualitative inquiry is grounded in constructivism, 'an alternative epistemology to the positivist orientation of quantitative research' (p. 117). Constructivism is 'the doctrine that complex mental structures are neither innate nor passively derived from experience, but are actively constructed by the mind.' (Mouton, 1996, p. 46). Constructivist theory is based on a relativist view of being and it holds as fundamental the premise that multiple, socially-constructed realities exist in which the knower and subject create meanings (Denzin & Lincoln, 1994; Smyth, 2006). The constructivist model is one that assumes 'a naturalistic (in the natural world) set of methodological procedures' (Denzin & Lincoln, 1994, p. 14). In this study, the constructivist paradigm permeates the research methodology. The data collection used multiple methods which led to a 'more valid, reliable and diverse construction of realities' (Golafshini, 2003, p. 604). The research questions (see Chapter 1) determined the methods selected so that rich and relevant data could be gathered. These methods included questionnaires, document analysis, interviews and focus group discussions. Interviews are one of the prevailing methods in qualitative research design (Hoepfl, 1997). Observations were not used for data collection purposes as the study set out to examine and explore teachers' perceptions of their existing practice and their perception of knowledge recontextualisation that took place through a process of participatory co-engagement. The study did not therefore explore and examine classroom practice, but rather the teachers' perceptions of their practice and the issues around implementation of 'indigenous technology and culture'. The data analysis was inductive which means 'that patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis' (Patton, 1980, p. 306).

For this study, a critical theory of technology as defined by Feenberg (1991) (see Chapter 2) is not dealt with as a separate paradigm to the constructivist paradigm, as suggested by Guba and Lincoln (1994), but rather as a supporting one. Stufflebeam (2008) suggested that the constructivist approach 'rejects the tenets of logical positivism and instead embraces phenomenology and critical theory' (p. 1395). Similarly, in a focus group session with Andrew Feenberg at the PATT-18 conference in Glasgow, 2007, although he was discussing philosophies of technology, he concurred with these paradigms as being supportive by stating 'I wasn't really thinking about social constructivism as a philosophy of technology, but in fact it does really exemplify what I call a critical approach'. It is this critical approach under the constructivist paradigm that is central to this study. To summarise, the constructivist paradigm assumes 'a relativist ontology (there are multiple realities), a subjectivist epistemology (knower and subject create understandings), and a naturalistic (in the natural world) set of methodological procedures' (Denzin & Lincoln, 1994, p. 14).

4.3 The research design

Any inquiry is guided and shaped by the choice of paradigm. This study, with its focus on understanding what teachers are making of the inclusion of 'indigenous technology and culture' in the technology curriculum, needed a research approach that would provide sufficient scope for understanding this phenomenon in all its complexity. This study therefore used a qualitative paradigm for its methodological approaches. Hitchcock and Hughes (1995) wrote:

> It has been our view for some time that the processes of education, teaching and learning are so complex and multifaceted that to focus only on cause and effect, products, outcomes or correlations in research on schools is of limited value. The complexity of education demands the use of very many different research techniques and models. The most productive approach we believe it is a qualitative one. (p. 25)

Hitchcock and Hughes further stated that a qualitative orientation focuses on context, meaning, culture, history and biography. It is this focus that is appropriate for this research and the reason a qualitative approach has been chosen. A qualitative approach recognises that 'what goes on in our schools and classrooms is made up of complex layers of meanings, interpretations, values and attitudes' (Hitchcock & Hughes, 1995, p. 26). This approach is therefore multifaceted as described by Denzin and Lincoln (1994). It is a set of interpretive practices which privilege no single methodology. This approach is difficult to define clearly as it has no theory or paradigm that is distinctly its own. In fact, as stated by Denzin and Lincoln, multiple theoretical paradigms, such as constructivism and cultural studies, use qualitative research methods and strategies. The choice of qualitative paradigm is therefore an appropriate one as it is more adaptable than the quantitative paradigm in dealing with multiple realities.

As discussed in Chapter 1, the best way to examine the subjective experiences of teachers was through an in-depth, interpretive design. Cohen, Manion and Morrison (2000) stated: 'the interpretive paradigms strive to understand and interpret the world in terms of its actors' (p. 28). This study is an interpretive case study that predominantly uses qualitative data. Quantitative methods are used to organise data, such as in the textbook analysis, but these methods are not used in the analysis of this data. In an interpretive design, meanings and interpretations are important. Mottier (2005) suggested that the interpretive turn in research 'rehabilitates subjectivity' and data collection is viewed as a mutual construction of meaning where the researcher is engaged in double hermeneutics. Giddens (1976) described the 'double hermeneutic' as a situation in which researchers strive to interpret and operate in an already interpreted world, in other words the researcher constructs interpretations of interpretations. In this study, policy documents and the perceptions of the participants in their interpretations of these documents were interpreted. In this sense, my interpretation is a 'triple hermeneutic', as I interpreted the perceptions of the participants in their interpretation of the curriculum statement, which is in turn an interpretation by the curriculum developers.

The purpose of this research was to examine and explore how teachers were dealing with curriculum changes and therefore the study set out to describe and analyse their experiences. Doll (1993) argued that positivism, with its putative political neutrality and objectivity, represents 'a closed system of planning and practice that sits uncomfortably with the notion of education as an opening process' and 'the view of postmodern society as open and diverse, multidimensional, fluid and with power less monolithic and more problematical' (as quoted in Cohen et al., 2000, p. 33). Fraenkel and Wallen (1996) agreed with Doll's notion by suggesting that the aim of qualitative research is not to be precise but to be 'open to whatever emerges without predetermined constraints on outcomes' (p. 444).

The interpretive research orientation adopted by this study has methodological implications. The methodological paradigm within this study is qualitative. Maykut and Moreland (1994) give the following as descriptions of qualitative research: it has an exploratory and descriptive focus; an emergent design and a purposive sample; data collection in a natural setting; an emphasis on 'human' as instrument; qualitative methods of data collection such as observation, interviews and document analysis; early and on-going data analysis; and a case study approach to reporting the outcomes. Lofland and Lofland (1995) outlined three stages in the qualitative research process. The first stage is 'gathering' in which data is collected and assembled; the second stage involves 'focusing', in other words interrogating the data; and the third stage is 'analysing' in which the data is developed and the results are presented.

The interpretive research design enabled me to work with teachers in order to understand how they were recontextualising curriculum documents. I was interested in finding out what the teachers were making of the recent inclusion of 'indigenous technology and culture' in the curriculum. Qualitative research methods were used as I needed to develop a deep insight into the way in which teachers responded to the change in the Technology curriculum with this inclusion.

The following quote by Beck (1979) illustrates the spirit of this research:

> The purpose of social science is to understand social reality as different people see it and to demonstrate how their views shape the action which they take within that reality. Since the social sciences cannot penetrate to what lies behind social reality, they must work directly with man's definitions of reality and with the rules he devises for coping with it. While the social sciences do not reveal ultimate truth, they do help us to make sense of our world. What the social sciences offer is explanation, clarification and demystification of the social forms which man has created around himself (as quoted in Cohen et al., 2000, p.20).

4.4 The research process

The latest curriculum change which was fully implemented in 2006, started the entry into the inquiry for this study, with its inclusion of 'indigenous technology and culture' in the Technology curriculum. An extensive literature study on the philosophy of technology, indigenous technology and Technology Education that dealt with the interrelationship between technology, science, society and the environment was then conducted. According to Mouton (2001), the literature review provides insight into the dimensions and complexity of the problem, and this was so with this study. The review of the literature was an integral part of the research process which contributed to a clearer understanding of the nature and meaning of the identified problem, which was how teachers were dealing with a change in the technology curriculum, namely the introduction of 'indigenous technology and culture'. The literature review enabled me to get a clearer understanding of the meaning of 'technology', 'indigenous' and 'indigenous knowledge systems'.

The rest of the study was divided into three phases. The first phase of the research dealt with how and why 'indigenous technology and culture' was proposed for Technology Education processes. For data collection purposes, this phase was separated into two parts. The purpose of the first part was to explore and examine the rationale for the inclusion of this assessment standard (LO3 AS1). The history of how 'indigenous technology and culture' came to be included in this learning outcome was investigated. In other words, according to Lindblad and Popkewitz's (2000b) notion of narrative, the argument put forward was explored. Data was gathered by means of questionnaires sent to curriculum developers and the Department of Education official for Technology. The purpose of the second part of Phase 1 was to examine how 'indigenous technology and culture' was being proposed in policy documents and learning materials. This part of the phase involved the analysis of texts that related specifically to the pedagogy of technology that included 'indigenous technology and culture'. Policy documents, such as the Department of Education curriculum statements for Technology (South Africa. Department of Education, 2002c) and the Teacher's Guide for the Development of Learning Programmes: Technology (South Africa. Department of Education, 2003), were analysed by looking for data on *how* the rationale was contextualised. Text books and other learning materials were analysed to establish *what* knowledge authors of learning materials were using and *how* they recontextualised this aspect of the National Curriculum Statement to produce learning materials. The issue that was being explored here was in what way was the argument put into a context (Lindblad & Popkewitz, 2000b). This part of the study analysed the production of knowledge in regard to 'indigenous technologies and culture' and its conversion into pedagogic texts.

The purpose of Phase 2 of the research was to analyse existing pedagogical practices in terms of 'indigenous technology and culture' as an assessment standard within Learning Outcome 3, and to explore the issues and problems associated with its implementation. In South Africa, the inclusion of 'indigenous technology and culture' as an assessment standard first appeared in 2002 in the revision of Curriculum 2005. This phase of the research explored the problems teachers encountered when dealing with 'indigenous technology and culture' as a new inclusion in the curriculum. Technology teachers had to deal with *what* knowledge to teach and *how* to recontextualise this knowledge. The teachers were from a sample of schools within a range of contexts. Data was gathered on the extent to which this section of the curriculum was being implemented, the issues and problems associated with this implementation, and the recontextualising of this section of the curriculum by teachers for pedagogical purposes. Semi-structured interviews and focus group sessions were used to gather this data.

The research process for Phase 3 consisted of analysing a process of participatory co-engagement around an area of shared concern. The shared concern in this study was the inclusion of 'indigenous technology and culture' in the curriculum and how to implement this in the classroom. This phase explored how knowledge recontextualisation took place with the introduction of 'indigenous technology and culture' in the Technology curriculum. Data collection for this phase was in the form of structured interviews and focus group sessions.

Phase	Purpose	Data source	Data collection method
PHASE 1 Part 1	Exploration of rationale for inclusion of 'indigenous technology and culture' in the Technology curriculum	Curriculum developers, DoE subject advisor	Questionnaires
PHASE 1 Part 2	Exploration of how 'indigenous technology and culture' is being proposed in policy documents and text books	NCS for Technology, Teacher's Guide, text books, other learning materials	Document analysis
PHASE 2	Analyse and explore existing pedagogical practices	Teachers from focus group	Individual interviews Focus group interviews
PHASE 3	Analysis of participatory co-engagement	Teachers from focus group	Focus group interviews Individual interviews

Table 4.1: Summary of the research process

Table 4.1 summarises the research process, the key features, the data sources and the data collection methods that were used in the three phases of data collection. Although this structure may give the impression of being linear, this was not the reality of the process. The process was more iterative, complex and dynamic with certain events happening, such as the draft Learning Area Guidelines sent out by the Independent Examinations Board in early 2007 for discussion, that influenced the outcome of the research.

According to Cohen, Manion and Morrison (2000), meta-analysis is essentially the analysis of analysis. A meta-level analysis was conducted after the analysis of the three phases so that a holistic view of the findings of the research and further analysis of the evidence could take place. This analysis was informed by Winschitl's (2002) framework of the challenges faced by teachers (see 5.6). The meta-level analysis allowed for a substantive overall view of the analysis and enabled the analysis to be lifted to another level.

4.5 Case study method

The primary goal of this study was to examine and explore pedagogic practice in relation to ‘indigenous technology and culture’ in the technology curriculum in South Africa. A qualitative case study was chosen as a method for this research as, according to Merriam (1998), case studies seek out meaning and understanding of a bounded system, support inductive investigative strategies and generate a richly descriptive end product. The bounded system in this study was the cluster group of teachers described in Chapter 3. Case studies focus on a particular instance of educational experience and attempt to gain both theoretical and professional insights from the documentation of that instance (Freebody, 2003), so the choice of an exploratory case study design for this research was congruent with the purposes of the study.

As a technology teacher, I was concerned with how I was going to implement the ‘interrelationship between technology, science, society and the environment’ (Learning Outcome 3), and in particular ‘indigenous technology and culture’ (Assessment Standard 1) in my teaching practice. It appeared to me from the cluster group meetings and the conferences that I had attended, that most teachers were also at a loss with this aspect of the curriculum and there was not much in the way of meaningful engagement in the classroom. This study set out to work with a focus group of Technology teachers on their dealings with ‘indigenous technology and culture’ to penetrate and portray what it was like for them. As Hitchcock and Hughes suggested (as quoted in Cohen et al., 2000), case studies focus on individual actors or groups of actors and attempt to understand their perception of events. Freebody (2003) stated the distinctive feature of a case study is:

> not so much the source of its data or pre-set procedures for its collection, but rather its focus on attempting to document the story of a naturalistic-experiment-in-action, the routine moves educators and learners make in a clearly known and readily defined discursive, conceptual and professional space and the consequences of those people’s actions, foreseen and otherwise, for learning and the ongoing conduct of the research project. (pp. 82-83)

It is this feature that was congruent with this research.

Hitchcock and Hughes suggested that the researcher is ‘integrally involved in the case’ (as quoted in Cohen et al., 2000, p. 182). This was the case in this study as I have been a member of the cluster group which became the focus group. We have been working together since 2001 as part of the requirements for the Grade 9 assessment.

According to Stake (1978), one of the best uses of the case study method is to add to existing experience and humanistic understanding. Similarly, Freebody (2003) stated that case studies are designed to ‘impact upon practice, and to refine the ways in which practice is theorized’ (p. 81). Due to the difficulties experienced in the introduction of technology as a learning area, as described in Chapter 2, one of the desired outcomes of the study was for it to have a positive impact on the teaching of Technology and to encourage a more critical approach in the classroom.

4.6 Data collection and management

Various methods of data collection were used in this study. These multiple sources of evidence allowed for development of converging lines of inquiry, which could be used to corroborate findings (Yin, 2003), as well as methodological triangulation. The techniques used for data collection were document analysis, questionnaires, interviews and focus group discussions. The interpretive paradigm views data collection as a ‘mutual construction of meaning’ and it is interactionist and contextual in nature (Mottier, 2005), hence the choice of interviews and focus group discussion.

The main data sources were the questionnaires filled in by the curriculum developers, the policy documents and learning materials concerned with the Technology curriculum for Grade 9, and the focus group of teachers. The methods used to generate and collect data as well as the data sources and types are given in Table 4.2.

Phases	Data type	Data source	Methods for generating data
PHASE 1: Part 1	Biographical information and information on rationale	NCS curriculum developers	Questionnaire
PHASE 1: Part 2	Documents (policy documents, text books)	Policy documents, text books, other learning materials	Document analysis
PHASE 2:	Information on existing practice	Teachers from the focus group	Focus group semi-structured interviews
PHASE 3:	Information on implementation of a specific aspect of the curriculum	Teachers from the focus group	Focus group semi-structured interviews

Table 4.2: Data collection methods

4.6.1 Questionnaires

The most convenient way to collect data for Phase 1 Part 1 of the research, in which the rationale for the inclusion of 'indigenous technology and culture' was explored, was to send the curriculum developers of the National Curriculum Statement: Technology a questionnaire. The development of the questionnaire was iterative as I asked a friend experienced in developing questionnaires in the business world for constructive feedback. He suggested using an electronic version in which the text boxes for the responses were designed to expand according to the length of the response. Unlike written responses to questionnaires, or those that are filled in on a computer-generated form, these text boxes did not restrict the respondents to the length of their responses. This aspect was made clear in the introduction to the questionnaire (see Appendix 2). The electronic questionnaire also allowed the respondents to edit their responses if necessary. The questionnaire was pilot tested on a colleague who at the time was a subject advisor for technology in Gauteng, one of the provinces of South Africa. The purpose of the pilot test was not to use the questionnaire as a pretest, but rather, as Yin (2003) suggested, to use the opportunity to develop relevant lines of questions. The questionnaire was then refined and further aligned with the research questions. This iterative process enhanced the quality of the questionnaire.

Questionnaires were used so that the respondents could think carefully about their responses as well as completing them in their own time. A realistic date was set for the completion of the questionnaires. With questionnaires, there was less pressure for an immediate response compared to interviews, and in-depth responses were required for these questions. To ensure quality, the respondents were asked to give careful time and thought to their responses, to respond with honesty, and they were informed of the purpose of the study at the beginning of the questionnaire. The questionnaire used open-ended questions to elicit the understandings of the respondents of the rationale for the inclusion of 'indigenous technology and culture' in the final National Curriculum Statements for technology. This invited honest, personal comments from the respondents. According to Cohen et al. (2000), the open-ended nature of the questions adds to the authenticity, richness, depth, honesty and candour of the study, and this contributed to the quality of this study.

Two of the returned questionnaires were lost due to a hard-drive crash on my computer. I had backed-up the other documents on a back-up system at the institution in which I work. The two respondents were contacted and asked if they would complete the questionnaires for a second time. I received one back. The non-return of one questionnaire posed a concern in terms of reliability and validity, but as other data collection methods were used, this concern was reduced.

4.6.2 Document analysis

It was important to understand the context in which the teachers in the focus group had to work. Part of this context is formed by the policy documents and text books from which the teachers then recontextualise the assessment standard of 'indigenous technology and culture', and so document analysis was used to generate data for Phase 1 Part 2 of the study. This part of the study examined how the assessment standard of 'indigenous technology and culture' was proposed for Technology Education processes in the policy documents and learning materials. These documents are listed in Table 4.3. The policy documents and learning materials concerned with Technology Education were analysed for their perspectives and interpretations of 'technology' and 'indigenous technology and culture'. As Lindblad and Popkewitz (2000b) stated:

> Texts are vital for the constitution and regulation of social and cultural phenomena … Such texts also inform us about perspectives, assumptions and arguments as well as about consideration of contexts where these texts are used. (p. 6)

Only texts that dealt with ‘indigenous technology and culture’ or ‘the interrelationship between technology, science, society and the environment’ were used for data collection purposes. The texts were chosen in light of their importance to the ‘why’ and ‘how’ of the inclusion of ‘indigenous technology and culture’. The documents used for analysis were the Technology curriculum, the Learning Programme Guidelines, the Learning Area Guidelines developed by the Independent Examinations Board, five of the major Technology textbooks and their accompanying Teacher Guides, and the Table of Analysis for the two-hour Common Task for Assessment Part 2 written by every Grade 9 learner in the public school system.

One of the strengths of using documentation as a data collection tool is that it enables triangulation through corroboration and augmentation (Yin, 2003). Robson (1993) argued that the advantages of documentary sources are that the data is permanent, it can be re-analysed, and it allows for reliability checks and replication. The different documents analysed in this study are listed in Table 4.3, and the aim and purpose of analysing these documents is given.

Year	**Name**	**Aim/Purpose**
2002	National Curriculum Statement Grades R-9 Policy: Technology	Provide a critical analysis of the inclusion of ‘indigenous technology and culture’
2003	Teacher’s Guide for the Development of Learning Programmes	Provide a critical analysis of how teachers are meant to deal with the inclusion of ‘indigenous technology and culture’
2006	Textbooks (A – E)	Provide a critical analysis of how ‘indigenous technology and culture’ has been recontextualised into learning materials
2006	Teacher Guides for textbooks	Provide a critical analysis of how teachers are meant to deal with the inclusion of ‘indigenous technology and culture’ according to the learning materials
2008	Table of analysis of CTA Part 2	Provide an analysis of the Table of analysis

Year	Name	Aim/Purpose
2008	Learning Area Guidelines (Technology Grade 9)	Provide a critical analysis of how 'indigenous technology and culture' is being proposed

Table 4.3: Summary of documents analysed

4.6.3 Interviews

Interviews, along with focus group discussions, were used to generate data for Phase 2 and Phase 3 of the research. The aim of the interviews was for both parties to actively construct meaning in regard to 'indigenous technology and culture' and on how to implement this aspect in a meaningful way in the classroom. As Holstein and Gubrium (1997) suggested:

> Both parties to the interview are necessarily and ineluctably *active*. Meaning is not merely elicited by apt questioning, nor simply transported through respondent replies; it is actively and communicatively assembled in the interview encounter. (p. 114)

Interviewing is an active process in which both parties to the interview are engaged in the meaning making, so the interview is an interpretive process that is congruent with the constructivist paradigm of this research. Interviews are not merely a data collection exercise but rather a social encounter. But this, according to Cohen et al. (2000), is a concern as the transcription of the interview becomes solely a record of data rather than a record of the social encounter. Cohen et al. suggested that transcriptions lose data from the original encounter and that they are decontextualised. Digital recordings of the interviews lessened this threat as the tone and expression of the voices was recorded. The other advantages of using digital recordings is that they allowed for ease of transcribing, more accurate transcribing and for the recordings to be easily accessible for checking purposes. .

The interview schedules were semi-structured to allow for exploration to create meaning-making through open-ended questions. The open-ended nature of the questions gave flexibility in regard to pursuing responses that were relevant, different or unexpected. A digital voice recorder was used for recording purposes. This allowed for high quality, audible recordings which enabled accurate transcribing to be done. The device is small and unobtrusive so it was not a focal point during the interviews.

An initial interview was conducted with each member of the focus group of selected teachers. Each member was then involved in a final interview with the researcher. Each of the interviews was digitally recorded, transcribed by me, and then handed back to the participants for member checking. The purpose of the initial interviews, conducted from the end of April 2007 to the beginning of September 2007, were to establish the participants' perceptions of key terms such as 'technology', 'indigenous' and 'indigenous technology and culture'. These interviews also elicited biographical information about the participants' qualifications and experience in teaching technology. The final interviews, conducted at the end of the research process between March 2009 and September 2009, were to elucidate some aspects that had emerged from the focus group discussions as well as to understand the impact of the study on the participants' teaching. An important aspect of the final interview was that it gave the participants an opportunity to reflect on the research process. Both the initial and final interviews were conducted with an interview guide with pre-established guiding questions written down. The interview guides provided a framework for the interview sessions.

4.6.4 Focus group discussions

In essence, focus group discussions are simply a discussion in which a small group of people talk about a selected topic (Fallon & Brown, 2002). It is a carefully planned discussion designed to obtain perceptions on a defined area of interest. Focus groups offer the researcher the opportunity to observe the 'co-construction of meaning in action' (Wilkinson, 1998a, p. 338). They 'facilitate the disclosure and validation of group attitudes and thinking' (Fallon & Brown, 2002, p. 197), which is pertinent to the nature of this study. In other words, 'how views are constructed, expressed, defended and (sometimes) modified in the context of discussion and debate with others' (Wilkinson, 1998b, p. 186) enable meaning-making to take place, whether expressing disagreement or agreement with each other.

The focus group method was of particular value to this study as it allowed me to examine ‘how people engage in collective sense-making’ (Wibeck, Dahlgren, & Öberg, 2007, p. 249). Focus groups are used most frequently within the interpretive paradigm as a qualitative method of data collection (Morgan, 1988). However, according to Fallon and Brown (2002), focus groups provide an unnatural setting and as a technique, they do not give access to naturally occurring data. Cohen et al. (2000) suggested that due to their contrived nature, focus groups have elicited both successes and failures for research. They stated:

> Focus groups are contrived settings bringing together a specifically chosen sector of the population to discuss a particular theme or topic, where the interaction with the group leads to data and outcomes. Their contrived nature is both their strength and their weakness: they are unnatural settings yet they are very focused on a particular issue and therefore, will yield insights that might not otherwise have been available in a straightforward interview. (p. 288)

The interaction between the participants was important for this study as the topic, ‘indigenous technology and culture’, was a new inclusion in the curriculum and would yield debate and discussion. The group dynamic of the focus group sessions often resembled a typical conversation rather than a formal interview, and this seemed to embolden the participants to make statements that they may not have disclosed in an individual interview situation. The size of the group also facilitated discussion, as there were between four and six participants as well as me in the discussions. Peek and Fothergill (2009) found that there was more room for disagreements in smaller groups. The size of this focus group was therefore ideal for probing the issues surrounding the implementation of a new aspect in the curriculum.

Focus groups ‘provide another level of data gathering or a perspective on the research problem not available through individual interviews’ (Fontana & Frey, 1994, p. 364) and ‘the activation of prior knowledge and the elaboration of new knowledge are important parts of the interaction process’ (Wibeck et al., 2007, p. 253).
According to Wilkinson (1998b), focus groups are valuable in that they allow researchers to study ‘how views are constructed, expressed, defended and (sometimes) modified in the context of discussion and debate with others’ (p. 186). This offers an opportunity for the research to observe ‘the co-construction of meaning in action’

(Wilkinson, 1998a, p. 338). One of the strengths of focus groups is that the interaction between the participants can create learning processes as the participants question each other, challenge each other, exchange experiences and sometimes change their opinions and arguments as a result of the discussion (Wilkinson, 1998b; Wibeck et al., 2007).

The type of data and 'collective sense-making' (Wibeck et al., 2007) that was needed about the issues surrounding the implementation on a new aspect of the curriculum would not have emerged in individual interviews. The participants and their interaction activated prior knowledge and allowed for the elaboration of new knowledge. The participants constructed their own cognitive models from their interactions. According to Wibeck et al. (2007), the specified subject of a focus group implies a systematic inquiry into the subject, and 'the activation of prior knowledge and the elaboration of new knowledge are important parts of the interaction process' (p. 253). Elaboration of new knowledge is a concept linked to problem-based learning (PBL). Elaboration of knowledge is the process of considering a piece of knowledge in a richer, broader context (Visschers-Pleijers, Dolmans, Wolfhagen, & Van der Vleuten, 2004). To elaborate, according to Wibeck et al. (2007), participants need to verbalise the content in collaboration with the other members of the group. According to Visschers-Pleijers, Dolmas, Wolfhagen and Van der Vleuten (2004), 'the elaboration is a result of interaction in small groups, but the cognitive process takes place at an individual level, within the thinking of a single person' (p. 471). So co-construction of knowledge is the shared thinking of a group who interact with each other to reach a shared understanding, whereas elaboration takes place within an individual's thinking as a result of interaction with a group. Co-construction is a special type of elaboration – a collaborative elaboration (Visschers-Pleijers et al., 2004). During a focus group discussion, the participants may change their opinions (Cohen et al., 2000; Kidd & Parshall, 2000). According to Wibeck et al.:

> the *interaction* between focus group participants has seldom been evaluated, analyzed or discussed in empirical research. We argue that considering the focus group in light of current research into interaction in problem-based learning (PBL) tutorial groups would facilitate the deliberate exploitation of group processes in designing focus groups, staging data collection and analysing and interpreting data' (p. 249)

In this study, the focus group were comfortable with each other and the reasons for this have been discussed (see 3.3). In Phase 2 and Phase 3 of the study both the individual cognitive processes and the elaboration of knowledge were of interest.

Some of the concerns and difficulties associated with focus groups, such as attendance, were not significant, primarily as the cluster group met three times a year and the other participant who was not a member of the cluster group was willing to attend these meetings. One participant was not a regular attendee due to difficulty with communicating the times and dates of the meetings, and sometimes transport proved to be a problem for this participant. I tried to lessen the effect of this on the participant by conveying what I considered to be the relevant issues that had emerged from the focus group sessions to the participant.

4.6.5 Presentation of interviews and focus group sessions

In Chapter 5, the relevant data from the individual initial and final interviews and the data from the focus group sessions are given in numbered text boxes. Separate extracts are given in the same text box, but the extracts are separated by a thick border line and the code for the data file is given at the end of each excerpt. These data file codes are given in Appendix 4. A continuous conversation is represented by having a thick line around the border of the text box but there are no inside border lines. Once more, the codes for the data file, as listed in Appendix 4, are given at the end of the extract.

4.6.6 Data management

Huberman and Miles (2000) stated that it is critical to have a good storage and retrieval system to keep track of data. I decided to store my data in a digital format. I used Micorsoft Word and Excel to store documents and texts. I also used two computer software programmes – one for referencing purposes and the other for qualitative research purposes. The digital nature of the data allowed for multiple copies to be stored on various computers for back-up purposes, and for cataloguing to be systematic and accurate. The case archive consisted of a comprehensive set of documents that were used and generated during the study. Appendix 4 consists of an inventory of the data files. These data files were created to organise and manage the recordings and transcripts used in the case study. These transcripts are of the digital voice recordings made during the interviews, focus group sessions and from the focus group session at the PATT-18 conference in Glasgow, Scotland in 2007. These data files and transcripts provided a data trail that adds to the trustworthiness of the study.

*QSR*NVivo*

NVivo, a Qualitative Research Solutions International (QSR) software package, is one of the more sophisticated qualitative analysis packages and is used world-wide (Crowley, Harre, & Tagg, 2002). NVivo was used to aid the management and facilitation of the data collection and analysis for this research. According to Miles and Huberman (1994), if a researcher's task is to develop and communicate an understanding of complex concepts by constructing knowledge, then it is important to record, code, search, condense and link data. NVivo enhanced the research process by allowing me to collect data and analyse it by recording themes that emerged whilst reading through the data; to record and incorporate ideas and reflections into memos during the data analysis; to develop an active model that could be changed and adapted as a tentative framework emerged; to develop models that showed the interconnectedness of data by using mapping techniques; to search transcripts; and to compile statistics about the number and types of responses collected for each category and sub-category. According to Smyth (2006), one of NVivo's most important features is its ability to 'honor and preserve the integrity of the multiple constructions represented in the data, and to establish dependability through an obvious audit trail' (p. 6). She further stated:

> the regrounding of a researcher in the worlds of the researched is enhanced as the researcher searches for shared meaning about disparate elements of the social construction under analysis. A series of refinements of tentative models can be used to show the interconnections between the deeper structures of the data as they emerge. (p. 6)

The NVivo method of data storage allowed for easy data access by me for the participants if they so requested, enhancing the credibility of the research. NVivo has the ability to track all structured and unstructured data to its original source ensuring a clear audit trail. Pictures of these screens are given in Appendix 3. Other uses of NVivo in this study were to help facilitate areas of commonality or disparity in the data; to probe misinterpretations and inconsistencies; and to clarify salient issues (Smyth, 2006).

Appendix 3.1 illustrates the screen in NVivo when the ‘node’ choice is selected. The purpose of this picture is to show the layout of the screen in order for the reader to see the tracking process which is a feature of this software. The nodes track the categories and sub-categories in the various documents once the documents have been analysed. NVivo facilitated the analysis of data by making the developing of categories and the subsequent synthesising and reorganising of these categories throughout the process easily accessible and changeable. This made the process so much easier than highlighting, copying and pasting in Word. It greatly enhanced the checking of categories and sub-categories as searching for a category or sub-category in NVivo brings up the document section with all its details.

Appendix 3.2 illustrates how NVivo assists with the organisation of categories and sub-categories by allocating tree nodes and nodes. There are active links from these nodes to the data concerned. The relevant document is then tracked from the node (see Appendix 3.3) and the instance of that category or sub-category is then shown in the transcript (see Appendix 3.4).

One of the advantages of using NVivo is not so much the ease of coding text, but rather the reviewing of coded material together, and being able to work with it as live data. This meant that I could, whilst investigating patterns in the data, take a coded segment back to the context, to rethink and recode the segment. This allowed for an iterative analysis process (Richards, 2002). One of the features I found particularly useful was the modelling of the coding. This allowed for a visual presentation which made the iterative process of refining simpler. Subsequent models were drawn up as more data was coded and the categories and sub-categories were refined. An example of a model is given in Appendix 3.5.

According to Richards (1999), the goal in the design of NVivo was to support a ‘weaving of rich primary sources with commentary and discussion and analysis’ (p.

414). Unlike previous software in which the original data had to be altered for the programme so that it could then be coded, in NVivo ‘rich text can stay rich, and rich documents develop as ideas do’ (p. 414). The memos facility allows the researcher to make tentative interpretations (Richards, 1999). This means that this is now not a note in the margin in a hard copy, but the memo is stored as a different entity. Memos are ‘rich’ documents as they grow, change and link. In NVivo, data memos are treated as full-status data (Richards, 1999). NVivo is a powerful organisational tool and it’s built in capacity for recording decisions, along with its active links between memos, documents, nodes and models assisted ‘in the development of a dynamic audit trail to meet the criterion of transparency’ (Bringer, Johnstone, & Brackenridge, 2004, p. 250). Unfortunately, I only considered using qualitative research software at an advanced stage in the doctoral process, and as a result used a small proportion of the tools available. At the stage where I considered using NVivo, I had completed the literature review, received the responses to the questionnaires and completed and transcribed some of the interviews and focus group discussions. I had used Microsoft Word to record the process up until this stage. I did, however, include as much of the data and links as possible of the work I had completed up until this time on the NVivo programme.

Some controversies surround the use of qualitative data analysing software. One of the concerns raised is that the use of this type of software package can turn analysis of data into a rigid, automated process. However, the researcher must still interpret, conceptualise, document decisions, examine relationships and develop theories (Bringer et al., 2004). Another concern is that ironically, software can allow the users to get too close to the data leading to a code and retrieve cycle (Jackson, 2006). Richards (2002) cautioned against over-coding and ritualistic coding. The development of models of the different stages of the coding process enabled me to think and reflect on the data, which helped in guarding against mechanistic coding or over-coding. Kidd and Parshall (2000) found that working in NUD*IST(an earlier version of NVivo) enhanced rather than inhibited reflective engagement with the data. They found that they had ‘more questions to ask, more issues to ponder, and more vantage points from which to explore the data’ (p. 299).

NVivo is a tool that can be used to aid qualitative analysis. It has many options for document preparation, coding, retrieval, text searches and links to memos and documents. These choices, according to Bringer, Johnstone and Brackenbridge (2004), give the power of analysis to the researcher. NVivo made it easier to make entire back-ups of the data and it made the data analysis process simpler. It does not, however, decrease the amount of time needed to read, conceptualise and analyse data (Bringer et al., 2004), as a qualitative researcher still needs to do these tasks. NVivo added quality to the research by establishing an audit trail and enabling an iterative coding process.

EndNote

In 1994, Miles and Huberman stated that ‘the researcher who does not use software beyond a word processor will be hampered in comparison to those who do’ (p. 43-44). As well as using NVivo as a qualitative research tool, I used the referencing programme ‘EndNote’ since the beginning of this study. This enabled me to keep an accurate record of all the texts read for the study. It also assisted in a good quality reference list as well as accurate referencing and quoting in the text.

Using both these software packages therefore added to the quality and credibility of the study.

4.7 Issues pertaining to case study research

Qualitative research values depth over breadth and it focuses on attempts to portray the subtle nuances of life experiences rather than aggregate evidence (Whittemore, Chase, & Mandle, 2001). It is contextual and subjective as opposed to generalisable and objective, and as such, has generated considerable debate around issues of reliability and validity. Flyvberg (2006) argued the following:

> the alleged deficiency of the case study and other qualitative methods is that they ostensibly allow more room for the researcher’s subjective and arbitrary judgment than other methods: They are often seen as less rigorous than are quantitative, hypothetico-deductive methods. Even if such criticism is useful, because it sensitizes us to an important issue, experienced case researchers

> cannot help but see the critique as demonstrating a lack of knowledge of what is involved in case-study research. Campbell and others have shown that the critique is fallacious, because the case study has its own rigor, different to be sure, but no less strict than the rigor of quantitative methods. The advantage of the case study is that it can “close in” on real-life situations. (pp. 234-235)

The concept of validity in qualitative research has been through many transformations in the last three decades. Initial conceptualisations applied the reliability and validity standards from quantitative research to qualitative research (Goetz & LeCompte, 1984). Subsequently, Lincoln and Guba’s (1985) four criteria for validity in qualitative research of credibility, transferability, dependability and confirmability were translated from the quantitative standards of internal validity, external validity, reliability and objectivity. Since then, numerous terms have been suggested to articulate validity criteria in qualitative research. Maxwell (1992) argued that qualitative researchers needed to guard against working within the positivist paradigm and he suggested replacing the notions of validity with the notion of authenticity. Eisner’s (1991) notion of trustworthiness and Emden and Sandelowski’s (1999) notion of goodness have all been put forward as more suitable terminology for the qualitative paradigm, but these terms have not been overwhelmingly supported (Whittemore et al., 2001).

In 1995, Lincoln stated that the whole area of qualitative research was still emerging and being defined, but even with this state of change, Guba’s translated criteria remain the standard (Whittemore et al., 2001; Shenton, 2004). Whittemore et al. (2001) stated that ‘despite the incongruency between quantitative epistemology and qualitative methodology, translated standards of validity have proven to be useful criteria for demonstrating rigor and legitimacy of qualitative research’ (p. 523). Together these criteria refer to the trustworthiness of an interpretive study (Lincoln & Guba, 1985). These criteria will therefore be used to determine trustworthiness in this study. However, Greene (1992) cautioned that the techniques of interpretivist inquiry should remain as options and therefore the researcher determines the most appropriate validity criteria for the investigation (Maxwell, 1992, 1996; Whittemore et al., 2001).

4.7.1 Trustworthiness

Trustworthiness is established by the researcher's attempts to demonstrate the robustness of the method (Smyth, 2006). Trustworthiness has been established in this study through a comprehensive and truthful report of what the study revealed. According to Patton (1990), qualitative work should be creative, but at the same time it needs to be rigorous and explicit. Lincoln and Guba's four criteria for validity in qualitative research are now discussed.

Credibility

The need to establish credibility in qualitative research is one of the most important factors in establishing trustworthiness in qualitative research (Lincoln & Guba, 1985). Credibility is achieved by addressing such aspects as immersion in the environment, accurate interpretation of the data, triangulation and member checking (Lincoln & Guba, 1985; Hoepfl, 1997; Whittemore et al., 2001; Smyth, 2006). To establish credibility, the researcher must ensure that he or she has a close relationship with the environment under scrutiny (Lincoln & Guba, 1985; Smyth, 2006). This relationship with the environment has already been discussed (see Chapter 3). The relationship provided a contextual richness which served as a basis for checking, questioning and theorising (Smyth, 2006).

According to Whittemore, Chase and Mandle (2001), credibility refers to the conscious effort to establish confidence in an accurate interpretation of the data. This aspect of credibility was addressed in the study by ensuring that the results reflected as accurately as possible the experiences and perceptions of the participants. This was achieved by making available to the participants the transcripts of the interviews and focus group discussions and the chapter on data analysis and the findings. The checking of the transcripts by the participants was done throughout the research process. The participants were also informed that they had access to any part of the study on request.

Cohen et al. (2000) stated that triangulation is used in interpretive research to investigate different actors' points of view. They defined triangulation 'as the use of two or more methods of data collection in the study of some aspect of human behaviour' (p. 112) and it is the thorough triangulation of descriptions and interpretations throughout the period of study that gives credibility to the study (Stake, 2005). In this study, both the questionnaires sent to the curriculum developers and the document analysis of policy documents and learning materials were used to establish the context in which the participants had to work. The purpose of the individual interviews was to explore the participants' viewpoints on key aspects used in the study. The aim of the focus group discussions was to examine, explore and develop these key aspects. This study therefore used methodological triangulation (Cohen et al., 2000) as different methods were used to examine and explore the same object of study. Interviews and focus group discussions do, however, suffer from the same methodological shortcomings as both are types of interviews, but their distinct characteristics also provide individual strengths (Shenton, 2004). This study used, according to Denzin's (1997) typology of methodological triangulation, the 'between methods' triangulation. Triangulation 'within methods' concerns the replication of the study as a check on reliability, whereas triangulation 'between methods' involves 'the use of more than one method in the pursuit of a given objective' (Cohen et al., 2000, p. 114).

Member checks are, according to Guba and Lincoln (1989), the most important criteria for credibility in qualitative research. Member checking was done informally through the interview process and focus group discussions and formally through giving the participants the transcripts of their interviews and focus group discussions. Emerging inferences were verified by sending the participants the sections of the thesis on data analysis and the findings. The participants were asked to comment on whether the descriptions, inferences and perceptions were accurately portrayed. This strategy is recommended by Miles and Huberman (1994).

Transferability

Lincoln and Guba (1985) argued that it is not the qualitative researcher's task to establish any degree of transferability but researchers should instead give in-depth, rich descriptions so that the readers and users of the research can determine whether transferability is possible. Wehlage (as quoted in Stake, 2005) agreed with this notion by stating ‘The consumer of the research, not the author, does the generalizing … It is up to the consumer to decide what aspects of the case apply in new contexts’ (p. 26). The richness of the detail in a case study should develop insights that have resonance in other social sites thereby allowing theoretical considerations to be established (MacPherson, Brooker, & Ainsworth, 2000). Sufficient contextual information needs to be provided by the researcher so that the readers and users of the research can make transfers (Lincoln & Guba, 1985). Lincoln and Guba claimed that since the researcher knows only the ‘sending context’, he or she cannot make any transferability references.

It is imperative that sufficient thick description is provided so that the reader has a proper understanding of the phenomenon under investigation enabling them to compare instances that have been described in the study with those that emerge in their situations (Shenton, 2004). The boundaries of a case study are therefore set in a time and place and transferability depends on the context and purpose of the investigation. The boundaries of this study have been given by providing a detailed description of the schools in which the participants teach, the data collection methods used, the number of data collection sessions and the time period over which the data was collected. This exploratory study has given rich and thick descriptions that have captured the essence of the perspectives and issues that teachers faced when implementing a new aspect of the technology curriculum.

Dependability

Lincoln and Guba (1985) stressed that a demonstration of credibility goes some way to ensuring dependability. They stated that dependability involves member checks, triangulation and prolonged engagement in the field. These have been discussed in the section dealing with credibility. In order to address dependability, the processes within the study should be reported in detail, enabling a future researcher to repeat the work, but not necessarily to gain the same results (Shenton, 2004). This has been achieved in this study by detailing the research design and implementation (this chapter), describing the data collection in detail (this chapter) and reflecting on the effectiveness of the research process (Chapter 6). An audit trail has been established by explaining how findings were arrived at in Chapter 5, and by using NVivo so that data can be traced to its original sources. These various factors contribute to the dependability of this study.

Confirmability

The concept of confirmability is comparable to objectivity. The confirmability of this study was enhanced by giving an in-depth methodological description so that the integrity of the research results could be scrutinised. It is also important to ensure that the findings of the investigation are the result of the experiences and ideas of the participants and not the preferences and characteristics of the researcher (Shenton, 2004). This was achieved by asking for comment by the participants on the findings of the study. Member-checking was used to ensure that the researcher's findings resonate with the participants' understandings. The findings are derived from the data and this process is detailed in Chapter 5.

4.7.2 Researcher bias

Due to the relationship between the participants in the focus group and me as the researcher, it was impossible for me to adopt a neutral stance devoid of engagement. As in MacPherson, Brooker and Ainsworth's (2000) account of their case study, in order to gain understanding of the problem, I decided to take on a collaborative role. I disclosed my personal beliefs and biases towards the implementation of 'indigenous technology and culture' to the participants. The topic is new and therefore there was no prior framework from which to work. The pre-existing professional friendship that had developed over the seven years prior to the study due to regular meetings as a cluster group, were advantageous as it promoted disclosure, validation and a sense of trust between us. I was aware of my role, as Wibeck et al. (2007) metaphorically describes, being the same as a tightrope walker, as there was always the need to 'walk' between being too directive and being a voiceless participant. The purpose of the focus group discussions was to elaborate on the topic and to co-construct knowledge.

4.8 Ethical considerations

Merriam (1998) stated that conducting a study in an ethical manner is a requirement for validity and reliability. Ethical issues were considered so that the rights and values of the respondents to the questionnaire and the participants in the focus groups would balance with my role as a researcher. In the administration of the questionnaire, ethical considerations were observed. The purpose of the study was explained in the introduction to the questionnaire (see Appendix 2). In the data analysis, the names of the respondents to the questionnaire were kept anonymous for ethical reasons and these respondents were given due recognition in the acknowledgements.

The agreements by the participants' in the focus group of selected technology teachers, to be interviewed and quoted, were done formally through the signing of a letter of permission (see Appendix 1) and informally at the beginning of each interview and focus group discussion. Honesty was necessary for building a trusting relationship with the participants as this was important for the focus group discussions. When an ethical dilemma arose in an interview, I assured the participant that the data would not be disclosed. The participant spoke freely in the interview and I needed to have the participant's trust. This issue was concerned with confidentiality of data as opposed to the anonymity of participants. It is not always the case that participants want to be anonymous (Wiles, Charles, Crow, & Heath, 2006). This was the case for the participants in the focus group of selected teachers. They all agreed that pseudonyms would not be used and that I could use their first names. It was also agreed that the names of the schools at which they teach would not be revealed, but the schools would be referred to according to the letter allocated to them in Table 3.1.

The focus group session at the PATT-18 conference in Glasgow, Scotland was recorded. This session was recorded using a digital voice recorder and the transcript is available. I sent the transcript to the participants for their verification. The participants in this focus group session were asked at the beginning of the session for permission to record the session as well as permission to use the data for analysis purposes for this study. Unfortunately, due to a hard-drive crash on my laptop in January 2008, I lost the recording of this session although another copy was made by the University of

Glasgow. I also lost the e-mail responses thanking me for the transcript. However, I do have a copy of the transcript. I sent e-mails to Andrew Feenberg and Vicki Compton requesting permission to quote extracts from this session and permission was granted. An e-mail was also sent to Kurt Seemann to request permission to use a part of a response to an e-mail that I had sent to him as part of a personal communication. He made a few changes and these were incorporated into his extract (see 1.5).

4.9 Conclusion

This chapter described the research orientation, the research design and the research process for this study. A description of the case study method was given and data collection and management techniques were detailed. The trustworthiness of the study was established, the researcher's biases were addressed and the chapter concluded by describing the ethical considerations. This chapter attempted to respond to the four fundamental questions: the ontological, epistemological, methodological and the axiological questions. The following chapter presents the results and findings of the data collected.

CHAPTER 5
DATA ANALYSIS AND FINDINGS

5.1 Introduction

‘Unquestionably, data analysis is the most complex and mysterious of all the phases of a qualitative project’ (Thorne, 2000). This part of the study set out to make sense of the data and in so doing, make the ‘mysterious’ less mysterious. Phase 1 of the analysis examined the rationale for the inclusion of ‘indigenous technology and culture’ by analysing policy and other relevant documents. For Phase 2 and Phase 3, the raw data from focus group sessions and individual interviews was read and reread until categories started to emerge. These initial categories then went through an iterative process of refinement and the findings that resulted from this process are presented. It is the purpose of this chapter to relate the process of the data analysis in this study from the ‘mysterious’ beginnings through to the findings.

5.2 Qualitative data analysis

This section of the chapter describes the data analysis approaches taken in this study, which included content analysis, and the use of NVivo software specifically for the analysis.

Qualitative data analysis is a complex process as shown in the two quotes given below:

> Qualitative data analysis requires methodological knowledge and intellectual competence. Analysis is not about adhering to any one correct approach or set of right techniques; it is imaginative, artful, flexible, and reflexive. It should also be methodical, scholarly, and intellectually rigorous. (Coffey & Atkinson, 1996, p. 10)

> Given the multiplicity of qualitative research and the incredible varieties and possible permutations of human beings and what they do, interpretive researchers have little choice but to deal with complexity and variety. (Brizuela, Steward, Carrillo, & Berger, 2000, p. xiv)

Due to the multiplicity of qualitative analysis approaches, this section of the chapter conveys the specific approaches taken for the various phases of the analysis in this study.

5.2.1 Qualitative data analysis approaches

There are many different approaches to qualitative data analysis and these have been widely debated and commented on (Strauss, 1987; Silverman, 1993; Miles & Huberman, 1994; Mason, 1996). Some of these approaches are associated with specific traditions such as grounded theory (Strauss & Corbin, 1990), discourse analysis, phenomenology and narrative analysis. Some analytic approaches are generic however, and are not situated within one of the specific traditions (Silverman, 2000; Ezzy, 2002), such as this study.

Mason (1996) defined three general approaches to qualitative data analysis: literal, interpretive and reflexive. She described the literal approach as an analysis process with a focus on the exact use of particular language, for example, whereas the interpretive approach has a focus on making sense of the participants' accounts and the researcher attempts to interpret the meaning of these accounts. The constructivist approach in data analysis stresses the process of emergence and shaping of opinions (Welsh, 2002) and so is synonymous with this interpretive approach. The reflexive approach attempts to focus attention on the researcher and his/her contribution to the data creation and analysis process. Mason suggested that sometimes in practice a combination all three approaches are used by researchers. Phase 1 of the data analysis mostly used a literal approach. This phase involved the analysis of policy documents and the learning materials that emanated from these documents. Phases 2 and Phase 3 of the data analysis used an interpretive analysis approach as these two phases were concerned with making sense of the participants' accounts on a specific section of curriculum policy and its implementation.

For Phase 2 and Phase 3 of the study, the analysis was an on-going process. It started soon after the first data was collected, and continued in an iterative process. Analysis should consist of reading, rereading and coding the data making reflexivity an important part of this process (Srivastava & Hopwood, 2009). Strauss (1994) stated that ‘at first the data collected may seem overwhelming and confusing, the researcher flooded by their richness and their often puzzling and challenging nature’ (p. 26). For Phase 2 and Phase 3 of this study, the data analysis method used the constant comparative method as developed by Glaser and Strauss (1967), and modified by Lincoln and Guba (1985). Using this method, texts are analysed so that ‘units’ or ‘incidents’ can be identified. The units are then grouped, regrouped and compared until categories emerge. There is therefore a two-way process between unit and category. So the first part of the data analysis for Phase 2 and Phase 3 was to identify units. The next part of the data analysis was to allocate categories to the units. Units were then grouped on the basis of shared characteristics and categories were refined. The conceptual framework from Chapter 2 guided the creation of these categories. Highlighting the interpretive nature of this process, Lincoln and Guba (1985) stated:

> the category set that emerges cannot be described as the set; all that can be reasonably required of the analyst is that he or she produce a set that provides a ‘reasonable’ construction of the data. ‘Reasonable’ is most easily defined as a judgement that might be made by [another] reviewing the process. (p. 137)

Analysis of qualitative data is ‘a dynamic, intuitive and creative process of inductive reasoning, thinking and theorizing’ (Basit, 2003, p. 143). This study relied on inductive reasoning to interpret and structure the meanings that were derived from the data (Thorne, 2000). As Patton (1980) explains, ‘Inductive analysis means that the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis’ (p. 306). In other words, inductive reasoning uses the data to generate ideas, unlike deductive reasoning which begins with the idea and uses the data to confirm or negate the idea. Table 5.1 summarises the approaches and reasoning methods used in each phase of the analysis.

	Approaches	**Reasoning method**
Phase 1	literal	inductive
Phase 2	interpretive	inductive
Phase 3	interpretive	inductive

Table 5.1: Approaches and reasoning methods used in the analysis

Analysis is an explicit step in interpreting the data as a whole, so analysis occurred throughout the data collection process. It is also explicit in that it transforms the raw data into a new depiction of the phenomena being studied. Srivastava and Hopwood (2009) suggested that patterns, themes and categories of analysis do not emerge on their own; rather, they are driven by 'theoretical frameworks, subjective perspectives, ontological and epistemological positions, and intuitive field understandings' (p. 77). Similarly, Thorne (2000) stated:

> The theoretical lens from which the researcher approaches the phenomenon, the strategies that the researcher uses to collect or construct data, and the understandings that the researcher has about what might count as relevant or important data in answering the research question are all analytic processes that influence the data. (p. 68)

The results of the data analysis are therefore dependent on the researcher's interpretation of events, processes and interactions. This analysis in this study has been influenced by my background, as described in Chapter 3, as well as events such as conferences at which I have presented papers and the ensuing discussions. As Schäfer (2003) stated, 'the analysis process can be a highly innovative and unique process – one that does not necessarily rely on accepted norms and standards' (p. 66). As a result of this uniqueness, credibility checks need to be rigorous (see Chapter 4).

According to Morse (as quoted in Thorne, 2000), the following cognitive processes are involved in all qualitative analysis:

- comprehending the phenomenon under study
- synthesizing a portrait of the phenomenon that accounts for relations and linkages within its aspects
- theorizing about how and why these relations appear as they do; and
- recontextualising, or putting the new knowledge about phenomena and relations back into the context of how others have articulated the evolving knowledge. (p. 70)

This study set out to understand firstly, the phenomenon of 'indigenous technology and culture' by exploring and examining the rationale for its inclusion in the most recent curriculum revision; secondly, how this was then recontextualised into learning materials; thirdly, how teachers were dealing with this in their teaching; and finally, to examine the process of participatory co-engagement that took place with a focus group of teachers. The next process in the analysis theorised on the relations and linkages between these aspects.

'Rich' text is collected in qualitative research. Miles and Huberman (1994) stated that rich data 'provide 'thick descriptions' that are vivid, nested in a real context, and have a ring of truth that has strong impact on the reader' (p. 10). According to Richards (1999), there are four different senses of the word 'rich', and these are relevance, impact, complexity and fluidity. Rich data implies complexity which arises from a diverse and wide range of data, and fluidity as ideas grow over a long period of time (Richards, 1999). Miles suggested that this complexity in rich data is what makes it such 'an attractive nuisance' (1979). The intention of this study was not to find generalisable explanations but rather to provide 'rich' descriptions of how teachers dealt with the inclusion of 'indigenous technology and culture' in their pedagogical practice.

5.2.2 Using NVivo software for analysis

Analytical reasoning processes need to be relevant. This is achieved, according to Richards (1999), by thorough organisation and coding; the ability to access all data to display and interpret patterns; to interrogate coding; and to question and test interpretation. In this study, the use of NVivo software assisted with the first three of these aspects and it made the fourth – to question and test interpretation – easier, by being able to track the categories back to the original sources. As discussed in Chapter 4, NVivo is a powerful organizational tool. One distinct advantage over manual methods is the ability to organise data efficiently (Bringer et al., 2004). The programme allows for quick access for coding and retrieving data (Richards & Richards, 2000). It does this by enabling the researcher to link documents under a folder named 'internals' with sub-folders. This means that all relevant documents are easily and quickly accessible or traced.

NVivo enhances the ability to access all data to display and interpret patterns in the data analysis process. The programme displays coding 'stripes' in the margins so that researchers can easily see which codes have been used and where. Keyword searches of the texts were conducted for the second and third phases of this study. NVivo searches for every instance of a keyword, adding rigour to the analysis process. However, a manual search was also conducted as a keyword search does not pick up words with a similar meaning.

Phase 1 of the data analysis did not involve the use of NVivo. This phase analysed policy documents and text books, and therefore the relevant texts were not digital and so would not have been able to be analysed using a software programme. Phase 1 analysed policy documents and learning materials and used content analysis (see 5.2.3) in order to establish the rationale. In the second and third phases of the analysis, which also used content analysis, units of text were identified during an initial reading. These texts consisted of transcripts of interviews, focus group sessions and a presentation given by Andrew Feenberg at the PATT-18 conference in 2007. These units were 'dragged and dropped' into the 'free' node section where tentative categories were developed. In NVivo, data are coded at nodes. Nodes are created and managed by the researcher, with 'free' nodes and 'tree' nodes being displayed separately. 'Free' nodes are used for stand-alone categories, whereas 'tree' nodes have 'child' nodes, and so are used for categories and sub-categories. After this initial reading, the nodes were examined and rearranged using the model function on NVivo. The model of the nodes as a whole, as well as each node and sub-node, enabled me to see both the 'big picture' and the detail. One advantage of using NVivo for data analysis is that it enabled coding, editing and linking to other sources to be seamlessly combined. The coding was therefore not a linear process, but rather an iterative one. For me there is no doubt that NVivo assisted and enhanced the analysis process.

5.2.3 Content analysis

Phase 1 of the study used content analysis as a method to analyse policy and other documents in order to establish the rationale for the inclusion of 'indigenous technology and culture' in the Technology curriculum. According to Bryman (2004), qualitative content analysis is 'probably the most prevalent approach to the qualitative analysis of documents' and it 'comprises a searching-out of underlying themes in the materials being analyzed' (p. 392). He further stated that it is:

> an approach to documents that emphasizes the role of the investigator in the construction of the meaning of and in texts. There is an emphasis on allowing categories to emerge out of data and on recognizing the significance for understanding the meaning of the context in which an item being analyzed (and the categories derived from it) appeared. (p. 542)

It is important for the researcher to delineate the specific approach to content analysis before starting the analysis of data (Hsieh & Shannon, 2005). Hsieh and Shannon describe three different approaches to content analysis: the conventional, the directed and the summative. All of these approaches are used to interpret textual data from a predominantly naturalistic paradigm. The conventional approach is usually used when the aim of the study is to describe a phenomenon. The purpose of using a directed approach is to validate or extend conceptually an existing theory or theoretical framework. This is a deductive application (Mayring, 2000). A summative content analysis approach starts by identifying and quantifying certain words in order to explore usage (Hsieh & Shannon, 2005, p. 1284).

For conventional content analysis, the codes are derived from the data during analysis, and it is this which differentiates it from the other two methods of content analysis. The directed approach to content analysis means that codes are derived using existing theory or prior research. The summative approach is very different from the other two as the text is not analysed as a whole, but 'the text is often approached as single words or in relation to particular content. An analysis of the patterns leads to an interpretation of the contextual meaning of specific words or content' (Hsieh & Shannon, 2005).

The conventional content analysis approach was chosen for the data analysis for this study as I needed to understand the participants' unique perspectives generated from the data. Hsieh and Shannon urged that the conventional content analysis approach must not be confused with phenomenology or grounded theory. The purpose of this research was to contribute to theory by exploring and explaining what teachers were doing with a newly introduced aspect to the Technology curriculum.

5.3 Phase 1: The rationale

This research was built on studies on different levels, requiring different types of analyses appropriate for each phase. Phase 1 used content analyses to analyse various policy documents as well as other relevant documents pertaining to the rationale for the inclusion of ‘indigenous technology and culture’ in the Technology curriculum and the subsequent recontextualisation into learning materials. Part 1 of this phase involved the analyses of various policy documents and an analysis of the responses to a questionnaire sent out to the developers of the National Curriculum Statement: Technology in an attempt to clarify the rationale for the inclusion of ‘indigenous technology and culture’. Part 2 of Phase 1 analysed textbooks and national assessment tasks to ascertain how this new inclusion in the Technology curriculum was being recontextualised.

5.3.1 Phase 1 Part 1

Phase 1 of the study set out to explore and examine the rationale for the inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement: Technology (South Africa. Department of Education, 2002b). In other words, it set out to examine the ‘argument put forward’ (Lindblad & Popkewitz, 2000a). The first part of this phase attempted to establish the rationale for the inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement. The purpose of this was to explore the ‘argument put forward’ in policy documents as it is policy documents that teachers then recontextualise into their own teaching practices. This first part of the phase used content analysis as a means to analyse policy documents and the questionnaires sent to the curriculum developers.

The curriculum reform processes in South Africa in the last two decades are described here (also see 2,4,2), as they are significant when analysing the relevant documents for this phase. Since 1994, education in South Africa has undergone fundamental transformation and the curriculum has been through unprecedented change. Curriculum reform is a highly political activity (Taylor, Riszvi, Lingard, & Henry, 1997) and the discourses that dominate these reform processes shape both the views that become accepted as legitimate as well as teachers' practice (Cannella, 1997). The educational transformation in South Africa was linked to the new democratic dispensation and it referred to a shift away from a monocultural educational system to a multicultural one and a shift from content-based education to one that is outcomes-based (Steyn, 2001; Weber, 2007). The new curriculum, known as Curriculum 2005 (C2005) and developed in 1997, was the first single curriculum for all South Africans and it was the pedagogical route out of apartheid education (Chisholm, 2003). The review of C2005 in 2000, which resulted in a report, was highly controversial for many reasons. Cabinet ultimately accepted the report but rejected the recommendations which called for a reduction of some learning areas, notably Technology and Economic and Management Science (EMS). Cabinet argued not only for the retention of these two learning areas but for their strengthening in the curriculum. As a result of this review, the National Curriculum Statements for grades R – 9 were developed to strengthen and streamline the original curriculum statements (C2005).

A problem extensively discussed in the literature on education in South Africa throughout these three curriculum reforms concerns the translation of idealistic goals contained in policy texts into transformative practices in the classroom (Christie, 1999; Chisholm, 2000; Jansen & Sayed, 2001). Phase 1 of the study attempted to establish the rationale for the inclusion of 'indigenous technology and culture' in the NCS: Technology by analysing relevant policy documents and text books. Phase 1 Part 1 examined the 'idealistic goal' put forward in the relevant policy documents in regard to 'indigenous technology and culture'. This section of the data analysis set out to explore the 'argument put forward' by using Lindbald and Popkewitz's (2001) notion of narrative as a tool for analysis. The narrative notion 'is used to capture transitions as narratives – to see changes as parts of narratives where we seek plots that present, legitimise, and contextualise transitions' (Ladwig, Linblad, & Popkewitz, 1998). This notion of narrative can be used as a tool for analysing texts but it is also a way of conceiving 'the ingredients of the plots as social constructions'. Popkewitz (1997) views curriculum

> as a particular, historically formed knowledge that inscribes rules and standards by which we 'reason' about the world and our 'self' as a productive member of that world. The rules for 'telling the truth' in curriculum, however,

> are not only about the construction of objects for our scrutiny and observation. Curriculum is a disciplining technology that directs how the individual is to act, feel, talk, and 'see' the world and 'self'. As such, curriculum is a social regulation. (1997, p. 132)

The following paragraphs examine how this reasoning about the world and the self is put forward in the National Curriculum Statement: Technology. Understanding this reasoning is important as it is in this context that 'indigenous technology and culture' was included as an assessment standard in the learning outcome that deals with 'the interrelationships between science, technology, society and the environment' (South Africa. Department of Education, 2002b, p. 9).

Popkewitz (2001) suggested that 'the nation' and the 'citizen', which are both cultural inventions of the nineteenth century, 'are being revisioned through new salvation narratives that link the nation, the global and the individual' (p. 179). The new salvation narratives that appeared in South Africa post-1994, such as the Constitution of the Republic of South Africa (Act 108 of 1996) which provided the basis for curriculum transformation (South Africa. Department of Education, 2002b, p. 1) and the National Curriculum Statement, give a strong sense of 'nation'. Part of the Preamble to the Constitution states that the aims of the Constitution are to 'build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations', and the White Paper on Education and Training (Government Gazette, 1995) states:

> For the first time in South Africa's history, a government has the mandate to plan the development of the education and training system for the benefit of the country as a whole and all its people. (p. 17)

In the National Curriculum Statement, the critical and developmental outcomes were inspired by the Constitution (South Africa. Department of Education, 2002b). The second of the developmental outcomes, which is generic to all eight learning areas in the General Education and Training band for Grade R to Grade 9 learners, states:

> The developmental outcomes envisage learners who are … able to: … participate as responsible citizens in the life of local, national and global communities. (South Africa. Department of Education, 2002b, p. 2)

These narratives emphasise the ‘nation’ with its link to the ‘individual’ and the ‘global’. They are visionary and future looking, complying with Anderson’s (1991, 2006) notions of ‘imagined communities’ and ‘the goodness of nations’.

The other cultural invention of the nineteenth century, the ‘citizen’, is also strongly emphasised in these narratives. Popkewitz’s (2001) notion of the ‘cosmopolitan, problem-solving child’ is a useful one to use as a description of the ‘citizen’ in an educational context. He stated:

> In the name of democracy is the *cosmopolitan*, problem-solving child; one who is continually and perpetually active in communities of learning and as a lifelong learner whose capacity and potentialities entail a perpetual intervention in one’s life. (p. 181)

Popkewitz further (2001) stated:

> The discourses of the child, the parent and the community embodied salvation stories through which people are to know, understand, and experience themselves as members of a community and as citizens of a nation. (p. 184)

The notion of the ‘cosmopolitan, problem-solving child’ is evident in one of the aims of the Constitution, which is to ‘free the potential of each person’ (South Africa. Department of Education, 2002b), as freeing the potential of a person implies that the person will be a problem-solver. The first critical outcome in the National Curriculum Statement states ‘The critical outcomes envisage learners who are able to: identify and solve problems and make decisions using critical and creative thinking’ (South Africa. Department of Education, 2002b, p. 1), complying with this notion. That people are to ‘know, understand, and experience themselves as members of a community and citizens of a nation’ is evident in the second and third developmental outcomes of the National Curriculum Statement, which states that learners must be able to ‘participate as responsible citizens in the life of local, national, and global communities’ and ‘be culturally and aesthetically sensitive across a range of social contexts’ (South Africa. Department of Education, 2002b, p. 2). Another generic paragraph in the curriculum documents for all eight learning areas (NCS) is concerned with the kind of learner that is envisaged. It states:

> The kind of learner that is envisaged is one who will be inspired by these values, and who will act in the interests of society based on a respect for democracy, equality, human dignity, life and social justice. The curriculum

> seeks to create a lifelong learner who is confident and independent, literate, numerate, multi-skilled, compassionate, with a respect for the environment and the ability to participate in society as a critical and active citizen. (South Africa. Department of Education, 2002b, p. 3)

The narratives mentioned in the preceding two paragraphs are evidence of the revisioning of ‘the nation’ and the ‘citizen’ in the newly democratic South Africa. Bhabha (as quoted in Popkewitz, 2001), however, cautions against the ‘image of nation’. He had the following to say:

> What I want to emphasize in that large and liminal image of the nation which I began is a particular ambivalence that haunts the idea of nation, the language of those who wrote of it and the lives of those who live it. It is an ambivalence that emerges from a growing awareness that, despite the certainty with which historians speak of the ‘origins’ of nation as a sign of ‘modernity’ of society, the cultural temporality of the nation inscribes a much more transitional social reality. (p. 179)

For me in this study, this ambivalence is evident in the policy documents (the language of those who wrote it) and what teachers are making of ‘indigenous technology and culture’ in their classrooms (the lives of those who live it). This study is evidence of a ‘more transitional social reality’ (see Chapter 6).

The development of new policy is always situated within a particular historical, economic, social and political context (Taylor et al., 1997). This is explicitly so with the National Curriculum Statement. In the introduction to the technology curriculum, a generic introduction for all eight of the Learning Areas, the preamble to the Constitution of the Republic of South Africa (Act 108 of 1996) is given. The introduction states that:

> The Constitution provides the basis for curriculum transformation and development in South Africa. The Preamble to the Constitution states that the aims of the Constitution are to:
>
> - heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights;
> - improve the quality of life of all citizens and free the potential of each person;
> - lay the foundations for a democratic and open society in which government is based on the will of the people and every citizen is equally protected by the law; and
> - build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations. (South Africa. Department of Education, 2002b, p. 1)

The National Curriculum Statement is therefore explicitly political. The Manifesto on Values, Education and Democracy (South Africa. Department of Education, 2001b) identified strategies which find expression in the National Curriculum Statement to familiarise learners with the Constitution. One of the strategies is ‘to learn about the rich diversity of cultures, beliefs and world views within which the unity of South Africa is manifested’. The Constitution and the Manifesto therefore provided the context for the inclusion of ‘indigenous technology and culture’ as an assessment standard in the National Curriculum Statement: Technology. The rationale for the inclusion of ‘indigenous technology and culture’ in the South African technology curriculum is therefore based in a political and historical context.

The revisioning of ‘the nation’ and the ‘citizen’ and its link to the rationale for the inclusion of ‘indigenous technology and culture’ in the curriculum is evident in the responses given by the curriculum developers to a questionnaire (see Appendix 2). The questionnaire was sent to the curriculum developers for the National Curriculum Statement: Technology. Their responses to the question ‘What was the rationale for the inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement?’ are given in Text Box 5.1.

Respondent	Response
2	Technology as a ‘problem solving’ discipline is not a modern phenomenon, although many of today’s youth are unaware of past achievements. (RQ2)
3	The balance was between ‘indigenous’ and ‘South African’ – We were ‘informed’ that indigenous was to be taken as South African. We felt that there needs to be an appreciation of South African cultures and their contribution to technology, and, that learners needed to understand the circumstances that lead to technological developments. (RQ3)
4	Indigenous Technology is part of the way of life of communities and part of the way of life within communities is informed by cultural practices and tradition. It was important that curriculum development marries the two. The sustainable development of people is dependent partly on the various knowledge systems that exist and how those systems could create a harmonious environment and promote coexistence. (RQ4)

Text Box 5.1

Respondent 2 acknowledges that the rationale for including ‘indigenous technology and culture’ in the technology curriculum is that technology is a problem-solving discipline, whilst Respondents 3 and 4 both emphasise the link between culture and technology, and the importance of including this aspect in the technology curriculum. Respondent 3’s response is confusing as the Grade 9 assessment standard for Learning Outcome 3 states that for ‘Indigenous Technology and Culture’:

> We know this when the learner: explores, compares and explains how different cultures in different parts of the world have effectively adapted technological solutions for optimum usefulness. (South Africa. Department of Education, 2002b, p. 51)

As the assessment standard states ‘different parts of the world’, ‘indigenous’ is obviously not meant to be taken as ‘South African’. It seems that there was not a clear understanding of ‘indigenous’ at the development level of the curriculum. In the focus group discussion at the PATT-18 conference in Glasgow, Scotland, Andrew Feenberg commented on this. Andrew Feenberg works in the philosophy of technology field and was a keynote speaker at the PATT-18 conference in 2007. An extract of the focus group discussion is given in Text Box 5.2.

Andrew:	What is it, what does that curriculum say is indigenous?
Sonja:	They don’t say anything. That’s why it’s so open to recontextualisation.
Andrew:	Then it doesn’t sound like they’ve made any decisions they should have made.
Sonja:	That’s what’s really worrying. How are teachers going to take that?
Andrew:	They can do anything with it. (FGS)

Text Box 5.2

The problem concerning lack of clarity in the National Curriculum Statement was reiterated in a recent draft report (South Africa. Department of Education, 2009) on a review of its implementation, which stated: ‘If the outcome is specified at a relatively generic or vague level, then what learning is measured at the end remains open’ (p. 43). The National Curriculum Statement, as previously mentioned, was the result of a process of revision with the purpose of strengthening and streamlining Curriculum 2005 (Chisholm, 2005).

The design elements of the National Curriculum Statement are given in Figure 5.1. This figure illustrates the interaction between these elements.

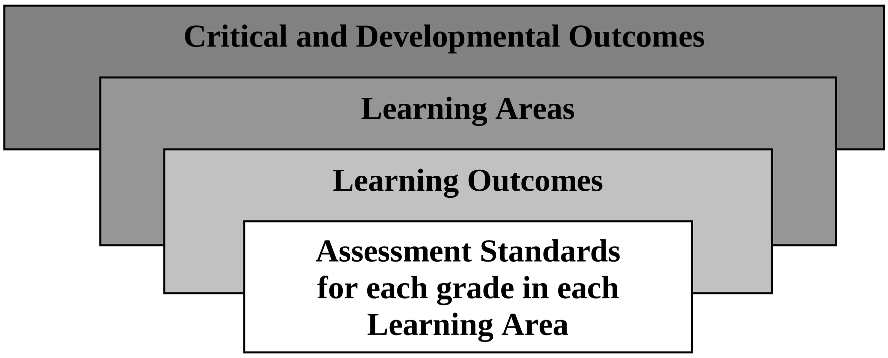

Figure 5.1: The design elements of the National Curriculum Statement (South Africa. Department of Education, 2002b, p. 53)

Assessment Standards are specific to each grade and they demonstrate the level at which learners should demonstrate their achievement of a Learning Outcome. A Learning Area is a field of knowledge and the Learning Outcomes are specific to the Learning Area. The General Education and Training band of the National Curriculum Statement for learners from Grade 9 to Grade 9 contains eight compulsory Learning Areas: Languages, Mathematics, Natural Sciences, Technology, Social Sciences, Arts and Culture, Life Orientation and Economic and Management Sciences. The Technology Learning Area has three Learning Outcomes: technological processes and skills (LO1); technological knowledge and understanding (LO2); and technology society and the environment (LO3). In the Foundation Phase (Grades R – 3), Technology is incorporated into the Life Skills Learning Programme and only Learning Outcome 1 is dealt with at this level. In the Intermediate Phase (Grades 4 – 6) and the Senior Phase (Grades 7 – 9), all three Learning Outcomes are assessed.

The National Curriculum Statement explicitly acknowledges, for the first time, ‘indigenous knowledge systems’. As far as I can ascertain, the National Curriculum Statement for South Africa is the only curriculum that includes indigenous knowledge for *all* learners. Curricula in other parts of the world include ‘indigenous knowledge’ for indigenous learners only (see 2.3.4). Indigenous knowledge systems (IKSs) are also included in the Natural Sciences learning area as Learning Outcome 3. This section of this chapter examines the development of the three curriculum reforms that have to do with the interrelationship between technology, science, society and the environment. In the first curriculum developed in 1997 (C2005), Technology had seven Specific Outcomes. The last three dealt with the relationship between technology and society, and so are of interest to this study. Table 5.2 lists these last three outcomes.

SO5	Demonstrate an understanding of how different societies create and adapt technological solutions to particular problems
SO6	Demonstrate an understanding of the impact of technology
SO7	Demonstrate an understanding of how technology might reflect biases and create responsible and ethical strategies to address them

Table 5.2: Specific Outcomes 5, 6 and 7 for Technology in Curriculum 2005.
(South Africa. Department of Education, 1997)

The Draft Revised National Curriculum Statement (South Africa. Department of Education, 2001a), released for public comment on 30 July 2001, placed these three Specific Outcomes under one Learning Outcome, that of ‘Technology and Society’. This outcome required learners to be aware of ‘changes in technology over time’ as well as ‘impacts’ and ‘biases’. The assessment standards included aspects such as ‘investigating the changes in fashion trends’, ‘researching use and abuse of labour in clothing industry’, ‘exploring career opportunities within the construction industry’ and looking at ‘impact’ and ‘bias’. Table 5.3 gives the details in the Draft Revised National Curriculum Statement for Technology.

Learning Outcome: Technology and Society
• changes in technology over time • impacts • biases

Table 5.3: Learning Outcome: ‘Changes in technology over time’ in draft revised National Curriculum Statement. (South Africa. Department of Education, 2001a)

The final revised National Curriculum Statements, finally approved in 2002, reviewed this outcome. The revised Learning Outcome 3 requires learners to demonstrate an understanding of the interrelationships between science, technology, society and the environment. Interestingly, and the focus of this study, is the first assessment standard for Learning Outcome 3 (LO3 AS1) in the revised curriculum. This assessment standard deals with ‘indigenous technology and culture’. This was a new inclusion to the curriculum. The other two assessment standards concerning the ‘impact of technology’ and ‘bias in technology’ had been kept consistent throughout the three curriculum revisions. Table 5.4 lists the assessment standards for Learning Outcome 3 of the revised National Curriculum Statement: Technology.

<table>
<tr><td colspan="2">Learning Outcome 3: Technology, Society and the Environment
The learner will be able to demonstrate an understanding of the interrelationships between science, technology, society and the environment.
The achievement of this Learning Outcome will ensure that learners are aware of:</td></tr>
<tr><td>indigenous technology and culture</td><td>changes in technology over time, indigenous solutions to problems, cultural influences</td></tr>
<tr><td>impacts of technology</td><td>how technology has benefited or been detrimental to society and the environment</td></tr>
<tr><td>biases created by technology</td><td>the influences of technology on values, attitudes and behaviours</td></tr>
</table>

Table 5.4: Learning Outcome 3 and its assessment standards in the National Curriculum Statement: Technology. (South Africa. Department of Education, 2002b, p. 9)

The inclusion of ‘indigenous technology and culture’ changed the emphasis of this part of the Learning Outcome. Curriculum 2005 placed the emphasis on technology and society, whereas the Draft Revised National Curriculum Statement placed an emphasis on the historical aspect of technology (‘changes in technology over time’). The National Curriculum Statement: Technology, however, gave a more inclusive approach as it encompassed ‘changes in technology over time, indigenous solutions to problems, cultural influences’ (South Africa. Department of Education, 2002b, p. 9), so it expanded on the assessment standard given in the Draft Revised National Curriculum Statement.

The traditional approach of Curriculum 2005 (C2005) required learners in Technology to explore the ‘positive and negative impacts of technology’. This approach addressed only the outcomes of technology and cast technology in a perspective of cause and effect relationships which presented a technologically determinist, or at best an instrumentalist, view to learners (see Chapter 2 for descriptions of technological determinism and instrumental approaches to technology). The latest curriculum revision addressed this simplistic approach to some extent by recognising that socio-cultural-ecological patterns are embedded in the content and processes of technologies. This is evident in the description for Learning Outcome 3 in the National Curriculum Statement: Technology which states that:

> All technological development takes place in an economic, political, social and environmental context. Values, beliefs and traditions shape the way people view and accept technology, and this may have a major influence on the use of technological products. (South Africa. Department of Education, 2002c:9).

The first part of this description for Learning Outcome 3 implies that technological development is influenced by other factors, suggesting the active role of humans in the shaping of technology. The emphasis on context encourages learners to explore the challenges faced in specific situations in terms of technological development. The economic, political, social and environmental contexts in which technology develops and on values, beliefs and traditions allows for a more critical stance to viewing technology compared to an instrumental or deterministic one (see Chapter 2). The second part of this description is deterministic in its outlook as it suggests that values, beliefs and traditions shape the way people view and accept technology, implying that it is technology that impacts on society and it neglects the fact that values, beliefs and traditions influence the way technology emerges and develops. It restricts this social influence to the 'use' of technological products and does not mention the development process of technological products, thereby giving a deterministic view of technology. It neglects the fact that values, beliefs and traditions influence the way a technology emerges and develops (Vandeleur & Schäfer, in press).

Learning Outcome 3, with its emphasis on the interrelationships between science, technology, society and the environment, engages with the principles underpinning the curriculum: social justice, a healthy environment, human rights and inclusivity. The inclusion of this outcome is in line with curriculum revisions in other countries such as New Zealand (Jones, 2003) and the United States of America (USA) (International Technology Education Association, 2002), which acknowledge the interrelationship between science, technology and society. An interest in the USA in the science-technology-society (STS) interrelationship started in the 1970s when universities such as Cornell and Stanford started programmes on what is now referred to as STS. The STS and environmental education movements in the USA came into being at the same time out of growing concern that education must do more to develop an informed citizenry capable of making decisions about problems. According to deBettencourt (2000), STS and environmental education share more than purpose; they share subject matter. It is noteworthy that the South African curriculum has included 'environment' in the exploration of interrelationships concerned with technology.

Other countries include the study of the interrelationships between science, technology and society in their curriculum for Technology Education. The 'Standards for Technological Literacy' developed by the International Technology Education Association (ITEA, 2002) has four standards that deal with this aspect of technology studies. In New Zealand, learners must develop an understanding of the ways in which beliefs, values and ethics promote or restrain technological development and influence attitudes towards technological development (Jones, 2003). But, as ascertained so far, the inclusion of 'indigenous technology and culture' in the technology curriculum seems to be unique to South Africa. This inclusion in the third curriculum revision, shows the development of the technology curriculum from its broad beginnings in Curriculum 2005 to a more unique aspect that I assume is designed to suit the diverse nature of the South African population. Williams (2004) stated:

> The type of Technology Education developed within a country must be designed to serve that country's needs … resulting in a unique Technology Education program … Other more traditional disciplines have developed an internationally acceptable body of knowledge, but technology has not and probably never will because of its variable historical significance and the diverse needs of different cultures. (p. 28)

5.3.2 Findings for Phase 1 Part 1

Lindblad and Popkewitz's (2001) notion of narrative in which they ask 'What argument is put forward?' and 'In what way is this argument put into a context and what is this context?', was used as a basis for this study to explore and examine the rationale for the inclusion of 'indigenous technology and culture' in the revised National Curriculum Statement. This narrative notion was used by Lindblad and

Popkewitz to capture transitions. This part of the analysis attempted to answer the first question – ‘What argument is put forward?’ - in relation to the curriculum changes that have occurred in South Africa since its first democratic elections in 1994. It set out to establish the rationale for the inclusion of ‘indigenous technology and culture’ in the Technology curriculum. Part 2 of this phase (see 5.3.3) responds to the second question – ‘In what way is this argument put into a context and what is this context?’

The inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement: Technology is a seemingly unique one and it is applicable to all Grade 4 to Grade 9 learners in South Africa. The revisioning of ‘nation’ and ‘citizen’ in the National Curriculum Statement is a result of South Africa’s historical and political past, and the inclusion of ‘indigenous technology and culture’ emerged from this revisioning. As Harley and Wedekind (2004) stated ‘an enduring characteristic of curriculum is its relay of an overt political vision. Historically, South Africa has exemplified this’ (p. 213). The aspect of ‘indigenous technology and culture’ is part of this political vision, and perhaps due to this, it had unanimous support from the focus group of teachers.

In the final interviews with the teachers from the focus group, it was evident that the unique aspect of the curriculum was given as a reason for keeping ‘indigenous technology and culture’ in the curriculum. In these interviews, the responses to the question ‘Do you think ‘indigenous technology and culture’ should be kept in as it is, or do you think it should be changed in some way, or do you think it should be taken out of the curriculum completely?’ showed the teachers’ unanimous support for the assessment standard of ‘indigenous technology and culture’ to be kept in the curriculum. There is evidence from the interviews in Text Box 5.3 showing this support.

Anne:	I think we need it in, because that’s what sets the curriculum apart as a South African curriculum. In terms of having it reworded, I don’t really think so. I think it’s very accessible as it is. (FI1)
Judith:	I think it should be kept in. Because children nowadays tend to think of technology only as electronic devices, and for them to realise that even making an ostrich egg water holder, is an important technology, is in fact more important – a matter of survival. (FI2)

Karen: Sonja: Karen:	I don't think it should be taken out. No, not at all. Why do you think it should stay? It's just making you aware of where technologies in Africa has come from and understand how things have developed through the years in order to see where we are now. (FI3)
Vivien:	I wouldn't take it out. I would like to make more of the social context. (FI4)
Vincent: Sonja: Vincent:	I think it should stay the way it is. Why do you think it should stay? We need to know where we're coming from, and then what is it that we can improve. Someone made a presentation to us last week, but even though his data was – he's part of the governing body – his data was outdated in terms of when was this data captured. And then the people who invent – scientists, researchers – these statistics showed us that Africa is very small – maybe it can make the size of a thread – but yet Europe, America is growing, it's big, - so if we know where we're coming from and maybe we can learn from where we're coming from, and develop something new from our history. But if we're not going to teach our future generations where we're coming from they wouldn't know how to move forward. So that's my standpoint to say, let's know where we're coming from and develop from that. And maybe invent something better than what we have. (FI5)

Text Box 5.3

5.3.3 Phase 1 Part 2

The purpose of Phase 1 Part 2 was to examine and explore how policy documents concerned with 'indigenous technology and culture' were recontextualised in Grade 9 technology textbooks and some of the national assessment tasks. Reform processes include the ongoing negotiation of competing perspectives and priorities (Ball, 1994; Taylor et al., 1997) and the intention of this section of the study was to examine these perspectives and priorities in the form of learning materials in regard to the curriculum reform processes in South Africa since 1994. The first part of Phase 1 set out to examine the 'argument put forward' (Lindblad & Popkewitz, 2000a). The second part of this phase explores *how* this argument was put into context. It did this by conducting a document analysis of textbooks in order to determine curriculum balance according to the three different learning outcomes and their allocated weighting, and the analyses of two Common Task for Assessments was also undertaken.

This section of the study analysed textbooks in order firstly, to establish whether they reflected curriculum reform recommendations, and secondly to explore how the curriculum statements were recontextualised. The role of textbooks in an educational system cannot be overemphasised as they ‘present a storyline for how the content can be communicated and learned’ (Chiappetta & Fillman, 2007, p. 1847). In the recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) it stated: ‘[T]extbooks have a crucial role to play in exemplifying how to teach’ (p. 44). Technology textbooks are important as they should reflect the goals of Technology Education and they are often used as the primary organiser of the subject matter that learners are expected to master. They can be helpful to the inexperienced or unqualified technology teacher, an important fact given the lack of trained teachers in this field in South Africa (Stevens, 2005; Nkosi, 2007). Given that textbooks are such a prominent part of the teaching and learning of technology, they should reflect reform recommendations as well as the goals of Technology Education. This part of the study set out to determine whether the Technology textbooks developed for the National Curriculum statement did so.

Chiappetta, Fillman and Sethna (1991) suggested that science textbooks should assist in the development of a scientifically literate society and that the textbooks should therefore provide curriculum balance. The same could be said for technology textbooks. The purpose of Technology Education is to develop technological literacy in learners. This is clearly stated in the introduction to Technology as a learning area:

> The Technology Learning Area will contribute towards learners’ technological literacy by giving them opportunities to:
>
> - develop and apply specific skills to solve technological problems;
> - understand the concepts and knowledge used in Technology, and use them responsibly and purposefully; and
> - appreciate the interaction between people’s values and attitudes, technology, society and the environment. (South Africa. Department of Education, 2002b, p. 4)

The purpose of the analysis of text books was to examine curriculum balance in regard to the weighting of the learning outcomes for technology, as stated in the ‘Teacher’s Guide for the Development of Learning Programmes: Technology’ (South Africa. Department of Education, 2003). Curriculum balance is a concept that is often recommended for school programs and is reflected in the major movements in USA science education to promote scientific literacy and science, technology and society (Wilkinson, 1999). Curriculum balance for technology should be achieved by the weighting of the three Learning Outcomes according to the Teacher's Guide for the Development of Learning Programmes (South Africa. Department of Education, 2003). Learning Outcome 1 reflects the essence of the Learning Area and therefore is more heavily weighted at 50%. Learning Outcome 2 and Learning Outcome 3 carry equal weighting of 25%. It is not clear as to whether the weighting refers to the amount of classroom time spent on each outcome, or whether it is assessment that must be weighted, or whether it is both of these aspects. For this study, the allocated weighting was used to analyse content coverage in Technology textbooks.

Learning Outcome 1 deals with technological processes; Learning Outcome 2 deals with the three content areas of structures, systems and control and processing; and Learning Outcome 3 deals with the interrelationships between technology, science, environment and society. It is noted that Learning Outcome 1, as the practical component of the learning area, is time-consuming and therefore the units of analysis in a textbook allocated to this Learning Outcome, as described later on in this section, do not give an accurate analysis of the coverage. This study was therefore concerned only with the comparison of text coverage between Learning Outcome 2 and Learning Outcome 3. The textbook analysis also examined the text that dealt with Learning Outcome 3 to see how authors dealt with this aspect of the curriculum. So, as well as examining the curriculum balance between Learning Outcome 2 and Learning Outcome 3, it examined which methods, such as case studies, research or design, these authors used as tasks for the learners to engage with 'indigenous technology and culture'. It must be noted here that the Teacher's Guide for the Development of Learning Programmes stated, in its description of Learning Outcome 3, that 'this outcome provides the research component into the interaction between technology and society' (South Africa. Department of Education, 2003, p. 4). I would like to suggest that this statement could give the impression to teachers that 'indigenous technology and culture' is something only to be researched, and not an aspect that could, for example, be used in the learners' designs of solutions.

With technology being a new Learning Area introduced into the curriculum that was launched in 2002, the first textbooks developed for C2005 were largely experimental. Technology textbooks are primary source materials used by Technology teachers to guide them in teaching content and skills prescribed in the curriculum. New

Technology textbooks were published after the most recent curriculum revision and these textbooks were and are one of the few resources available to teachers, along with the curriculum statements. Textbooks assisted, and still assist, teachers with recontextualising the curriculum statements into learning materials.

Content analysis is a research technique that has been used by the social sciences to quantify the symbols and messages used to communicate through various media (Chiappetta & Fillman, 2007). According to Chiappetta and Fillman (2007), the most critical aspect of any analysis of information is the conceptual framework used to guide the inquiry. This study needed to develop a framework that addressed the inclusion of subject matter content and the epistemological orientation of the text, specifically that to do with 'indigenous technology and culture'. As far as can be ascertained, there is no previous study in South Africa on analysis of technology textbooks from which to draw information and comparison. I therefore developed a framework which was based on the one used by Chiapetta, Fillman and Sethna (1991) in their analysis of Science textbooks. This method was adapted to fit in with the needs of this study. This method was chosen as it provided an example determining the emphasis placed on themes in the analysis of Science education textbooks. Similarly, the Technology textbook analysis attempted to determine the emphasis placed on the themes that correspond to the three Learning Outcomes in the National Curriculum Statements: Technology. This analysis was therefore an audit of content against standards. This investigation therefore sought to answer the following questions:

1. What content is emphasised relative to the learning outcomes?
2. Is there a balance within the sections on 'Technology, society and the environment'?
3. How is 'indigenous technology and culture' being proposed in these textbooks?

To investigate the first question, the balance between the three Learning Outcomes for Technology was determined. Therefore the three categories used in this part of the analysis were: the technological process; technological knowledge and understanding; and technology, society and the environment. The content analysis was based on the relative emphasis placed on each of these themes. Most of the learners' textbooks were accompanied by teacher guides. The teacher guides assisted in the analysis for confirmation of which sections were allocated to which assessment standards, as these are either given at the beginning of each section in the learner's book and/or they are given in the teacher's guide.

The categories for the analysis given in Figure 5.2 correspond directly to the three learning outcomes:

1. The design aspect of technology: it reflects the learners' ability to design and make by using the technological process. (Learning Outcome 1)
2. Content knowledge of technology: it reflects the transmission of technological content knowledge where the learner receives information. Information is presented to the student to be learned. Learning materials will present facts, concepts and principles. (Learning Outcome 2)
3. Interaction of science, technology, society and the environment: the intent of the text is to reflect one of the three assessment standards, that is, indigenous technology and culture, impact of technology, bias in technology. (Learning Outcome 3)

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1. TECHNOLOGICAL PROCESSES AND SKILLS

a) investigate
b) design (verb)
c) make
d) evaluate
e) communicate

2. TECHNOLOGICAL KNOWLEDGE AND UNDERSTANDING

a) structures
b) processing
c) systems and control

3. TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

a) indigenous technology and culture
b) impacts of technology
c) biases created by technology

Figure 5.2: The three categories of Technology Education and their descriptors used for analysing curriculum balance in technology textbooks.

A second analysis was conducted of the subcategories. The subcategories correspond to the assessment standards for Learning Outcome 3, which deals with Technology, Society and the Environment. The three assessment standards for Learning Outcome 3 deal with ‘indigenous technology and culture’, ‘the impact of technology’ and ‘bias in technology’. This second analysis determined the relevant emphasis of each of these subcategories.

A third more in-depth analysis was then conducted of how ‘indigenous technology and culture’ was being recontextualised into learning materials. It examined whether the learning materials encouraged a link to be made between ‘technology, science, society and the environment’ as this is the description for Learning Outcome 3: ‘The learner will be able to demonstrate an understanding of the interrelationships between science, technology, society and the environment’ (South Africa. Department of Education, 2002b, p. 9). It also examined whether a link was made between ‘indigenous technology’ and ‘culture’. The analysis then determined how this aspect of the curriculum was introduced to the learner. In other words it looked to see if it was introduced as a case study or a research task, and whether learners were encouraged to use what they had learnt in their design tasks.

The units of analysis were based on those given by Chiapetta and Fillman (2007) in their framework for analysis of science textbooks. They used ‘complete paragraphs; figures, pictures, and tables with captions; marginal comments and definitions; questions in and at the end of the chapter; and each complete step of a laboratory or hands-on activity’ (p. 1856) as their units of analysis. I adapted this and used a complete paragraph; a figure or a table; a picture with a caption; definitions; an activity; or a set of questions at the end of a chapter as the units of analysis. The two aspects that were not used were ‘marginal comments’, as none of the textbooks used this method to convey information, or ‘each step of a laboratory’, which is specific to science-based activities. The ‘hands-on activities’, related to Learning Outcome 1, were included in the paragraph analysis. The sections omitted from the analysis were goal or objective statements, normally found at the beginning of each chapter; summative assessments as these combined all three Learning Outcomes; or self assessments usually found at the end of each chapter. The procedure for the analysis consisted of a tally that was undertaken by the researcher for each unit in each of the five textbooks. The analysis involved matching the three main categories (directly related to the Learning Outcomes) and sub-categories (directly related to the assessment standards for Learning Outcome 3) to the text. A percentage of units of analysis per learning outcome in the first instance, and per assessment standard for Learning Outcome 3 in the second instance, were then calculated.

Five technology textbooks were analysed. These textbooks were selected as they were published by the major publishers in South Africa. All of these textbooks were published in 2006 in response to the implementation requirements of the National Curriculum Statement: Technology. Samples of these textbooks along with the teacher guides were sent to schools. The selected group of teachers mostly used one of the textbooks from this group. In the selection of texts, I went beyond choosing a 5% random sample of pages as suggested by Chiappetta et al. (1991) and analysed complete textbooks as the purpose of the analysis was firstly, to establish the curriculum balance between the three Learning Outcomes and secondly, to examine how ‘indigenous technology and culture’ had been recontextualised by the authors of the textbooks. So in order to establish curriculum balance, it was necessary to analyse entire textbooks. One of the difficulties with the first analysis was that sometimes the paragraph combined two of the Learning Outcomes, for example structures (Learning Outcome 2) and evaluation (Learning Outcome 1). This unit would then be categorised in both Learning Outcomes.

The next part of the analysis of the textbooks, explored *how* the sections dealt with ‘indigenous technology and culture’. It did this by establishing the following:

- Do the learning materials concerned with ‘indigenous technology and culture’ deal with ‘the interrelationship between technology, science, society and the environment’ as stipulated in the National Curriculum Statement?
- Do the learning materials relate to the assessment standard stipulated for that grade?
- Which assessment tasks are used to assess ‘indigenous technology and culture’?

In other words, this part of the analysis attempted to establish whether the sections of the textbooks dedicated to ‘indigenous technology and culture’ engaged learners with an appropriate depth of understanding of the interrelationship between technology, science, society and the environment for this level (Grade 9); whether there was link between the sections allocated to ‘indigenous technology and culture’ and the rest of the chapter; which view of technology (instrumental, deterministic, substantive or a critical view) was being represented in these sections of the textbooks; and whether the social and environmental aspects were being explored as well as the product itself.

National assessment tasks were also analysed. ‘Teachers often teach and authors often write to cover the material that appears in examinations’ (Wilkinson, 1999, p. 12). Therefore it was useful to examine the assessment that happens at Grade 9 level, as this assessment is a national requirement for all Grade 9 learners. Grade 9 learners are required to complete the General Education and Training (GET) assessment at the end of their Grade 9 year and this is the first exit point for learners from the education system. There are two national examinations: the one set by the Department of Education and the other by the Independent Examinations Board. Each of these examinations follows the same format and they are standardised by UMALUSI, the national standardisation body for qualifications. At the Grade 9 level, learners are required to complete school-based assessment which constitutes 75% of the final mark. They then work through a Common Task for Assessment (CTA) which is made up of two parts known as Part 1 and Part 2. The Common Task for Assessment is externally set but internally marked. Learners’ work for Part 1 of the Common Task for Assessment is moderated in cluster groups, which are normally made up of five or more schools in a region. Part 1 of the Common Task for Assessment for Technology consists of five hours made up of a combination of individual and group tasks. It includes a ‘design and make’ task, also known as a ‘capability’ task and therefore mostly assesses Learning Outcome 1, which consists of the design process. Part 2 is a two-hour written examination.

5.3.4 Findings for Phase 1 Part 2

Table 5.5 lists the percentage of content for each theme. It then compares, by giving a ratio, the content coverage of Learning Outcome 2 (LO2) to Learning Outcome 3 (LO3). This analysis was done on content and not on the time allocated for activities for each Learning Outcome. It is therefore not applicable to make any comparisons between Learning Outcome 1 and the other two Learning Outcomes, as Learning Outcome 1 deals with technological processes and skills, and due to the practical nature of this outcome, it is time-consuming in the classroom. Learning Outcome 1 is included in the tally but it is not used for any comparison of curriculum coverage. Of interest to this study is the comparison between Learning Outcome 2 and Learning Outcome 3, as these should be weighted equally according to the Teacher's Guide for the Development of Learning Outcomes (South Africa. Department of Education, 2003).

Textbook	LO1: Technological processes	LO2: Technological knowledge and understanding	LO3: Technology, society and the environment	Ratio of LO2:LO3
A	37,6	53,8	8,6	6,2 : 1
B	32,2	48,6	19,2	2,5 : 1
C	53	44,7	2,3	19,4 : 1
D	54,7	38,6	6,7	5,8 : 1
E	37,9	55,1	7,0	7,9 : 1
Average	43,0	48,2	8,8	8,4 : 1

Table 5.5: Analysis of technology textbooks according to the percentage coverage devoted to the Learning Outcomes.

The ideal ratio of content between Learning Outcome 2 and Learning Outcome 3, according to the weighting given in the Teacher's Guide for the Development of Learning Programmes: Technology (South Africa. Department of Education, 2003, p. 24) should be 1 : 1. As can be seen in the last column of Table 5.5, this is not achieved in any of the textbooks. The lowest ratio is 2,5 : 1 for textbook B and the highest ratio being 19,4 : 1 for textbook C. The average ratio for these five textbooks is 8,4 : 1. The difference in content emphasis between these two outcomes is significant. This means that there is, on average, more than eight times the content for Learning Outcome 2 than there is for Learning Outcome 3. This finding makes explicit the content-based aspect of the textbooks, as Learning Outcome 2 deals with the content areas of structures, processing and systems and control. The lack of content for Learning Outcome 3 could be that it is much more difficult to recontextualise into learning materials and there is very little previous work done in this area to use as a starting point, as 'indigenous technology and culture' was a new inclusion to the National

Curriculum Statement: Technology. The reality, therefore, is that the selected technology textbooks emphasise content and do not give an appropriate weighting to technological issues as defined in Learning Outcome 3.

The second analysis examined the curriculum balance between the assessment standards for Learning Outcome 3. The subcategories consist of: indigenous technology and culture; impact of technology; and bias in technology. Table 5.6 lists the percentage of content for each of these subcategories.

Textbook	**LO3 AS1: Indigenous technology and culture**	**LO3 AS2: Impacts of technology**	**LO3 AS3: Bias in technology**
A	29,6	61,1	9,3
B	55,2	38,8	6,0
C	0	100	0
D	45,5	36,4	18,2
E	20	36,7	43,3
Average	30	54,6	15,4

Table 5.6: Analysis of technology textbooks according to the percentage of content devoted to the assessment standards of Learning Outcome 3

Unlike the Learning Outcomes, no weighting has been stipulated in any policy documents for the assessment standards for any of the Learning Outcomes. If the intention of the curriculum developers was that each of these assessment standards should receive an equal weighting, it certainly has not been achieved in the selected textbooks. In three of the textbooks, the portion for 'impacts of technology' was higher than that for 'indigenous technology and culture', and one of these books dealt only with 'impacts of technology' and did not include any content on the other two assessment standards. Of interest, although not pertinent to this study, is the significantly small allocation of content to 'bias in technology'. If the average for the content allocated to these assessment standards is considered, over half of the content for Learning Outcome 3 in Technology textbooks is devoted to 'impacts of technology', under a third for 'indigenous technology and culture' and less than a fifth for ‘bias in technology’. I think that this is probably due to ‘impacts of technology’ being easier to recontextualise into learning materials, compared to the other two assessment standards of ‘indigenous technology and culture’ and ‘bias in technology’. With the emphasis on ‘impacts of technology’, a deterministic view of technology is being portrayed in technology textbooks and therefore to learners, and very little content is being devoted to developing a critical technological literacy in our learners (see Chapter 2). If learners are exposed only to examining the impacts of technology, they are examining the end point of technological development, and not the contingent aspects, such as culture and politics, that affect the emergence and subsequent development of the technological development. Part of the reason for the lack of emphasis on ‘indigenous technology and culture’ could be the difficulty of interpreting the word ‘indigenous’ and also, as most indigenous knowledge is handed down orally from generation to generation, there is very little for authors to recontextualise into learning materials.

All the textbooks, except for Textbook B, used case studies to deal with ‘indigenous technology and culture’. In fact, the Teacher’s Guide for Textbook E specifically stipulated that the form of assessment for Learning Outcome 3 should be a case study. Very few of the tasks used the overall description of the learning outcome (‘the interrelationship between technology, science, society and the environment’) to guide the development of their learning materials. The majority of the tasks were instrumental, as they asked learners to describe the materials used, preservation techniques and manufacturing processes. Very few tasks involved the learners in any questions concerning culture, or how different cultures in the world had adapted technological solutions for optimum usefulness. For example, the first task in Textbook E that dealt with ‘indigenous technology and culture’ was given as an ‘informal self-assessment’ and promoted ‘indigenous technology and culture’ as historical. The emphasis was on the artefact itself, as it asked learners to find out the manufacturing process, the preservation techniques and the materials used. No questions were asked on the link between the artefact and the culture, on any values attributed to the artefact, on any link with environmental aspects or on how the technology was effectively adapted. So these tasks did not assess ‘indigenous technology and culture’, instead they assessed the learners’ ability to analyse existing products. This means that Learning Outcome 1 was assessed, not Learning Outcome 3.

This section of the study analysed some of the national assessments for Grade 9s in South Africa. Table 5.7 shows the analysis of Part 2 of the Common Task for Assessment set by the Department of Education in 2008. The analysis of Part 2 of the Common Task for Assessment was done according to the allocation of marks per Learning Outcome and not the amount of content given to each Learning Outcome, as was the case for the analysis of the textbooks.

The Independent Examinations Board (IEB) provided two taxonomies to analyse levels of cognitive demand in their Learning Area Guidelines for Technology. They suggest that Bloom's 'Taxonomy of Educational Objectives' is valuable, but they also include Shulman's Table of Learning as another option when analysing cognitive demand in assessments (Independent Examinations Board, 2008b). The use of these taxonomies to analyse cognitive demand is debatable, but Schulman's Table of Learning was used by the examiners to analyse the Common Task for Assessment. The Learning Area Guidelines states '60% of the marks should relate to lower order thinking skills such as recall of knowledge, understanding and practical tasks, and 40% to higher order thinking skills such as judgment, critique and design' (Independent Examinations Board, 2008b, p. 1).

The Learning Area Guidelines for Technology (Independent Examinations Board, 2008b) state:

> The hierarchical and sequential aspect of the different cognitive levels devised by Bloom do not always fit in with the way in which Technology projects are conducted. Design and innovation sometimes require higher levels of cognition than does evaluation (the highest level on Bloom's taxonomy). (p. 8)

The assessment tasks of the Common Task for Assessment Part 2 of 2008 were analysed using the middle four levels of Schulman's Table of Learning. These four levels are: knowledge and understanding, performance and action, reflection and critique, and judgment and design. Shulman's complete Table of Learning is given in Appendix 5. This analysis was done by the examiners of the Common Task for Assessment.

	marks allocated to each LO per question						**levels of cognitive demand targeted by questions**			
	LO1		**LO2**		**LO3**		**1**	**2**	**3**	**4**
	AS	**mark**	**AS**	**mark**	**AS**	**mark**	**mark**	**mark**	**mark**	**mark**
Q1					AS1	6				6
Q2					AS1	4				4
Q3					AS2	2			2	
Q4			AS2	2			2			
Q5	AS5	2							2	
Q6	AS5	3							3	
Q7	AS6	2								2
Q8					AS1	6	3		3	
Q9			AS1	5			5			
Q10			AS1	4			4			
Q11 a-d					AS2	6	3		2	1
Q11 e-g			AS4	3			3			
Q11 f					AS2	2			2	
Q12	AS15	15						15		
Q13			AS1	3			3			
Q14			AS3	8			8			
Q15			AS3	8			8			
Q16			AS3	4			4			
Q17			AS3	4			4			
Q18			AS4	11			11			
Total:		**22**		**52**		**26**	**58**	**15**	**14**	**13**

Table 5.7: Allocation of marks per LO and ASs with levels of cognition (adapted from Shulman's Table of Learning (2002)) for the CTA Part 2, 2008, Department of Education.

It is interesting to note that in examination of the spread of marks in Table 5.7 according to the four levels of cognitive demand adapted from Shulman's Table of Learning (Independent Examinations Board, 2008b), Learning Outcome 3 questions on the interrelationship between technology, science, society and the environment, mostly fall under a cognitive demand of level 3 or level 4 whereas Learning Outcome 2 questions on the content knowledge of technology require a cognitive demand of level 1. All of the 52 marks allocated to Learning Outcome 2 fall into the cognitive demand of level 1 category, whereas Learning Outcome 3 has 6 marks allocated to level 1, 9 marks allocated to level 3 and 11 marks allocated to level 4.

Table 5.8 compares the marks allocated to Learning Outcome 2 to those allocated to Learning Outcome 3 according to lower-order thinking and higher-order thinking as suggested by the Independent Examinations Board (Independent Examinations Board, 2008b). Therefore, most of the responses required by learners for Learning Outcome 3 in this Common Task for Assessment require reflection and critique or judgement and design, considered by Shulman (2002) to be higher-order thinking. He stated:

> Critical reflection on one's practice and understanding leads to higher-order thinking in the form of a capacity to exercise judgment in the face of uncertainty and to create designs in the presence of constraints and unpredictability. (n.p.)

It is not appropriate to include any comparison with Learning Outcome 1 here, as Learning Outcome 1, which deals with technological processes, is mostly assessed in Part 1 of the Common Task for Assessment.

	lower order thinking skills	**higher order thinking skills**
Learning Outcome 2	100%	0%
Learning Outcome 3	23,1%	76,9%

Table 5.8: A comparison of the ratio of lower order thinking to higher order thinking for LO2 and LO3 in the CTA Part 2, 2008, Department of Education.

Table 5.9 compares the ratio between the marks allocated to Common Task for Assessment Part 2 (2008) to the content allocated to these two Learning Outcomes in textbooks. Although this does not compare like with like, the difference in the weighting in the textbooks and the weighting in the Common Task for Assessment Part 2 is significant. The two Learning Outcomes should be weighted equally and therefore the ratio should be 1 : 1. The weighting in the Common Task for Assessment Part 2 (2008) is therefore more reflective of the reform recommendations as stipulated in the National Curriculum Statement. Even so, Learning Outcome 2 is weighted twice as heavily as Learning Outcome 3 for the Common Task for Assessment Part 2 (2008).

	LO2	**LO3**
textbooks	8,4	1
Common Task for Assessment Part 2 (DoE)	2	1

Table 5.9: Comparison of ratios between LO2 and LO3

This section of the study examined whether the questions in a national assessment task for Grade 9s have been correctly allocated to their stipulated Learning Outcome and assessment standard, or not. The Common Task for Assessment Part 1 for Technology for 2008 developed by the Independent Examinations Board had 'Energy Efficient Decorations' as the overall theme. According to the Table of Contents (Independent Examinations Board, 2008a: p. 2), there were two instances in which Learning Outcome 3 was assessed. In the first task allocated to Learning Outcome 3, the learners were required to write an e-mail response to an article titled 'Can you celebrate Christmas without lights?'. This article referred to energy-saving and was topical at the time due to load-shedding of electricity in South Africa. Learners had to define the core issue of the article, include their views on the article and suggest alternative ways of creating a 'festive atmosphere'. This task fulfilled the requirements for LO3 AS2 (impact of technology) well. This assessment standard requires that learners must recognise and identify 'the impact of technological developments on the quality of people's lives and on the environment in which they live, and suggest strategies for reducing any undesirable effects' (South Africa. Department of Education, 2002b, p. 51).

The second instance of Learning Outcome 3 in this Common Task for Assessment is in a task in which the learners have to choose a celebration, such as New Year, Hanukkah, the Festival of Lights, etc. and then select two decorations for this celebration, sketch them, analyse the decorations according to size, purpose, cost, etc. and finally to identify the materials that would be used to create these decorations. In the 'Table of Contents' in the Teacher's Book (Independent Examinations Board, 2008a), this task has been allocated to LO3 AS1 (indigenous technology and culture). However, this part of the task does not fulfil the requirements for this assessment standard entirely (indigenous technology and culture) as it does not compare and explain 'how different cultures in different parts of the world have effectively adapted technological solutions for optimum usefulness' (South Africa. Department of Education, 2002b). This part of the task fulfils the requirements for Learning Outcome 1 Assessment Standard 2 (LO1 AS2), in which learners are required to 'analyse existing products relevant to an identified problem, need or opportunity based on: safety, suitability of materials, fitness for purpose, cost, manufacturing methods' (p. 35), rather than fulfilling the requirements for Learning Outcome 3

Assessment Standard 1 (LO3 AS1). So the assessment focuses on the product and its impact, rather than on the cultural meaning of the technological solution or any comparisons between how different cultures have adapted these technological solutions for optimum usefulness. It seems that the authors have, as the recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) states, struggled to 'unpack' the assessment standards and link these to specific assessment tasks, and what results is a mechanical and bureaucratic process of listing learning outcomes and assessment standards.

5.4 Phase 2: Existing teacher practice

This part of the study set out to examine what the teachers from the selected focus group, as described in Chapter 5, were doing with the implementation of the assessment standard of 'indigenous technology and culture'. It attempted to do this by examining teachers' understanding of concepts central to the implementation of 'indigenous technology and culture' as well as aspects such as time spent teaching Learning Outcome 3 and the availability of teaching and learning resources.

5.4.1 Findings on existing teacher practice

These findings emanate from the individual interviews, the first two focus group discussions held with the focus group of teachers and the focus group discussion held at the PATT-18 conference in Glasgow, Scotland in 2007 (FG1, FG2, FGS, II1 – II5). Rogan and Grayson (2003) suggested that in most cases of curriculum reform, the emphasis is placed on the 'what' of desired educational change and the 'how' is neglected, and as a result good ideas are often not translated into classroom practice. For curriculum change to occur, both the 'what' and the 'how' need to be addressed. Phase 1 of the study attempted to explore the rationale for the inclusion of 'indigenous technology and culture' in the curriculum. Phase 2 of the study examines the 'how' by analysing the implementation of 'indigenous technology and culture' by the focus group of technology teachers.

Teachers' interpretation of policy and corresponding issues

A recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) stated 'The curriculum implementation literature emphasises the central role that teachers play in how a curriculum is realised in practice. Central to this are teachers' understanding of policy' (p. 22). The draft report also stated that teachers spend an inordinate amount of time trying to interpret the Learning Outcomes and Assessment Standards rather than focusing on the teaching and application of concepts. This section of the study examined the teachers' understanding of the Technology curriculum by analysing their understanding of concepts central to the implementation of 'indigenous technology and culture' (LO3 AS1).

'Technology' is a complex phenomenon and difficult to define. This does not mean, however, that key attributes should not be identified (Keirl, 2006). It is meaningful to give these attributes again here (see Chapter 2) due to their significance in understanding the concept 'technology'. The attributes identified by Keirl (2006) are:

- technology cannot 'be' in any functional sense without a relational human engagement;
- no technology is neutral or universally good;
- all technologies are created by a manufacturing process or enabling process resulting from human intention and design;
- all technologies have contested values.

These key attributes are present in the definition given in the National Curriculum Statement: Technology. This definition, in the introduction to the Learning Area states:

> Technology has existed throughout history. People use the combination of knowledge, skills and available resources to develop solutions that meet their daily needs and wants. Some of these solution have been in the form of products (e.g. shaping bones into fishhooks and needles, making clay cooking pots), while some solutions have combined products into working systems (e.g. bow and arrow, moving water and a wheel, pestle and mortar).
>
> Today people still have needs and wants. However, skills and resources used to find solutions are of a different kind because of accelerating developments in technology. Today's society is complicated and diverse. Economic and environmental factors and a wide range of attitudes and values need to be taken into account when developing technological solutions. The development

of products and systems in modern times must show sensitivity to these issues. It is in this context that Technology is defined as:

> *The use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration.*

(South Africa. Department of Education, 2002b, p. 4)

As discussed in Chapter 2, pedagogical implications for Technology Education arise from the epistemological debate about the nature of technological knowledge (Rowell et al., 1999). The way in which technology is conceptualised by teachers will therefore have a direct bearing on the shaping of technology as a subject. This in turn will influence the way in which they deal with 'indigenous technology and culture' in their classrooms. 'Teachers' perceptions of technology influence what they perceive as being important in learning technology' (Jones, 1997, p. 83). In other words, teachers' assumptions about the nature of technology will affect how and what they teach.

There is evidence in the extracts from the initial interviews given in Text Box 5.4 that suggested that most of the teachers in the focus group did not have a common understanding of the meaning of 'technology' according to that given in the curriculum. There has been a general failure to reach a consensus about the meaning of technology, as discussed in Chapter 2, and there is not a single, precise definition. Even so, there is a definition given in the National Curriculum Statement, yet few of the teachers had an understanding related to this specific definition.

Anne:	Technology … is … I think exactly that. The knowledge of how technical things need to function. I think that's really what I'm teaching. (II1)
Judith:	Problem solving, but also in a very practical way, I would like to add in that - seeing things in real terms rather than just abstract. (II2)
Karen:	I started to link it with Science. I saw once a grid with the steps showing … and how one is your investigating also with your science and everything. (II3)
Vivien:	Well, sometimes I don't think I have an understanding. I think it's basically using a modern interpretation of lots of different subjects, to be honest – the old industrial arts, computers, Home Economics, Consumerism. I think its sort of putting them all into a modern context that you can relate to today, because of the advances we've made. (II4)

Vincent:	My understanding is its development. That's how I put it to my learners. Dealing with development – improving things, from the ancient times of the olden times, since the beginning of man, or since the discovery of fire. (II5)

Text Box 5.4

From this short extract, Anne's comment would suggest that she held an instrumental view of the nature of technology at this time. This view is one of the most widely accepted views of technology, and it is based on the idea that technologies are tools used to provide the means for the realization of independently chosen ends (Feenberg, 1991). As Dakers, Dow and de Vries (2007) stated 'There is a tendency in the teaching of Technology Education at school level, to present information about some pre-existing technologies in an instrumental form' (p. 7). The instrumental view perceives technology as neutral products separated from values. In other words, means are separated from ends (see Chapter 2). Judy's understanding of technology was more in keeping with the description given in the National Curriculum Statement: Technology, which states that technology is defined as 'the use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems' (South Africa. Department of Education, 2002b, p. 4). It seems as though Karen's view of technology had been influenced by her training as a science teacher as she viewed technology as applied science. As discussed in Chapter 2, science and technology have very strong links, but these two domains have very different ways of viewing the world. Research by Jones and Carr (1992) in New Zealand found that secondary school subject subcultures had a strong influence on teachers' concepts of technology and their classroom practice and this is very much in evidence in Karen's case. That technology is a subset of science has been challenged by educationists such as Williams (2002a) and Compton (2004). Vivien stated that she did not have a clear understanding of technology. As discussed in Chapter 2, 'technology' is a complex concept. Misa (2003) stated that the nature and meaning of technology has changed over time and continues to change, and therefore 'technology' cannot be defined statically. Keirl (2006) suggested that the complexity of this phenomenon did not make it impenetrable as it is possible to identify key attributes (see Chapter 2). Even so, Vivien did not draw on any understanding from the definition from the National Curriculum Statement: Technology. Vincent's comment on the development and progress suggested an instrumental view. In this view, technology is seen as an instrument of progress and it encounters raw materials as waiting to be transformed into whatever it is that humans desire (Feenberg, 2006).

Many aspects affect teachers' perceptions of technology. Lindblad (1990) found that teachers in Sweden, when responding to a new technology curriculum, formulated classroom experiences based on their past experiences. As mentioned in the previous paragraph, research by Jones and Carr (1992) found that secondary school subject subcultures influenced teachers' concepts of technology and therefore their classroom practice. Jones (1997) commented on the fragile nature of teachers' newly developed concepts of technology and Technology Education. He stated:

> Teachers developed strategies to allow for learning outcomes that were often more closely related to their particular teaching subject than to technology hence affecting the student learning in Technology Education. This was particularly noticeable when teachers entered areas of uncertainty and they often reverted to their traditional teaching approaches and learning outcomes. Teachers newly developed broad concepts of technology and Technology Education appeared to be somewhat fragile and transient in nature. (pp. 86 - 87)

This fragility is evident in the teachers' confidence in teaching Technology, and specifically 'indigenous technology and culture'. Extracts from the initial interviews and the first focus group discussion, given in Text Box 5.5, show their responses in this regard.

Anne:	To try and get indigenous anything, in anything else is like - I'm not sure about this. (II1)
Karen:	Pleading guilty. Not knowing enough about it. (II3)
Karen:	I don't think the implementation would be difficult it's just I don't feel competent enough. I don't think I know enough. And I think the learners nowadays are more open-minded to those kinds of things. They're growing up knowing that it's all OK. If it was ten years back I think we would have had a huge issue with it. I think the biggest issue is from the teacher point of view. The teachers are not really trained and don't really know enough about this to actually give it and that's why they avoid teaching it because they don't know enough. (II3)
Judith:	It's difficult. I mean this is an area that I've been so busy just trying to get the basics right with LO1 and LO2 that I haven't even looked [at LO3]. (FG1)

Text Box 5.5

Another concept important to the implementation of ‘indigenous technology and culture’ is, of course, ‘indigenous’. ‘Indigenous’ is a term that is being increasingly used in policy documents and it can be found in the education policy documents of countries such as Canada, New Zealand and South Africa (Phiri, 2008). Issues surrounding the definition of ‘indigenous’ and ‘indigenous knowledge systems’ have been articulated in Chapter 2. The responses to the question ‘What do you understand by the word ‘indigenous’?’ from the initial individual interviews are given in Text Box 5.6.

Anne:	That again is a fuzzy area. Indigenous to whom? Indigenous to Africa? Indigenous to Europe? Traditional. I think is what I see. (II1)
Judith:	I do think they mean local. Local, Khoisan. (II2)
Vivien:	See that for me is rural Africa. (II4)
Vincent:	If we’re talking about indigenous – let’s go back to this guy in Soweto. There’s this guy in Soweto who discovered a smokeless stove, something like that. But I don’t think the research council in Pretoria has endorsed it yet. But there’s another person who came up with the doldrums (sic)? for the beach. Do we classify that as ‘indigenous’?(II5)

Text Box 5.6

So, as evident in the above responses, the teachers had very different understandings of the meaning of the word ‘indigenous’. Anne equated ‘indigenous’ with ‘traditional’, whereas Vivienne stated that ‘indigenous’ and ‘traditional’ are different in her understanding. She viewed ‘indigenous’ as being ‘rural Africa’ and ‘traditional’ as that which emerges from a cultural background. Judith took the meaning of the word to represent the original inhabitants of the country, hence the Khoisan in South Africa, whereas Vincent equated the word ‘indigenous’ with anything that is local, although he was not sure of this definition. The fact that Anne said ‘That again is a fuzzy area’ suggests that there are many aspects in the Technology curriculum that lack clarity. The issue of clarity was mentioned in the draft report on the implementation of the National Curriculum Statement. The report had the following to say on content specification:

> A key dimension related to the successful implementation of curriculum relates to the detail and clarity provided by policy in relation to what to teach. Recent research by UMALUSI (2009a), as well as hearings and submissions indicate that in certain key FET subjects (with the highest enrolments in the National Senior Certificate) the content and/ or skill topics to be covered is extremely clear in the *National Curriculum Statement* (Umalusi, 2009a:38).

> Guidance in other subjects and at other levels, however, is uneven. Most learning areas in the Intermediate and Senior Phases still lack clarity… (pp. 42 – 43).

In an attempt to clarify the meaning of 'indigenous' as pertaining to the National Curriculum Statement, Vivien and I had a discussion as shown in Text Box 5. 7.

Vivien:	I would never use the term 'indigenous' in Europe.
Sonja:	No?
Vivien:	Never!
Sonja:	So you don't really see it anywhere except for here? But in Grade 9 now we have to look at indigenous technologies around the world. So?
Vivien:	I think that's hard because I'm not sure in many of the European cultures I could find that. It could, possibly in Australia – you've got your Aborigines.
Sonja:	But, even in Scotland, come on, whiskey is an indigenous technology, isn't it?
Vivien:	I suppose it is. I suppose so.
Sonja	And your girdle scones or whatever they're called? What are they?
Vivien:	Ah yes, soda scones. And your girdle scones. That kind of thing.
Sonja:	Yes. So that comes out of that tradition, that culture.
Vivien:	But you see, I see traditional as somehow …
Sonja:	Is traditional different?
Vivien:	Yes, for me. For me indigenous is maybe something I don't understand because it's not an understanding of a culture I have, whereas traditional for me is what would be traditional to a particular country, and I can relate that to first world. Somehow I see the fact that most people in this country are living in the third world. I see that as where indigenous technology needs to move in and improve peoples' lives. But I'm not sure that's the understanding other people would have.
	(II4)

Text Box 5.7

There were different attitudes towards the use of the word 'indigenous' in the National Curriculum Statement: Technology. Vivien in particular found the word offensive, and reiterated her stance on a number of occasions. This is evident in the extracts from the two focus group sessions and the final individual interview with Vivien, as shown in Text Box 5.8. Different interpretations of and attitudes towards the word will lead to different practices in the classroom. One of four broad themes in a study of mapping policy onto practice conducted by Harely, Barasa, Bertram, Mattson and Pillay (2000), was that 'Teachers' personal value systems are often at odds with policy' (p. 294). This was definitely so with Vivien.

Vivien:	But also where you have racism still reeling itself in the head. And it does. I mean it still does. Even you know … we were just talking about the Zulu department and the mentorship and how problematic it was. Because it is a white person coming in as the mentor, who is fluent. But it is seen as problematic. (FG1)
Vivien:	I think 'indigenous' for some people is seen as slightly offensive.(FG1)
Vivien:	I find it a derogatory term. (FG2)
Vivien:	Well you see I just see this culture of, background culture, history, I just find it such an offensive term. And even our children, you know, they're very, they're very quick. They're quite sophisticated, actually, and then the minute you talk say about rural cooking and rural food they, kind of see it as an offence. … I tend to want to leave it – the term 'indigenous', I can't tell you what it does to me. I just find it offensive. (FG2)
Vivien:	So you see for me, I wouldn't – for me indigenous means indigenous people. People that have always had their rights taken away from them, perhaps something I don't understand and it's a bit – I definitely find it derogatory. It's why I hate whenever I see it I sort of think 'Oh, no!' (II4)

Text Box 5.8

Another issue with using the word 'indigenous' was the aspect of which group of people gets to be included and which is excluded, and which technologies would be classified as 'indigenous' and which would not. This issue was discussed by the teachers in the initial interviews and the first focus group discussion. These extracts are presented in Text Box 5.9.

Karen:	'Indigenous' in my opinion at this point in time is all very much based on what the Zulu did and what the Xhosa did and what the Sotho did. All of that …but no-one does the impact on what the Afrikaner did or even the English impact … Because all of us have been born here and all of us have had a huge impact on those things and whatever was indigenous over there was brought here but … so I still have a definition problem because I don't think we always look broad enough in terms of indigenous. (II3)
Vincent:	I don't say 'black culture' - it's indigenous and leave it at that. Everyone who's within South Africa that's indigenous cultures. (II5)
Anne:	Ja. I would think. And, and possibly, the fact that one needs to look at developing an understanding of other cultures within that. You know. OK, indigenous for you is 'x' but what about all the other cultures? Let's look at indigenous technology in terms of a variety of cultures in South Africa. Because … Chinese, Indians … you know, what's their indigenous technology? (II1)
Vivien:	I think if you ask a black person – they see it – indigenous culture as black culture. I guarantee it. That's how they see it. (FG1)

Judy:	With them wanting to have the Jewish thing, I was saying … what about… we always …. Is it just black South Africa indigenous or is it like when our people were in Egypt and making Matzo before they ran across the Red Sea. What kind of technology …All our bread making is all related to every religious holiday. There's different things for every holiday.... in the Jewish religion – everything - the food – food is a major thing. The whole kosher thing. Everything is so much … and the technology of doing it right. (FG1)

Text Box 5.9

In a focus group discussion with Andrew Feenberg at the PATT-18 conference in Glasgow in 2007, the discussion around the meaning of 'indigenous' was very interesting as the focus group consisted of Technology Educationists and philosophers of technology from various parts of the world, such as New Zealand, the United States of America, India, England, Canada, South Africa and Australia (see 3.4.2). This part of the discussion is given in Text Box 5.10.

Andrew:	What is indigenous?
Sonja:	Yes, well, we've had lots of discussions around that because it can be – in South Africa it can looked at as black culture. And the Afrikaner person says no but we're also an indigenous grouping. So what is indigenous? There's a time and a space thing that's problematic. How long do you have to be in a place before you're indigenous?
Vicky	Exactly.
Andrew:	Well, usually I mean I would have guessed – I was assuming that by 'indigenous' was meant the pre-modern techniques that …
Sonja:	No
Vicky:	No.
Andrew:	But if what you mean is whatever is done locally then of course there's all kinds of adaptations that take place when technology is transferred so modern technology moves around the world and gets adapted in each place it goes and so it's localised but still there's a difference between the pre-modern techniques that people inherit from their ancestors and these modern techniques which have then been locally adapted in some way but which belong to a very different cultural universe. (FGS)

Text Box 5.10

Andrew Feenberg attempted to clarify the different meanings derived from the word 'indigenous'. The following dilemma arose from this discussion: could 'indigenous technology' be taken to mean those technologies that have been developed over centuries of use or is it taken to mean technologies that have been adapted for local use? It is this difference in the meaning of ‘indigenous’ that is problematic in interpreting the National Curriculum Statement: Technology. In Andrew Feenberg’s discussion, he talks about the difference between technologies that are localized, in other words they get adapted for local use, to technologies that have been inherited from ones’ ancestors. These two different types of technology belong to a ‘very different cultural universe’. The one is inherited and is therefore culturally based, and the other is introduced and is then locally adapted, although it is then influenced by local factors such as culture. Andrew Feenberg was asked for his meaning of ‘pre-modern’ due to the ideologies surrounding the word. His response is given in Text Box 5.11.

Andrew:	It could be, of course, it could imply some sort of progressive hierarchy but we do need a word for signifying what was done independent of and mostly before the development of modern types of machine-based technology and so pre-modern is a convenient word to use. Maybe it’s the wrong word but I’m not sure what the right word is. Do you have a better one? (FGS)

Text Box 5.11

In the recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009), it stated that in the hearings and submissions on the implementation of the curriculum, Assessment Standards were argued to be vague at times. The report further stated: ‘At present Learning Outcomes do provide a very broad general sense of what a subject or learning area is about, but we argue that they are ineffective in providing a means for 'designing down' what to teach’ (p. 42). I agree with this statement in regard to the National Curriculum Statement: Technology, as a broad definition of technology and Technology Education is given. However, it does not provide any description or definition of central concepts within the Assessment Standards, such as ‘indigenous’ or ‘culture’. The draft report further stated:

> They [the teachers] reported struggling to 'unpack' assessment standards and link these to specific assessment tasks. Often what results is a mechanical and bureaucratic process of listing learning outcomes and assessment standards to show that these are covered, without opening up for teachers the logic of what they are doing in the classroom. In addition, the process distracts from the teaching and learning of the subject. (p. 43)

The overarching statement for Learning Outcome 3 is that 'The learner will be able to demonstrate an understanding of the interrelationships between science, technology, society and the environment' (South Africa. Department of Education, 2002b, p. 9). The focus group of teachers understood there was an interrelationship between technology, science, society and the environment, even though Vivien, due to her view on the concept 'indigenous', did not agree that there was a relationship between science and indigenous technology. Extracts from their initial interviews are given below in Text Box 5.12.

Anne:	Science and technology are very closely related. (II1)
Anne:	So it's taking that [science] and using it to design something and work out how it would work. How those, how those principles that you learn in Science can be put into action. (II1)
Anne:	In terms of environment, Technology and the impact on the environment is really part of our, if you like, social responsibility if you want in terms of who we are as South Africans. You've got to look at the impact that you have all the time. And that's where there's a huge closely interactive link between Technology and Geography. (II1)
Judith:	I think it's very basic and important to technology. That everything you do in technology should relate to society and the environment. And even if it's in a bad way it does effect the environment or society. (II2)
Karen:	I think there's quite a big interrelationship. I think the one depends on the other one and has a huge impact on everything. (II3)
Karen:	I'm sure if you look back at it there are lots of scientific principles that you can apply to it. And maybe the people did that unknowingly. Like those Nguni grain pits. (II3)
Vivien:	Now you see I can see society and the environment, but with indigenous technology I would not see science as part of indigenous technology. Because I view indigenous technology the way I do. So for me science does not quite fit in there. (II4)

Text Box 5.12

It is notable that in the Technology Learning Area Glossary in the National Curriculum Statement: Technology (South Africa. Department of Education, 2002c), there is no definition given for 'indigenous' or 'culture', which means that teachers have no guidance in interpreting this assessment standard. The ways in which these words are conceptualised by teachers will have a direct bearing on how 'indigenous technology and culture' is taught and learnt in the technology classroom. In some cases, lack of confidence in knowing what to do due to uncertainty about the meaning of these words is the reason why some teachers did not include 'indigenous technology and culture' in their classroom practice.

Implementation of 'indigenous technology and culture' in the classroom

When the teachers were asked at their initial interviews as to whether they had spent 25% of their teaching time on Learning Outcome 3, which is the stipulated weighting given in the curriculum document, four out of the five teachers had not done so. Judy, a new Technology teacher trained in Art education, in trying to understand the subject and how to teach it, had dealt only with the first two Learning Outcomes (see Text Box 5.5). Karen, a Science teacher, felt that she did not know enough about it and therefore did not implement it (see Text Box 5.5). In response to being asked whether they spent 25% of the teaching time on Learning Outcome 3, two teachers replied in the negative, as given in Text Box 5.13.

Anne:	I haven't yet but I will be.	(II1)
Vivien:	I certainly don't.	(II4)

Text Box 5.13

Four out of the five teachers from the focus group had therefore not done very much work with Learning Outcome 3, and one of the four had not included it at all. There was also a lack of confidence with the teachers in implementing 'indigenous technology and culture' (see Text Box 5.5). As stated in the draft report on the implementation of the National Curriculum Statement: 'Learning Outcomes and Assessment Standards are not guarantee that the key content, concepts and skills are being covered' (South Africa. Department of Education, 2009, p. 43). At the time of the initial interviews, very little in the way of implementation of Learning Outcome 3 was happening in the classrooms of the teachers who were in the focus group.

As mentioned in Chapter 3, the Technology teachers in the focus group did not have any formal qualifications in Technology Education. The evidence of this is given in Text Box 5.14 which gives extracts from the initial interviews and the focus group discussions. It is also important to note that the teachers had very different subject specialties, ranging from teaching Geography and Science to Art. Rresearch by Jones and Carr (1992) stated that this has a strong influence on teachers' concepts of technology and their classroom practice.

Anne:	Well hello. I'm hardly qualified. (II1)
Judy:	So my degree is a Fine Arts degree which is an honours degree obviously. So that I've got. (II2)
Vivien:	I have a degree in Home Economics, a degree in Food and Nutrition. (II4)
Vincent:	Well, in terms of not like the ones recognised by institutions, but for in-service, yes. From the EU that was training us in North-West. (II5)
Judy:	And technology teachers – I mean – a lot of teachers are not technology teachers at all. I mean I was doing art in the girls' school and the rabbi said "Do you think you can do Technology?" So I went and read up on Technology. I don't really have any qualifications to do it. (FG2)
Karen:	All of us were trained as other types of teachers and now we all just picked up Technology because it came our way. (FG2)

Text Box 5.14

Two teachers out of the five in the focus group had implemented 'indigenous technology and culture' in some form in their classrooms. The most prolific in terms of examples of 'indigenous technology and culture' used in the technology classroom was Vincent (see Text Box 5.15). It is interesting that Vincent seemed to incorporate this aspect seamlessly into his teaching and he did not have difficulties in finding examples. This aspect is dicussed further in the findings for Phase 3 (see 5.5.1). Karen had used the Nguni Grain Pit example. She and I had developed a Common Task of Assessment in 2006, and so she had that as an example in her repertoire.

Karen:	OK. Nguni grain pit. OK. We've done that one. (II3)
Vincent:	I'm very fortunate in the classroom I have different cultures. Then when I say to them 'How is the skin hide, I mean the cow hide done at home, how is it dried?' A Xhosa child will tell me a different way, the Zulu child, the Pedi child, so at the end of the day you have this vast knowledge of how different cultures do that particular process. So it becomes easier that way. (II5)
Vincent:	I told them go home, find a way, I mean get information, of how you have used colour because most of your garments are colourful. That should be your indigenous knowledge system. So ask your parents. (II5)
Vincent:	So well they did come with it. And some of them are coming up with the different types of food that they prepare at home. Like there's this – I think they call it 'fufu'. Where they mix pap and potatoes. (II5)
Vincent:	When I was doing … with raw materials, I wanted the olden ways of keeping food warm. Keeping food warm, the old ways, you know,

	without a microwave oven or anything. How were our mothers doing that? I must say some of my information is from teachers. I have vastly different languages in the staffroom. They are my resource base. I go to them – 'Guys, by the way, in your culture, how you do this?' And I take that and then use it in the classroom. (II5)

Text Box 5.15

In conclusion, this section of the analysis on the findings of teachers' classroom practice in regard to 'indigenous technology and culture' demonstrated that not much was being done to implement this assessment standard. Various reasons could be given for this, namely:

- Technology is a new Learning Area and therefore some teachers are still trying to understand the first two Learning Outcomes and how to teach them;
- teachers do not possess formal qualifications in Technology;
- policy is not clearly understood by teachers and parts of it, such as the definition of Technology, are ignored; and
- lack of knowledge and understanding of what and how to teach 'indigenous technology and culture' as it is a new inclusion in the National Curriculum Statement.

5.5 Phase 3: The process of participatory co-engagement

Phase 3 of the study consisted of an analysis of the results of a process of participatory co-engagement with the selected teachers in the focus group. The process centered on a shared concern of how to implement 'indigenous technology and culture' so that it was meaningful to learners. The teachers were asked to implement 'indigenous technology and culture' in their technology lessons and to record the process.

5.5.1 Findings on the implementation of 'indigenous technology and culture' during a process of participatory co-engagement

These findings are the result of the analysis of the final focus group discussion and the final individual interviews (FG3 and FI1 – FI5).

Available resources

All the teachers had implemented 'indigenous technology and culture' to some extent, as shown in Text Box 5.16. Most of the teachers used material from a school text book (dome structures and bread making) or a case study from a Common Task of Assessment (Nguni grain pit) in their lessons.

Judith:	Yes, I did. But from your book – the dome, the traditional domes. (FG3)
Anne:	We spent a lesson talking about what it meant – what is traditional? Technology - how could it be defined? And all the different aspects. How far can we talk about traditional as being something that is modern in South Africa and how far is it going back in time, as to what you did three or five hundred years ago. So we spent a whole lesson debating and talking about that, more as a definition. (FG3)
Anne:	On bread, traditional breads, those kinds of things. (FG3)
Karen:	The Nguni grainpit. (FG3)
Vincent:	I depend on the knowledge that I have, the knowledge from the kids and it's like I'm picking from there and there. (FI5)

Text Box 5.16

Due to the lack of resources regarding 'indigenous technology and culture', teachers were asked if they had developed any of their own materials. Their responses are given in Text Box 5.17 and Text Box 5.18. Text Box 5.18 gives a section of the final interview I held with Vincent. It is interesting to note that he was the only teacher to develop and implement his own learning materials concerning 'indigenous technology and culture', due perhaps, to the fact that he has 'been exposed to it'. Vincent also uses the staff at his school to give examples of indigenous technology and culture from their experiences. Vincent suggested that he would prefer textbooks to have better materials on 'indigenous technology and culture' so that he can verify what he is doing on his own (see Text Box 5.19).

Karen:	I want, like that chapter, something that's already worked out. For me to go and find all that energy to go and develop something like that – it's really, really hard. I think it's possible but to find the time now to do that. (FG3)
Judith:	We all use your text book. (FG3)
Anne:	I don't get enough time to exploit it correctly though. But definitely I think it is a very important part of what we should be teaching. (FG3)
Anne:	I just used what was available and that was it. (FI1)
Vincent:	I've been exposed to it. (FI5)

Vincent:	I use Mr Sibuye from … Mr Sibuye Baloyi from the Shangaan background … I would refer kids to him. To say sometimes he might have some knowledge, so try and find out from him what he has. (FI5)

Text Box 5.17

Sonja:	So you base the teaching and learning of 'indigenous technology and culture' on - not on textbooks at all, it's really on your prior knowledge and the knowledge of some of your other members of staff?
Vincent:	Exactly. Because I mean with the books I haven't seen enough. (FI5)

Text Box 5.18

Vincent:	I would prefer books to have more materials because sometimes I'm looking at my situation. The library's not enough for them and the internet again doesn't have much. I think someone, we need to sit down and have someone just get all the information regarding 'indigenous technology' and then let's produce a material and I think that would be better. Because here am I teaching alone. Sometimes I don't have someone to verify what I have. (FI5)

Text Box 5.19

It is difficult to find examples of indigenous technology to develop into learning materials as indigenous knowledge is passed down orally from generation to generation (see Chapter 2), and, being a new assessment standard in the Technology curriculum, there is very little in the way of learning materials on 'indigenous technology and culture' for teachers to use.

Difficulties with implementation

The teachers from the focus group were asked what difficulties they had experienced with the implementation of 'indigenous technology and culture' for this phase of the study. The main issue was lack of time. Another issue was the focus on Learning Outcome 1. This is evident in the extracts from the final focus group discussion and a final individual interview given in Text Box 5.20.

Anne:	Mine's time. Time, time, time. (FG3)
Judith:	Time. Definitely time. Time. Absolutely, without doubt that is my biggest problem. (FG3)
Karen:	Because the focus is too much on the product that had to be made. (FG3)
Judith:	You see for me, because I have so little time, I have never managed to get three projects done for any of my three grades at all and I'm lucky if I can get one done properly. But if we could spend more time on case studies, research things. (FG3)
Judith:	The projects take time. (FG3)
Karen:	I'm thinking of the weighting of the actual project that you make. (FG3)
Anne:	We have such limited time. 18 lessons to teach two years worth of work. Everything that we've done has been has been done at such a basic level and very simply. (FI1)

Text Box 5.20

It is stipulated in the Overview to the National Curriculum Statement (South Africa. Department of Education, 2002d) that Technology should receive 8% of classroom time which amounts to 2 hours per week. Two of the schools from the focus group allocate this amount of time to Technology, but at one school this time also includes teaching Computer Skills, whilst another school allocates 9 hours per year to Technology. It is therefore a difficult task to complete the requirements of the Technology curriculum for Grade 9. It was evident from the final focus group discussion (Text Box 5.17) that most of this teaching and learning time is spent dealing with Learning Outcome 1.

It is my view that one of the reason technology teachers are hampered in their implementation of 'indigenous technology and culture' is that there are confusing aspects in policy documents. Until 2008, the requirement for the Grade 9 Technology portfolio for independent schools was that learners needed to complete three projects per year. In 2009, this was changed to two projects (Independent Examinations Board, 2008b). Projects are 'design and make' tasks and due to their practical nature are time-consuming in the classroom situation. The components for a Grade 9 portfolio and their weighting are stipulated in the Learning Area Guidelines (Independent Examinations Board, 2008b). These components and their weighting are given in Table 5.10. In the analyses of the Independent Examination Board's break down of the marks allocated for a Grade 9 portfolio for Technology, the two projects and the

CTA Part 1, which deal with Learning Outcome 1, are allocated 50 marks out of the 75, which accounts for 67% of the total marks. This is significantly higher than the stipulated weighting 50% given in The Teacher's Guide for the Development of Learning Programmes (South Africa. Department of Education, 2003). This focus on Learning Outcome 1 then detracts teaching and learning and assessment opportunities for Learning Outcome 3.

Component	**Weighting**
2 Projects (2× 20)	40
1 Case study	5
1 Research task	5
1 Assignment	5
1 Controlled test or examination	10
CTA Part 1	10
TOTAL	**75**

Table 5.10: Component requirements for the Grade 9 Portfolio for Technology
(Independent Examinations Board, 2008b, p. 1)

The Teacher's Guide for the Development of Learning Programmes has a confusing aspect with regard to assessment in Technology. It states 'All the Learning Outcomes in Technology are important as they compliment [sic] each other and therefore they cannot be taught in isolation' (South Africa. Department of Education, 2003, p. 24). The integration of the three Learning Outcomes is emphasized. Yet in a table showing the relationship between Learning Outcomes and Forms of Assessment (see Table 5.11) it suggests that Learning Outcome 3 should only be assessed as an assignment/research or a case study. There is no suggestion that it should be integrated with projects or even used in a test. This lessens the opportunities for teachers to include 'indigenous technology and culture' in other forms of assessment, such as projects. The Learning Area Guidelines developed by the Independent Examinations Board (2008b) on the other hand, state that Learning Outcome 3 can be assessed using projects, research, case studies, assignments and/or tests. So the Teacher's Guide for the Development of Learning Programmes (South Africa. Department of Education, 2003) and the Independent Examination Board's Learning

Area Guidelines are not aligned. This lack of clarity can only add to the confusion of teachers and their lack of confidence in the implementation of Learning Outcome 3.

Forms of Assessment	LO1	LO2	LO3
Assignment/Research	I, D, C		√
Case Study	I	√	√
Test	D	√	
Project	I, D, M, E, C		
Practical Work	M, C	√	

Table 5.11: The relationship between Learning Outcomes and Forms of Assessment (South Africa. Department of Education, 2003, p. 30)

Key:
- I - investigate
- D – design
- M – make
- E – evaluate
- C communicate

If technology teachers try to match the break down of marks for the Grade 9 portfolio as given in the Learning Area Guidelines (Table 5.10) with Table of the Forms of Assessment (Table 5.11), it is evident that Learning Outcome 1 is oversubscribed. Learning Outcome 3 is meant to be assessed only through assignments/ research and case studies. According to the Learning Area Guidelines, these two forms of assessment are allocated 10 marks out of the 75. The Forms of Assessment table shows that Learning Outcome 3 must share this allocation with Learning Outcome 1, so this lessens the allocation of marks for Learning Outcome 3 even further. There are too many confusing aspects in the policy documents and this contributes to the difficulty with implementation that teachers have experienced.

In conclusion, there are three issues that impacted on the meaningful implementation of ‘indigenous technology and culture’ in the teachers’ classrooms. The first was lack of time as none of the schools allocate the stipulated amount of time to Technology. The second was the emphasis placed on Learning Outcome 1 in both policy documents and in time spent on this outcome in the classroom. This problem is exacerbated by the third issue, which a lack of clarity and contradictions in policy documents.

Ways of implementation

According to the Forms of Assessment table (see Table 5.11) given in the Teacher's Guide for the Development of Learning Programmes, Learning Outcome 3 should only be given as a research task or as a case study. The Learning Area Guidelines state that a case study 'describes an event concerning a real-life or simulated situation, usually in the form of a paragraph or text, a video, a picture or a role-play exercise' and a research task 'involves methodical investigation using a variety of resources in order to discover facts or revise theory' (Independent Examinations Board, 2008b, p. 2). As has already been mentioned, the Learning Area Guidelines also suggest that Learning Outcome 3 should be assessed using projects, case studies, assignments, research and/or tests. As all the teachers in the focus group are from independent schools, they should all be aware of the Learning Area Guidelines, which were made available in 2008. As evident from the final interviews (see Text Box 5.21) all the teachers used a case study to introduce 'indigenous technology and culture' to their learners. The case study was used as an introduction to the project. Judith saw the benefit of including 'indigenous technology and culture' in with the learner's projects, as shown in Text Box 5.22. She was the only teacher who suggested other ways of including 'indigenous technology and culture' besides case studies.

Vincent:	I'm doing it as a case study leading to a project. (FI5)
Anne:	It was very definitely a separate case study. (FI1)
Karen:	No, I still use it just as a case study. (FI3)
Karen:	Most of it now was just the case study, you know, because of your portfolio requirements. You've got to do some case studies and it was always just easier for me to do the LO3 link it to a case study. (FI3)

Text Box 5.21

Judith:	I would really like to find a way of including it. Because then you know you can cover it more if every 'design and make' has some aspect of that then it would be great. (FG3)

Text Box 5.22

Support for the inclusion of 'indigenous technology and culture'

As has already been mentioned (Text Box 5.3), there was unanimous support from the teachers for the inclusion of 'indigenous technology and culture' in the curriculum. Text Box 5.23 provides extracts from the final focus group discussion and the final individual interviews showing the support for the inclusion.

Anne:	That's what sets the curriculum apart as a South African curriculum. (FI1)
Anne:	Yes. I don't get enough time to exploit it correctly though. But definitely I think it is a very important part of what we should be teaching. (FG3)
Judith:	Absolutely. I don't know about my pupils – they live in such a world that nobody knows about, they really do live in a different world. But I think it's important that they consider these things, absolutely. (FG3)
Judith:	Children nowadays tend to think of technology only as electronic devices, and for them to realise that even making an ostrich egg water holder, is an important technology, is in fact more important – a matter of survival. (FI2)
Vincent:	We need to know where we're coming from, and then what is it that we can improve. … But if we're not going to teach our future generations where we're coming from they wouldn't know how to move forward. So that's my standpoint to say, let's know where we're coming from and develop from that. And maybe invent something better than what we have. (FI5)
Vivien:	I would like to make more of the social context. (FI4)
Karen:	It's just making you aware of where technologies in Africa has come from and understand how things have developed through the years in order to see where we are now. (FI3)

Text Box 5.23

Usefulness of the participatory co-engagement process

There were some positive comments from the teachers about being involved in the study. Anne recontextualised her concept of technology and this impacted on the way she now teaches this subject and specifically Learning Outcome 3. She suggested that without being involved in the focus group, she would not have been as aware of both 'indigenous technology and culture' and bias in technology. Karen said it opened up her mind and made her more aware of 'things out there' (see Text Box 5.24). It was interesting to note that she started out with the perception that technology was applied science, but through the participatory co-engagement process, she changed her view.

She also said that aspects from our focus group discussions had spread to her cluster group. Karen does not belong to our cluster group, so it was interesting that our discussions were brought up at her cluster group meetings, and that the difficulty her cluster group had with introducing ‘indigenous technology and culture’ was that ‘they did not know what to do with it’ (Text Box 5.25).

Anne:	Oh absolutely. I think it’s pushed me to do so, and to include it, whereas I would have probably done what a lot of other people do, and that is left it out. And it’s also made me, interestingly, include the section on bias, which I would’ve not normally done, either. (FI1)
Anne:	So in terms of bias it’s just trying to create awareness in each section of that whole concept. But if I hadn’t been part of a focus group, and if I hadn’t been thinking through ‘indigenous technology’ I probably would have left out bias. (FI1)
Anne:	And to try and source things that you can add. The kids always call it “Mrs Netteleton’s random question”. You know the question at the end of the paper on something to do with something relevant. And I’ve been looking for a whole variety of different contexts in terms of bias and technology. And then you can include the same thing, with indigenous technology to actually find interesting questions that you can give them a scenario and ask them about it is quite a challenge because there’s not much available. (FI1)
Karen:	I first started originally to link it [technology] with Science. But I now know looking after what we’ve done … (II3)
Karen:	To open up my mind and be aware of things out there, definitely. Yes, it’s really opened up my mind. (FI3)

Text Box 5.24

Karen:	At our clusters we definitely do talk about it more. (FI3)
Karen:	Instead of really understanding what ‘indigenous’ meant. I think they’re starting to get a better idea. Like this hippo roller came from another teacher from Saheti. And for the first time I was starting to see that people are getting really on board and really starting to understand exactly what it is, what we’re looking for. (F13)
Karen:	They still keep on asking questions about it, and they are still very reluctant to use it. But with all of these ideas coming through the CTAs especially … we have more, we have more ideas as to what to do. (FI3)
Karen:	They [her cluster group] are the ones who are also sharing notes, shouting ‘We don’t know what to do, what to do!” and I said the LAGs are there now. So it’s way more specific, so start following that. More than that we cannot really tell people what more to do. Unless we write a new textbook to match that curriculum perfectly. And then that will probably help. (FI3)

Text Box 5.25

5.6 Meta-level Analysis

This section of this chapter holistically examines the findings of the research and further analyses the evidence. In making sense of the initial categories that emerged in Phase 2 and Phase 3 of the study, the difficulties that teachers faced seemed to be generic and the categories fitted broadly into the four frames of reference as defined by Windschitl (2002). He developed a framework that defined the conceptual, political, pedagogical and cultural challenges faced by teachers which prevent them from realizing in practice the theoretical ideals of constructivism. The 'dilemmas' are aspects of teachers' intellectual and lived experiences. A dilemma in used here in the broadest sense as 'referring to a wide variety of problematic situations that defy easy answers' (Windschitl, 2002, p. 165).

Windschitl described the four frames of reference as follows:

> *Conceptual dilemmas* are rooted in teachers' attempts to understand the philosophical, psychological, and epistemological underpinnings of constructivism. *Pedagogical dilemmas* for teachers arise from the more complex approaches to designing curriculum and fashioning learning experiences that constructivism demands. *Cultural dilemmas* emerge between teachers and students during the radical reorientation of classroom roles and expectations necessary to accommodate the constructivist ethos. *Political dilemmas* are associated with resistance from various stakeholders in school communities when institutional norms are questioned and routines of privilege and authority are disturbed. (p. 132)

He presented a theoretical analysis of 'constructivism in practice'. For me, Windschitl's framework was one that would assist me in analysing the challenges that the teachers in the focus group faced in taking policy and putting it into practice. Although Windschitl's framework refers to an analysis of 'constructivism in practice', the four dilemmas provided a frame of reference for this study. I have adapted Windschitl's four frames of reference to align with this study and I have included a fifth dilemma: the professional dilemma. For this study, professional dilemmas are the difficulties that teachers face in the teaching of Technology, such as being competent to teach the subject and the credibility of Technology as a subject. I have also adapted Windschitl's notion of cultural dilemmas to include 'religious' dilemmas. The conceptual, pedagogical, cultural and religious, political and professional dilemmas form the categories for the meta-analysis of the study.

Windschitl emphasized that the critical juncture at which the four planes overlap illustrate that the lived experiences of teachers cannot be neatly packaged under these four dilemmas. The challenges that teachers face on a day-to-day basis are ‘the products of the interplay of the four domains’ (p. 134). He also suggested that, as a heuristic, this framework

> has significant implications for teachers in examining their own practice. … the framework involves a number of critical questions that can prompt teachers to interrogate their own beliefs, question institutional routines, and understand more deeply the forces that influence their classroom practice. (p. 134)

So to adapt Windschitl’s descriptions to fit in with this study, the following categories emerged from the initial data analysis (see 5.3, 5.4 and 5.5):

- *Conceptual dilemmas* are rooted in teachers’ attempts to understand the philosophical and epistemological underpinnings of Technology Education.
- *Pedagogical dilemmas* for teachers arise from the recontextualisation of the curriculum and the issues surrounding its implementation in the classroom.
- *Cultural and religious dilemmas* emerge when these two aspects hamper the implementation of ‘indigenous technology and culture’ due to the cultural or religious beliefs of the school, the learners and/or the teacher.
- *Political dilemmas* in this study are associated with the curriculum reform processes which are political in nature and whether teachers support these processes or not.
- *Professional dilemmas* for teachers emerge from issues they might deal with associated with their competence in teaching Technology.

5.6.1 Conceptual dilemmas

The main conceptual dilemmas that arose for the selected group of technology teachers for the focus group were concerned with the disconnections between theory and practice. The conceptual dilemmas that emerged from the data generated by the focus group discussion and the individual interviews were that the teachers in the focus group did not have a clear understanding of certain concepts such as ‘indigenous’ or ‘indigenous technology and culture’. There is no description of these words in the Glossary in the National Curriculum Statement: Technology or in any other South African policy document related to Technology Education. This lack of definitions led to difficulties for the teachers in interpreting the assessment standard ‘indigenous technology and culture’. Teachers need to have a basis from which to work, whether they agree with the definition or not. A broad definition for ‘indigenous technology and culture’ would have clarified the concept and probably have made the teachers more confident in their classroom practice in this regard.

Another conceptual dilemma was that some of the teachers did not have a clear understanding of the difference between science and technology, although there was an understanding that these two domains are closely related (see Text Box 5.26). The link between science and technology was discussed in 2.2.2. As Feenberg (2006) stated, one of the differences between these two domains is their purpose: the purpose of technology is to intervene in the world whereas the purpose of science is to explain the world. This understanding of the difference between science and technology could possibly affect or change the way in one would implement technological literacy in classroom practice.

Anne:	Science and technology are very closely related. I think that technology is an offshoot of science. (II1)
Anne:	Technology is a subset, definitely. Many of the scientific or the physics in science underpins a lot of what you do in technology. Like for example hydraulics, and that kind of thing. … The principles that you learn in science underpin those components of technology. (II1)
Anne:	So it’s taking that and using it to design something and work out how it would work. How those principles that you learn in Science can be put into action. That’s really what we’re looking at. (II1)
Karen:	I first started originally to link it [technology] with Science. I saw once a grid with the steps showing and how one is your investigating also with your science and everything. (II3)

Text Box 5.26

In some cases, lack of confidence in knowing what to do due to uncertainty about the meaning of certain concepts and words was the reason why some of the teachers did not include ‘indigenous technology and culture’ in their classroom practice. The concept of the ‘interrelationship’ between the four aspects of technology, science, society and environment was an issue for another teacher. Extracts from the initial teacher interviews are given in Text Box 5.27.

Karen:	I don't think the implementation would be difficult it's just I don't feel competent enough. I don't think I know enough. And I think the learners nowadays are more open-minded to those kind of things. They're growing up knowing that it's all OK. If it was ten years back I think we would have had a huge issue with it. I think the biggest issue is from the teacher point of view. The teachers are not really trained and don't really know enough about this to actually give it and that's why they avoid teaching it because they don't know enough. (II3)
Vivien:	Now you see I can see society and the environment, but with indigenous technology I would not see science as part of indigenous technology. Because I view indigenous technology the way I do. So for me science does not quite fit in there. (II4)

Text Box 5.27

A further conceptual issue is the dichotomy between 'indigenous technology and culture' and science that is created when they are dealt with as separate entities in the learning materials. This issue of dichotomies was discussed in detail in Chapter 2 (see 2.3.2).

The way in which 'indigenous technology and culture' was introduced into the teachers' technology lessons as a case study only, showed that the teachers had a tendency to rely on this type of task to teach this aspect. Although using a case study to teach 'indigenous technology and culture' is not problematic in itself, the issue was that 'indigenous technology and culture' was abstracted from the learning outcome which deals with 'the interrelationship of technology, science, society and the environment'. In most case studies, 'indigenous technology and culture' was presented as an artefact that needed to be evaluated in regard to its manufacturing process and the materials used, and often the relationship with society, culture and the environment was neglected (see 7.3). In some of the national assessment tasks for Grade 9s that dealt with 'indigenous technology and culture', the context of the artefact being used was 'indigenous', but the tasks either assessed the impact of the technology (Learning Outcome 3 Assessment Standard 2) or they analysed the artefact in regard to the type of materials used and manufacturing methods (Learning Outcome 1 Assessment Standard 2). The tasks did not require the learner to 'compare and explain how different cultures in different parts of the world have effectively adapted technological solutions for optimum usefulness' (South Africa. Department of Education, 2002b, p. 51). This emphasis on evaluating products according to the type of materials and manufacturing methods promotes an instrumentalist view of technology.

As stated in the recent draft 'Report of the Task Team for the Review of the Implementation of the National Curriculum Statement' (South Africa. Department of Education, 2009):

> Often what results is a mechanical and bureaucratic process of listing learning outcomes and assessment standards to show that these are covered, without opening up for teachers the logic of what they are doing in the classroom. (p. 43)

This statement was in regard to policy documents, but the issue is the same for developers of assessment tasks and authors of textbooks. 'Indigenous technology and culture' was documented as having been covered in technology textbooks or national assessment tasks for Grade 9 learners, but 'indigenous technology and culture' was mostly used merely as a context. There was no meaningful engagement for the learners concerning the interrelationship between technology and culture or technology and society. This aspect was usually presented in an instrumental or deterministic way.

5.6.2 Pedagogical dilemmas

Many pedagogical dilemmas arose in this study. One of the most significant is the lack of resources in regard to 'indigenous technology and culture'. The lack of resources could be due to a number of reasons: namely, indigenous knowledge is passed down from generation to generation orally and therefore there is very little that is recorded; 'indigenous technology and culture' is a new inclusion in the revised National Curriculum Statement, and as such there was not much time for any development of learning materials; and, as a new inclusion with little clarity in policy documents on what 'indigenous' means, authors had difficulty with developing learning tasks. The difficulty in accessing resources concerning 'indigenous technology and culture' could be the reason why the content coverage in technology textbooks was insufficient according to the stipulated weighting given in the

Teachers' Guide for the Development of Learning Programmes (South Africa. Department of Education, 2003) (see 5.3.4).

Another pedagogical dilemma was the lack of time allocated to Technology as a Learning Area in the schools at which the teachers in the focus group taught (see Text Box 5.20). This could be due to the fact that there are few qualified technology teachers or that the subject lacks credibility as a Learning Area in some schools. At the start of the study, only one of the teachers from the focus group had implemented the assessment standard of 'indigenous technology and culture'. The other teachers from the focus group had not included this aspect in their teaching at all (see Text Box 5.13).

Two other pedagogical dilemmas were the fact that 'indigenous technology and culture' was implemented as a case study only and the over-emphasis on Learning Outcome 1 which deals with technological processes. Policy documents lack clarity on the forms of assessment and even though weighting per outcome is given in the Teachers' Guide for the Development of Learning Programmes, this is not reflected in the 'Component requirements for the Grade 9 portfolio for Technology' (Independent Examinations Board, 2008b) or in the table showing 'The relationship between Learning Outcomes and Forms of Assessment' (South Africa. Department of Education, 2003) (see 5.5.1). By using only case studies to teach and learn about 'indigenous technology and culture' promotes a narrow view of indigenous knowledge. If learners are not encouraged to use what they have learnt from 'indigenous technology and culture' in their designs it is promoting an historical view of this aspect. The over-emphasis on Learning Outcome 1 is not only promoted in technology textbooks and assessment tasks, but in the training of technology teachers as well. One of the curriculum developers stated that in her training of technology teachers very little was done in regard to Learning Outcome 3.

Respondent	Response
1	As I have said, we have focused on the teachers understanding the content (LO2) and the process (LO1) and not much has been done in ensuring that LO3 as a whole is covered by teachers. (RQ1)

Text Box 5.28

The implications of this statement are that technology teachers will most probably omit teaching Learning Outcome 3, and this will impact on the technological literacy of these learners (see Chapter 2). The lack of implementation of Learning Outcome 3 is detrimental to Technology Education as it places the three Learning Outcomes in a perceived hierarchy. This casting aside of Learning Outcome 3 implies that it is less important than the other two. If teachers do not teach Learning Outcome 3 and learners are not enabled to engage with this outcome in a critical way, an instrumental view of technology will prevail. The training of teachers was raised as an issue in the recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009):

> Training for both Curriculum 2005 and the National Curriculum Statement was shown to be too superficial and too generic. It is increasingly clear from our history of curriculum training that a one-size-fits-all approach is not effective. (p. 51)

Learners need to start dealing with social and environmental issues surrounding the development and use of technologies as well as the interrelationship between technology, science, society and the environment so that a critical technological literacy is encouraged. Shulman (1987) suggested ‘Teacher comprehension is even more critical for the inquiry-oriented classroom than for the didactic alternative’ (p. 7), and as the assessment standard of ‘indigenous technology and culture’ lends itself to this method of teaching and learning, technology teachers need to be confident in their understanding of this aspect.

5.6.3 Cultural and religious dilemmas

For this study, cultural and religious dilemmas refer to the cultural or religious beliefs or background that the teachers from the focus group have that could hamper or enhance their implementation of ‘indigenous technology and culture’. From the individual interviews and the focus group discussion, it was clear that Vincent had little difficulty in implementing ‘indigenous technology and culture’ in his lessons. As he said in his final individual interview: ‘I have been exposed to it’ (FI5). The other teachers come from a ‘westernised’ background and this seemed to hamper their implementation of ‘indigenous technology and culture’, as they did not know what to do (see Text Boxes 5.25 and 5.27). There was little in the way of available resources to assist teachers from a ‘westernised’ background with the implementation.

One of the teachers in the focus group teaches at a Jewish school that trains rabbis. It is therefore strictly religious and certain protocols are followed due to their beliefs. This had a significant impact on the way she could implement ‘indigenous technology and culture’ (see Text Box 5.29).

Judith:	It restricts you in so many ways. I mean if we do a food thing – I actually, what I do when we do a food thing, and especially with the boys, is I make them make it at home. So we'll do like the picnic that they did a few years ago so that the actual – their mothers can see that everything is above board. (FG3)
Judith:	And then they wouldn't even let my Grade 7 girls have Technology this year. Oh, they need to do some airy, fairy nonsense. They keep the girls so … (FG3)

Text Box 5.29

However, Judith did find a way of dealing with the restrictive nature of the school by using their own religious traditions to include ‘indigenous technology and culture’, as is evident in Text Box 5.30.

Judith:	That's why I thought bringing in their own cultural stuff, from way back, with this temple could be – because there's also materials that's been used in the temple, and the gold menorahs, and the this and the that. (FI2)

Text Box 5.30

There seems to be an underlying assumption made by the curriculum developers that teachers everywhere will be able to implement ‘indigenous technology and culture’, and yet, as shown in the extracts, the teacher's own cultural background will either enhance or hamper the implementation and the religious denomination of the school could be at odds with the concept of ‘indigenous technology and culture’.

5.6.4 Political dilemmas

Political dilemmas for this study are taken to be the challenges that the focus group of teachers have encountered during the curriculum reform processes and whether or not teachers have supported these processes. Curriculum reform is a highly political activity (Taylor et al., 1997) and South African teachers have had to deal with two major curriculum reforms since the first democratic elections held in 1997. Curriculum reform was viewed as the route out of apartheid education, and so Curriculum 2005 and its revision (the National Curriculum Statement) were overtly political (see 5.3.1). The recent draft report for the Review of the Implementation of the National Statement (South Africa. Department of Education, 2009) stated that 'the notion of a national curriculum was a new concept that coincided with the birth of a new democracy' (p. 11). During the apartheid years, there were seventeen departments of education with many different curricula, and these were no symbolically combined into one national department. The roles of the new national curriculum were to:

- Promote the new constitution
- Rebuild a divided nation
- Establish and promote a sense of national identity in general but particularly for a troubled education sector (17, largely race-based, education departments with several different curricula)
- Be inclusive in the broad and narrow sense of the term
- Offer equal educational opportunity for all
- Inspire a constituency that had been oppressed by the very nature of the previous education dispensations and policies
- Establish the socially valued knowledge to be transmitted to following generations. (p. 11)

All of these roles are political and they were inspired by the new constitution. There was a revisioning of 'the nation' and 'the citizen' through the 'new salvation narratives that link the nation, the global and the individual' (Popkewitz, 2001, p. 179) in the form of Curriculum 2005 and its revision. As the draft report (South Africa. Department of Education, 2009) stated:

> The marketing of *Curriculum 2005*, the timing, and the compelling story it told, ensured its acceptance and primacy within a very short space of time. The key and clear messaging included a positive new beginning, the move away

> from Fundamental Pedagogy, a new emphasis on rights based education and the notion of learner centredness. Quite simply, the nation, particularly teachers and the media, embraced the story it told and the ideological turn it promised. (p. 11)

However, one of the problems extensively discussed in the literature on education in South Africa (see 5.3.1) is the translation of idealistic goals into transformative practices in the classroom (Christie, 1999; Chisholm, 2000; Jansen & Sayed, 2001). The demands on teachers' skills and professionalism have been great, and for those teachers working in impoverished schools without textbooks or electricity, the challenge has been exceptionally daunting (Harley et al., 2000).

Christie (1997) noted that in developing the policy documents there was an interesting interplay between global imperatives and local resources, risks and opportunities. This is why, although South African policy drew on developments in countries such as New Zealand, Australia, England and the United Stated of America, 'it has features that are different from those countries of origin' (Harley et al., 2000, p. 288).

There was unanimous support from the focus group of technology teachers for the inclusion of 'indigenous technology and culture' (see Text Box 5.3), regardless of the difficulties experienced in regard to implementation. One teacher stated that the inclusion of indigenous knowledge in our general curriculum was what made it unique.

5.6.5 Professional dilemmas

In this study, professional dilemmas are those challenges that the focus group of technology teachers faced to do with their competence in teaching Technology.
One of the professional dilemmas that arose in the study was the lack of formal qualifications in Technology Education by the teachers. None of the teachers had any formal qualifications in Technology Education (see Text Box 5.14). The teachers came from wide disciplinary backgrounds, ranging from adult education to geography. As a result, some of the teachers were still getting to grips with the fundamental aspects of this newly introduced subject into the curriculum, and so for technology in particular, there should have been a lot of support for teachers by the Department of

Education and the Independent Examinations Board for its implementation. As Harley et al. stated:

> Indeed, the roles and competences of teachers have recently been outlined in four new policy documents. With respect to the curriculum and teacher development, then, a clear set of policies for transformation and development is firmly in place. However, as we know, policy has to be effected in a world that is real rather than ideal, and in education the difficulties associated with policy-into-practice are legion. (p. 289)

Some of the teachers did not feel confident or competent enough to teach 'indigenous technology and culture' (see Text Box 5.5). Some of the teachers did not have the necessary conceptual knowledge in regard to technology or indigenous technology and culture. The lack of clarity and confusing aspects in the policy documents sometimes makes them unhelpful, especially to unqualified Technology teachers (see 5.5.1).

Teachers' subject specialities can have an influence on the way they interpret the Technology curriculum (see 5.4.1). Anne, as a geography teacher, emphasised the environment. Vivien focused her teaching of 'indigenous technology and culture' on aspects such as fermentation processes, as she is comfortable around topics that deal with food and nutrition. Judith, the art teachers, focused on design. Judith is affected in her teaching by the strictly religious nature of the school at which she teaches. Boys and girls are taught separately and there are certain beliefs that have to be observed that hamper her teaching. However, she also managed to find a way of using the historical aspect of the religion to include 'indigenous technology and culture'.

The professional dilemmas of technology teachers in South Africa are therefore significant. As Enslin and Pendlebury (1998) stated

> formal changes cannot guarantee better practice, and where the policy makers take little account of the context and agents of implementation, policy may impede rather than enable transformation. (p. 262)

The recent draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) recommended that 'in-service teachers training should be targeted to where it is most needed. Training needs to be subject-specific' (p. 52). It seems as though the Department of Education is now going to focus on implementation of the curriculum. It stated:

> A unique opportunity has presented itself for the new Ministry of education to consolidate the gains from previous curriculum reform and revision, and to provide teachers with curriculum support to ensure better learning for all South African students. (p. 56)

5.7 Conclusion

This penultimate chapter presented the findings emanating from the data analysis. The data gathered during each of the three phases of the study was analysed. Phase 1 used content analysis to analyse policy and other relevant documents. In Phase 2 and Phase 3, the raw data from the focus group sessions and the initial and final interviews with the focus group of technology teachers was analysed. Initial categories from this analysis emerged. A second level of analysis, the meta-level analysis, was performed to establish a more comprehensive picture.

CHAPTER 6
RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

In this final chapter, a summary of the findings is presented and tentative recommendations from these findings are given. The limitations of the study are addressed and reflected upon. The findings of the study are summarised by showing how the research questions have been answered. The concluding remarks include implications of the study for Technology Education and for future studies. The significance of the study is then discussed. This chapter serves to provide a synopsis of the study.

6.2 A summary of the findings

This research set out to find how a selected group of teacher were dealing with the inclusion of 'indigenous technology and culture'. It firstly explored the meaning of technology and 'indigenous technology and culture' and then briefly examined the development of Technology Education internationally since the 1980s and in South Africa since 1997, when the educational system was reformed in line with the new political dispensation. 'Indigenous technology and culture' was a new inclusion in the South African technology curriculum and so it applied to all learners from Grade 4 to Grade 9. As far as has been ascertained, this inclusion of 'indigenous technology and culture' in the curriculum for *all* learners is unique. Other curricula from other parts of the world include indigenous knowledge for indigenous peoples and not in general education for all learners.

In Phase1 the study set out to determine the rationale for this inclusion and to examine how 'indigenous technology and culture' was being proposed in policy documents and learning materials. The revisioning of 'nation' and 'citizen' as a result of South Africa's political and historical past is evident in the National Curriculum Statement. The inclusion of 'indigenous technology and culture' in the technology curriculum was part of this revisioning and there was unanimous support for its inclusion by the focus group of technology teachers. However, in the examination of selected textbooks and national assessment tasks it was evident that the required curriculum balance between technological processes, technological content knowledge and the interrelationship between technology, society and the environment was not observed. It was found that the majority of tasks were instrumental or deterministic in nature and required learners to evaluate technological products, including indigenous artefacts, according to their impact or their manufacturing process or materials used. There was very little in the way of tasks that required learners to engage with 'indigenous technology and culture' in respect to the culture or values embedded in the technology. The cultural meaning of the technology or any comparisons between how different cultures have adapted technological solutions for optimum usefulness as given in the curriculum document, were, to a large extent, ignored.

Phase 2 of the study explored the existing teacher practice of the selected group of teachers in regard to 'indigenous technology and culture'. One of the findings was that there were various interpretations of the concept 'technology'. This is not necessarily a negative aspect as 'technology' is a complex phenomenon, but only one teacher gave a definition that was in keeping with the definition given in the National Curriculum Statement: Technology. Even more significant, was the debate around the meaning of 'indigenous' and, as there was no definition given in any policy document, it was open to many interpretations. The main issue was around which group of people were included or excluded from this definition. One teacher found the word 'offensive', whilst another absorbed the notion into many aspects of his teaching. In regard to implementation of 'indigenous technology and culture' in technology lessons, only one teacher had done so in any significant way. Two out of the five teachers had not dealt with Learning Outcome 3 (the interrelationship between technology, society and the environment) in their technology lessons at all. The fact that none of the selected teachers had any formal qualifications in Technology Education is significant as their interpretation of Technology Education was formulated on their specialist teaching subjects, such as geography and science.

Phase 3 of the study was an analysis of a process of participatory co-engagement around an area of shared concern. This shared concern was on the implementation of ‘indigenous technology and culture’ in a meaningful way in their technology lessons. The findings show that all the teachers from the focus group had implemented ‘indigenous technology and culture’ to some extent during this phase of the study. One of the issues surrounding the implementation was the scarcity of resources to help teachers in regard to ‘indigenous technology and culture’. As there is very little that is documented in regard to ‘indigenous technology and culture’, there is not much in the way of resources from which teachers can draw to develop their own learning materials. Only one teacher had developed his own learning materials and this was probably due to the fact that he considered himself an ‘indigenous person’. He did, however, state that he would prefer textbooks to give examples of ‘indigenous technology and culture’ so that he could verify his own work. This scarcity of resources detracts from the implementation of ‘indigenous technology and culture’ specifically and Learning Outcome 3 generally. Another issue was the lack of classroom time given to Technology Education in most of the schools in which the selected group of teachers work. These are all independent schools and the time available for this subject ranged from 18 lessons per year to the required two hours per week. A third issue that arose was the emphasis given to Learning Outcome 1 which deals with technological processes. This emphasis is evident in textbooks and national assessment tasks for Grade 9 learners as well as on the classroom time spent on this Learning Outcome. Another issue was that ‘indigenous technology and culture’ was given only as a case study and it was not included in other forms of assessment such as projects, which includes ‘design’. This could be due to confusing aspects in this regard in policy documents. This narrow application of ‘indigenous technology and culture’ would promote the idea that ‘indigenous technology and culture’ is not something that could be used in developing technological solutions. This approach would contribute to a narrow technological literacy and view of knowledge in our learners.

As a result of this participatory co-engagement, it was evident that there was unanimous support for the inclusion of ‘indigenous technology and culture’ in our curriculum by the selected group of teachers. The teachers stated that it was this aspect that made our curriculum unique. They also suggested that it gave the learners an opportunity to develop a broader technological literacy. The teachers found the participatory co-engagement process worthwhile and for one teacher it resulted in a recontextualisation of the concepts of ‘technology’. Another teacher found the process beneficial as it broadened her understanding of ‘indigenous technology and culture’. The implementation of Learning Outcome 3 as a whole was enhanced and one teacher took more cognisance of ‘bias in technology’, one of the other assessment standards for this outcome. An exchange of ideas and debates during the focus group sessions were found to be beneficial.

6.3 Recommendations

This section of the chapter provides tentative recommendations for Technology Education in general and the implementation of ‘indigenous technology and culture’ in particular. The recommendations are articulated according to the phases of the study.

6.3.1 Recommendations related to Phase 1

Recommendation 1:
Quality learning materials in which a critical stance of technology is encouraged need to be developed.

In my view, Technology Education has been slow to adopt the viewpoints of the more phenomenological theories which would bring the social and cultural aspects of technology into the classroom. I concur with Keirl (2006), who stated that the operational is emphasized at the expense of the cultural-symbolic and the eco-critical dimensions of technology. In Technology Education there is an overemphasis on skills and competencies without much critical engagement concerning technological development. This was evident in both the textbook analysis and the analysis of the Common Task for Assessments. But designing learning activities to get students to question assumptions is difficult as environments in which a technology is developed and used are complex and dynamic (Michael, 2006), so this remains a substantial challenge for authors of learning materials. However, authors of textbooks need to include more of this aspect in their work so that the textbooks reflect curriculum reform recommendations. A more reflective ratio between technological content knowledge (Learning Outcome 2) and the interrelationship between technology, science, society and the environment (Learning Outcome 3) would hopefully develop more critical technological literacy amongst learners. A critical technological literacy should be the one of the main goals of Technology Education. It would also assist in the translation of the idealistic goals in policy documents into transformative practices in the classroom, which has been one of the biggest problems throughout the curriculum reforms in South Africa (Christie, 1999; Chisholm, 2000; Jansen & Sayed, 2001)

6.3.2 Recommendations related to Phase 2

Recommendation 2:
Policy documents need to provide more clarity by giving broad descriptions in policy documents of concepts that are to be taught, especially if these concepts are newly introduced. (refer to Text Boxes 5.4, 5.5, 5.6, 5.8, 5.9, 5.10)

One of the key issues with the implementation of 'indigenous technology and culture' is the lack of clarity around certain concepts given in policy documents and also the understanding of these concepts by the teachers. As the draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) stated: 'A key dimension related to the successful implementation of curriculum relates to the detail and clarity provided by policy in relation to what to teach' (p. 43). As Technology was introduced in 1997 as a new Learning Area, many teachers do not have an in-depth understanding of what 'technology' itself is. The Technology curriculum statement, unlike the Natural Sciences curriculum statement, gives no definition or description for 'indigenous'. If a definition or description had been given, it would have clarified some of the issues that emerged in the focus group discussion with Andrew Feenberg and the initial interviews with the teachers, namely whether 'traditional' and 'indigenous' mean the same thing, and whether 'indigenous technology' is equated with 'pre-modern technology' or 'locally-adapted technology' or both. This is why the sense of the word 'indigenous' needs to be broadly defined in the curriculum documents so that it is clear which sense is meant, as the different meanings attributed to the word 'indigenous' obviously have implications for the way in which teachers interpret and recontextualise the assessment standard 'indigenous technology and culture'. The National Curriculum Statement: Natural Sciences (South Africa. Department of Education, 2002a) gives the following as part of the description for their Learning Outcome 3:

> *Traditional technologies may reflect people's wisdom and experience*: Indigenous or traditional technologies and practices in South Africa were not just ways of working; they were ways of knowing and thinking. Traditional technologies and practices often reflect the wisdom of people who have lived a long time in one place and have a great deal of knowledge about their environment. Wisdom means that they can predict the long-tem results of decisions, and that they can recognise ideas which offer only short-term benefits. Much valuable wisdom has been lost in South Africa in the past 300 years, and effort is needed now to rediscover it and to examine its value for the present day. (p. 10)

Recommendation 3:

Training of technology teachers is of paramount importance. This training needs to include ways of teaching 'the interrelationship between technology, science, society and the environment' so that it is meaningful. (refer to Text Box 5.14)

The learning community of Technology teachers needs to be strengthened significantly. The selected group of technology teachers did not have any formal Technology Education qualifications and it is an assumption made here that this is generalisable in South Africa. The lack of qualified teachers is not unique to technology. As Rogan and Grayson (2003) stated, in 1995 50% of mathematics teachers and 60% of science teachers had no formal training. It is reasonable to assume that the percentage of unqualified technology teachers is higher as technology is a new Learning Area. So the suggestion by Harley et al. (2000), that 'what teachers need is not impersonal policy directives implemented from above with the overtones of authority and control, but localized, contextualized, even personalised, developmental support and assistance' (p. 300), is especially true for technology teachers. An annual conference is held by the Technology Association, and this has greatly assisted in strengthening the field, but more needs to be done to reach teachers who are unable to attend conferences. There now needs to be an emphasis not just on content knowledge, but on developing teachers' understanding of concepts central to the teaching of the Learning Outcomes. Teachers need to take heed of the weighting given to Learning Outcome 3 and to develop meaningful ways of teaching it. There needs to be a greater emphasis on ways in which Learning Outcome 3 could be introduced and taught in classrooms, especially ‘indigenous technology and culture’, as this is a new inclusion in the curriculum. We, as technology teachers, need to engage our learners in exploring the diverse contexts in which technologies emerge and develop, and Grade 9 learners should be able to work in unfamiliar contexts. Teachers need to be given examples of ‘indigenous technology and culture’ as well as suggested ways of developing these into learning materials.

Recommendation 4:
Teachers and learning material developers need to overcome the dichotomies created between ‘western’ science and indigenous knowledge by using a heterogeneous, dynamic, plural notion of knowledge and culture. (refer to Text Box 5.12)

Learning material developers need to guard against oversimplifying or mystifying indigenous knowledge systems, and it is my view that ‘indigenous technology’ should not be separated from ‘western’ technologies in learning materials as this would create an incorrect notion in our learners of differentiation. All technologies need to be examined under the same critical banner.

6.3.3 Recommendations related to Phase 3

Recommendation 5:
Research and development of high-quality learning tasks on ‘indigenous technology and culture’ need to be developed for textbooks. This is especially so for new aspects introduced into the curriculum. Teachers do not have the time to develop their own learning materials and therefore textbooks are of the utmost importance in promoting correct curriculum coverage. (refer to Text Boxes 5.17, 5.18, 5.19)

The draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) stated that the curriculum reform processes in the last decade have been difficult for teachers in South Africa. One of the reasons given for this is that a lot of paperwork, due to having to be accountable, has led to little time for teachers to implement curriculum reform requirements. According to the report (South Africa. Department of Education, 2009):

> The proper and comprehensive use of textbooks was discouraged and undermined by C2005, and teachers were encouraged to produce their own materials. Yet, both local and international research has shown that the textbook is the most effective tool to ensure consistency, coverage, appropriate pacing and better quality instruction in implementing a curriculum. (p. 9)

However, not enough has been done, both in independent and government schools, to assist teachers with implementation of the new aspects of the curriculum, such as 'indigenous technology and culture'.

The teachers in the focus group stated that they had used one Technology textbook and a previous Common Task for Assessment task in order to teach 'indigenous technology and culture' at Grade 9 level, and only one teacher had developed his own material. One of the difficulties with the meaningful implementation of 'indigenous technology and culture' is the lack of resources. As the draft report on the implementation of the National Curriculum Statement (South Africa. Department of Education, 2009) stated 'Textbooks were reported to be of uneven quality and insufficient to provide to all learners' (p. 47) and:

> Both national and international research has repeatedly underscored the role of the textbook as one of the most effective tools through which to deliver the curriculum and support assessment. Not only can it ensure curriculum content and assessment coverage, but it can also offer appropriate pacing and weighting of content and assist teachers with lesson and year planning. This is especially important during periods of curriculum and assessment reform. (p. 47)

Recommendation 6:

Schools need to give the correct allocation of classroom time to technology. Technology teachers should then be able to give the allocated weighting to Learning Outcome 3 which includes 'indigenous technology and culture' in order to give learners breadth and depth of experience in exploring 'the interrelationship between technology, science, society and the environment' and to encourage a critical stance towards technology. (refer to Text Box 5.20)

The over-emphasis on Learning Outcome 1 promotes a deterministic or instrumental view of technology. Yet, worldwide, bigger frameworks that are embedded in curriculum, such as democratic citizenship, are being put in place. Vicki Compton, at the focus group discussion at the PATT-18 conference in Glasgow, had the following to say:

> Our overarching curriculum statement is now all around democratic citizenship and we now have to say 'OK. What is technology's role in that?'. We have a really huge role, I believe, because of the level of uncertainty that we have to work with all the time and the way in which citizens are in the future going to have to deal with levels of that – something that is second nature to a technologist. People have got lots to offer I think in terms of other curriculum areas and so in terms of our ability to draw on other disciplines, to provide a robust setting because we don't invalidate other knowledge bases, so we can sort of go Yeah, we need to draw off, you know, religion here because it's the context in which we're working, we have to draw off science over here because that's what we need to understand in order to make the right decisions that are appropriate here. So in terms of where we sit, I think, it's very central at the moment and I think we can go along and pick up your points about the amount of money that is going into places like numeracy and literacy and which I am assuming is the same here. All in a very isolated way and still not making any difference. You know, so, we can provide authentic sites for things that actually allow levels of empowerment for kids because they can actually get in and make a difference. And that becomes, I think, more of a pedagogical than a curriculum issue, around, you know, you have to sort what it is that we think the literacy needs to look like. It has to be deep, it needs to be critical and it needs to be broad. What we're finding in New Zealand at the moment is that we have literacy being developed through practice alone. It was very narrow, very local and very personal. So the kids could step outside of themselves to actually look at what this might mean in the bigger sense, so by increasing the breadth of experience, looking at things from multiple perspectives, being able to step outside of their own frame, is a really critical thing. So we had to get that right before we could start then getting back into the pedagogy … we're expecting students to come out with an understanding of the philosophy of technology does not mean we stand up and lecture them. It's a whole different issue. The best way to do that is through practice, I suggest. But, the outcome is to increase your understanding of the philosophy. So those issues I think need to be tackled in different ways. (FGS, 2007)

The teaching and learning of 'the interrelationship between technology, science, society and the environment' is therefore an important aspect of our curriculum.

Recommendation 7:

'Indigenous technology and culture' should be included in all forms of assessment, including project, as ways of learning in the classroom. (refer to Text Boxes 5.21, 5.22)

When 'indigenous technology and culture' is presented to learners only as a case study, it promotes a historical stance towards this aspect. Learners need to be encouraged to use 'indigenous technology and culture' as a starting point for some of their designs in their projects. Policy documents give contradictory information, and this has possibly led to uncertainty amongst technology teachers. Learning Outcome 3 should be included in projects as 'indigenous technology and culture' could have an influence on the design aspects of Learning Outcome 1.

Recommendation 8

Cluster groups could be used for teacher development sessions. Historically, they have been used as a moderation process for assessment at Grade 9 level. Technology teachers would then be able to have discussions on the issues and concerns on implementation of the curriculum. (refer to Text Box 5.25)

Most Technology teachers are not qualified and therefore they learn to teach Technology as they go along. Karen shared the focus group discussion sessions with her cluster group and this clarified certain issues surrounding 'indigenous technology and culture' for these teachers.

In conclusion, I would like to quote from O'Riley (1996), who stated:

> So, what might technology look like if it included technologies of, and was designed for, the majority of the world? A serious re-vision of Technology Education curriculum stories might mean a reshaping of technology narratives "committed to increasing consumerism and profit, maintaining social control, and legitimating the authority of elites" (Harding, 1993, p. 3). Rather than converging into standardized narratives, Technology Education textual practice might become a space of embodiment of divergent, contradictory, and multiple perspectives consisting of "partial, locatable, and critical knowledges sustaining the possibility of webs of connections in solidarity in politics and shared conversations in epistemology . . . but not just any partial perspectives" (Haraway, 1991, p. 191-192). (p. 55)

6.4 Limitations

There are some limitations to this research and these are discussed in this section. Firstly, a selected group of five technology teachers formed the focus group for this study, even though the study did not set out to be transferable. The teachers were all from independent schools except for one school. This school does, however, participate in the Independent Examination Board's assessment processes and so the teacher has been part of the cluster group since the national assessment process begun in 2001. The four independent schools vary in their focus and this was discussed in Chapter 3.

Another limitation was in the content analysis in Phase 1 Part 2 in which five technology textbooks for Grade 9 level were analysed. These were the main textbooks that were sent to technology teachers before the National Curriculum Statement had to be implemented in 2006. There were other textbooks published at this time, but these five were from the better known school textbook publishers. These textbooks were sent as samples accompanied by their teacher guides.

The cluster group, to which I belong, has been working together since 2001 and so there is a level of trust that has been instilled amongst the members. This could impact on the credibility of the study as member-checking might not have been thorough enough due to this trust.

There is the threat with using NVivo software as a qualitative data analysis tool, that data can be over-analysed. I was aware of this threat since I started using it as I had read up on the software and its uses before I purchased it. The use of extensive text boxes in the reporting of the analysis reduced the effects of this limitation.

With using Feenberg's theories of technology and placing the theories in four quadrants (see Figure 2.1), as Feenberg himself does, the risk of using an overly simple bipolar spectra and analysing the teacher's views of technology without taking cognisance of the many variations or the 'fuzzy' borders of this table, was a limitation on the research. In retrospect, I should have been more aware of this over-simplification.

Another limitation of this study was the use of Western theories and research methodologies in a study that addresses the issues of integrating ‘indigenous technology and culture’ into classroom practice, thereby promoting the positional superiority of Western knowledge. The study would have benefited from a more extensive engagement of indigenous theories and methodologies.

6.5 The emerging significance of this study

The value of this exploratory study is that it is has established a platform for other researchers to further explore and test issues on implementation of the technology curriculum. This study is significant in its own right as it has generated tentative explanations and interpretations around the implementation of ‘indigenous technology and culture’ as prescribed in the technology curriculum for South Africa. The findings may elicit broader implications for curriculum design and implementation.

This study has demonstrated that the new inclusion of ‘indigenous technology and culture’ in the National Curriculum Statement: Technology did not mean that it was being implemented in any meaningful way in Technology classrooms. After discussion and debate in the participatory co-engagement process, the implementation of ‘indigenous technology and culture’ improved as the teachers implemented it in some way.

6.6 Implications for future studies

This study explored and explained the implementation of ‘indigenous technology and culture’ by a focus group of technology teachers. The following are possible ideas for further research:

- What strategies are best suited to train teachers in implementing ‘indigenous technology and culture’ in a meaningful way?

- What impact does an understanding of ‘indigenous technology and culture’ have on our learners?
- How does one develop a resource base of learning materials on ‘indigenous technology and culture’ that involves a critical technological literacy approach that is mindful of cultural integrity?

6.7 Concluding remarks and personal reflections

The purpose of this study was to examine and explore pedagogic practice in relation to ‘indigenous technology and culture’. I am confident that the study answered the three research questions:

- How is the aspect of ‘indigenous technology and culture’ being proposed for Technology Education processes in policy documents?
- What is the existing pedagogical practice in regard to this aspect of the curriculum?
- Does a process of participatory co-engagement with teachers, with reference to ‘indigenous technology and culture’ in the technology curriculum, improve teaching practice?

The study aimed to contribute to a deeper meaning of ‘indigenous technology and culture’ so as to enable a more meaningful implementation of this assessment standard in the classroom. The research in this study was an interpretive case study. It used an in-depth, interpretive design to examine the subjective experiences of the focus group of teachers. The research findings have been summarised in this chapter and recommendations based on these findings were presented.

Most of the teachers in the focus group faced challenges in implementing ‘indigenous technology and culture’ in their classrooms. All but one of the five teachers had not implemented this aspect at all previous to this study. Evidence from the study showed that even after discussion and debate, ‘indigenous technology and culture’ was only ever introduced to learners in the form of a case study. It was not integrated to any extent in the other learning outcomes, such as part of the design of a product. Apart from one teacher, the selected teachers did not develop any of their own learning materials in regard to ‘indigenous technology and culture’. The reflexive practice occurred in the teachers in their consideration around the implementation of ‘the interrelationship between technology, science, society and the environment’. From this study it was evident that curriculum reform is ineffective unless teachers implement the reforms in the classroom, and for this to happen, teachers need to be confident about the subject matter and the teaching method, as well as conversant with the current debates on the topic they are teaching. If the implementation of ‘indigenous technology and culture’ is going to be meaningful, then we need to consider the relevancy of the context to meet the needs of the learners in our technology classrooms. As O’Riley (1996) stated:

> I would like to place into question both the adequacy of the selection of technology narratives to represent the study of technology in our current technologized/technocratized society, and the relevancy of these stories to meet the needs and interests of the diversity of students entering today's Technology Education classrooms. (p. 28)

This study for me has been a period of great learning and I have experienced a change in my worldview. The realisation that the way I had been teaching for many years was based on one knowledge system made me change my teaching practice. My engagement with indigenous knowledge also made me change the way I relate to other cultures. I started the study as I was not sure of what was meant by ‘indigenous technology and culture’ in the revised curriculum and therefore did not know how to teach it. I phoned one of the curriculum developers to ask him what I was meant to do and his reply was ‘That’s for you to find out!’ Hence the start of this journey.

The teachers in the focus group gave generously of their time and their viewpoints, and much was expected of them in their busy teaching lives. This study is not an end in itself and I hope that I will be able to continue to research and develop learning materials that make ‘indigenous technology and culture’ a meaningful assessment standard in our curriculum.

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APPENDIX 1

PERMISSION TO USE DATA

16 Chatou Rd
Richmond
2092
Gauteng

[Address of participant]

Dear [Name]

Permission to use data

I am a PhD candidate in the Department of Education at Rhodes University. The focus of my study is to explore and examine how technology teachers are dealing with the implementation of 'indigenous technology and culture'. As part of my research, I need to collect data from teachers. I will use individual interviews and focus group discussions to do this. The results of the research will hopefully inform future practice and the development of learning materials.

I therefore request your permission to use the data collected from the interviews and focus group discussions. I would like to use your name in the study, but if you would like to remain anonymous please would you tick the relevant box, and I will abide by the principles of anonymity and confidentiality. You will be given all the relevant transcripts and parts of the thesis to check that you have been represented correctly and accurately, and that my interpretation is valid.

Yours sincerely
S. Vandeleur

APPENDIX 2
Data Collection Instruments

2.1 Questionnaire

This questionnaire forms part of the initial phase of a PhD study in the field of Technology education. Establishing the rationale for the inclusion of 'indigenous technology and culture' as the first assessment standard in Learning Outcome 3 in the Technology curriculum is one of the purposes of the study. Issues and problems around the implementation of this assessment standard will also be identified. The outcome of the study will be to develop a learning programme based on 'indigenous technology and culture' that will be suitable for use in South African schools for Grade 9.

It would be appreciated if you would take careful consideration and time to develop honest responses. In these interests, confidentiality will be assured. The textboxes for the responses are designed to expand according to the length of the response.

Please would you return the questionnaire by the 19th March 2007 to the following e-mail address:
svandeleur@acenet.co.za

Your participation in this study is very much appreciated.

Yours sincerely
S Vandeleur

Contact details:
Ph: 011 482 6222 (h)
083 2289276 (cell)
svandeleur@acenet.co.za
svandeleur@roedeanschool.co.za

1. What has been your role in the development of the South African Technology curriculum?	
2. Has there been more emphasis on the interrelationship between technology, society, science and the environment in the National Curriculum Statements compared to Curriculum 2005? If yes, what is the reason for the increased emphasis?	
3. What was the rationale for the inclusion of ‘indigenous technology and culture’ (AS1) in Learning Outcome 3 (LO3) for Technology in the National Curriculum Statements?	
4. Please provide a brief overview of your interpretation of ‘indigenous technology and culture’.	
5. Did the curriculum developers anticipate any problems with the implementation of ‘indigenous technology and culture’ by technology teachers? If yes, what were these anticipated problems?	
6. Are you aware of any problems that technology teachers have had with the implementation of ‘indigenous technology and culture’ as an assessment standard? If yes, please would you elaborate on the type of problems that were encountered e.g. lack of content knowledge by the teacher, lack of learning materials, learning materials of poor quality, etc..	

7. Are you aware of any positive teaching experiences by technology teachers in the implementation of ‘indigenous technology and culture’? If yes, please would you elaborate on the nature of these experiences.	
8. Has any assessment been done to find out the degree to which learners have found engagement with ‘indigenous technology and culture’ (LO3 AS1) in technology lessons meaningful? If so, what were the results?	

2.2 Initial Teacher Interview Outline 2007

Purpose:

- To establish a relationship with the teacher before the 'participatory co-engagement' begins
- To establish the teacher's understanding of concepts such as 'technology', 'the interrelationship between technology, science, society and the environment', 'indigenous technology and culture'.

Interview Outline:

Introduction (for researcher to set the scene)	Explain specific purpose of this interview Explain about member checking, anonymity if required, etc.
Demographics (so interviewee can introduce themselves)	Find out about teaching of technology: - length of teaching experience - how started teaching technology (shortage of technology teachers or qualified, etc.) - any formal qualifications? - other subjects? - Do other teachers teach technology as well?
Perception of concepts (to elicit teachers' understanding of discipline)	- what is your understanding of 'technology', 'interrelationship between technology, science, society and the environment', 'indigenous technology and culture'.
Existing practice regarding LO3 AS1 (indigenous technology and culture)	- have you included any 'indigenous technology and culture' in lessons? - if so, what? - have the been any issues with implementation of 'indigenous technology and culture'
Conclusion	Explain purpose of study: participatory co-engagement to develop a learning programme for use in South Africa

2.3 Final Teacher Interview Questions 2009

Purpose:

- To clarify some points that arose form the focus group discussion, such as the helpfulness of textbooks, developing own materials.
- To establish whether the process of participatory co-engagement was worthwhile or not.

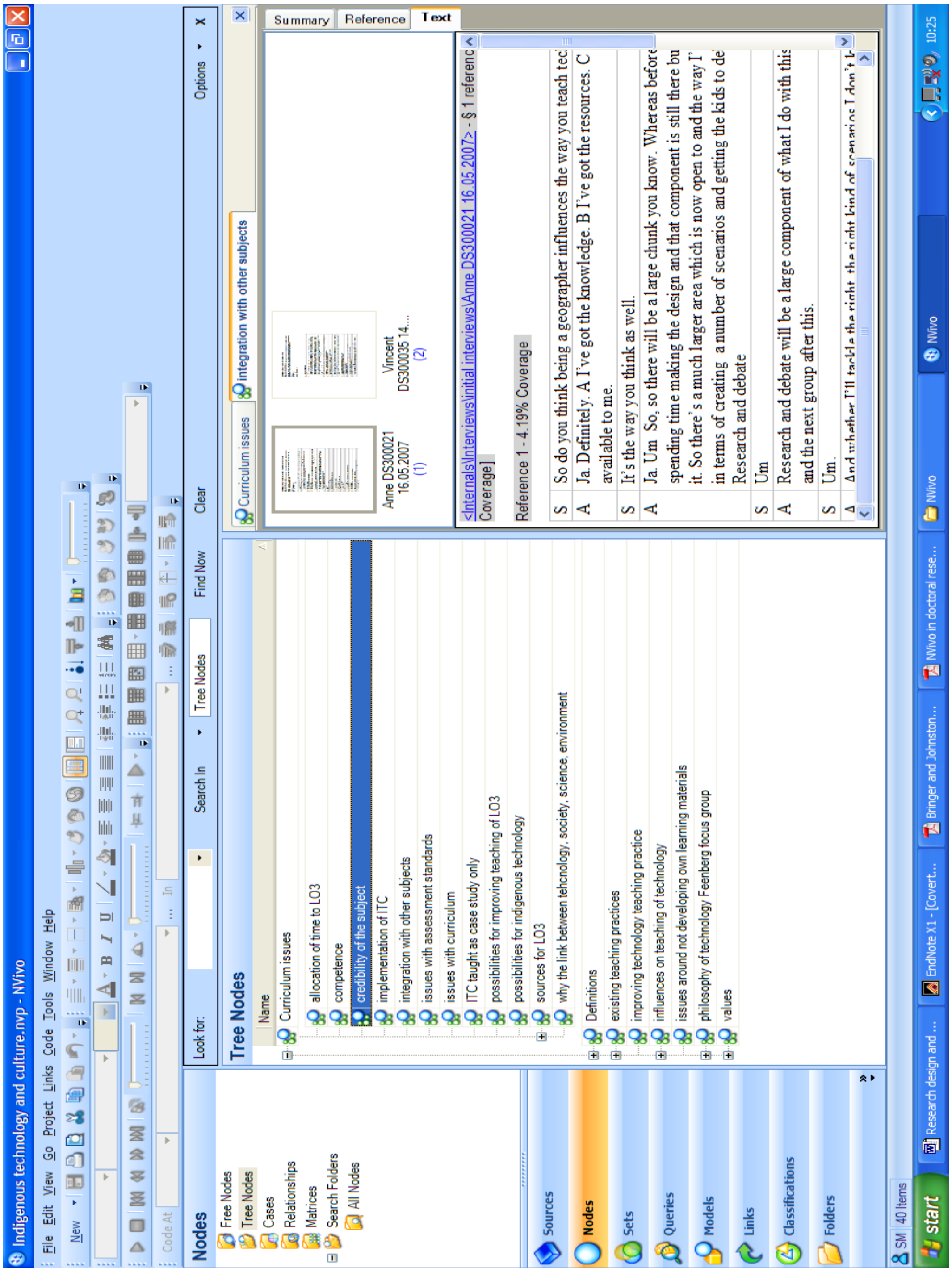
Interview Questions:

1. How helpful were textbooks in your teaching of ‘indigenous technology and culture’?
2. How helpful were teacher guides in your teaching of ‘indigenous technology and culture’?
3. Did you ever try to find your own materials on ITC?
4. Did your learners make any connections from what they had learnt about ITC in their designs?
5. What would you like to be changed in order to improve your teaching or learner’s performance in regard to ITC?
6. If there were to be another curriculum review, do you think ITC should be kept in, included in another format, or taken out of the curriculum completely?

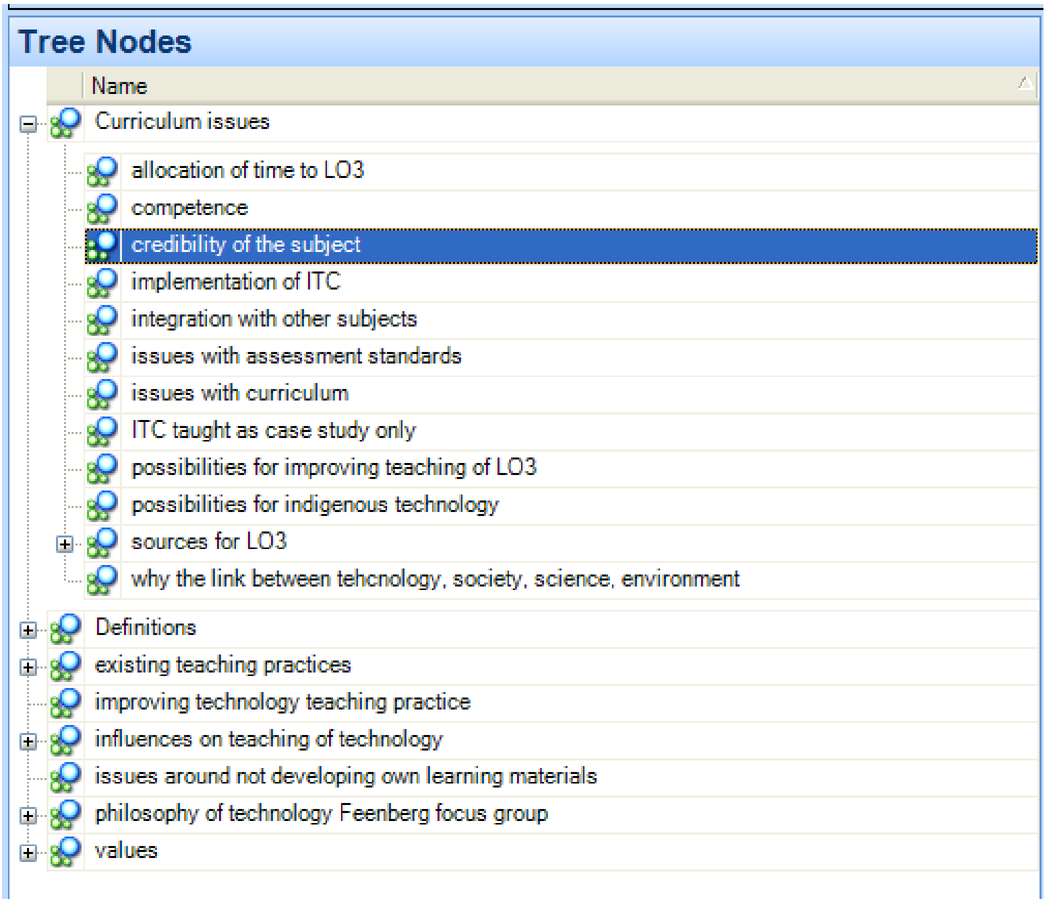
APPENDIX 3
NVivo Screens

The following are merely examples to show how NVivo assisted in the data management and analysis process.

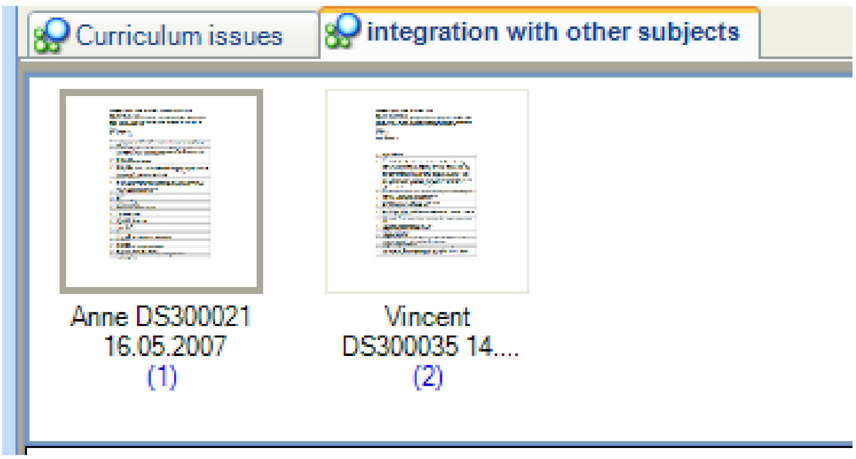
3.1 The tree node function (sections are enlarged in 3.2 – 3.4)



3.2 An enlargement of the 'tree node' part of the screen: to show categories and sub-categories



3.3 Active links: if a node is selected, the documents that have been linked to this node are shown



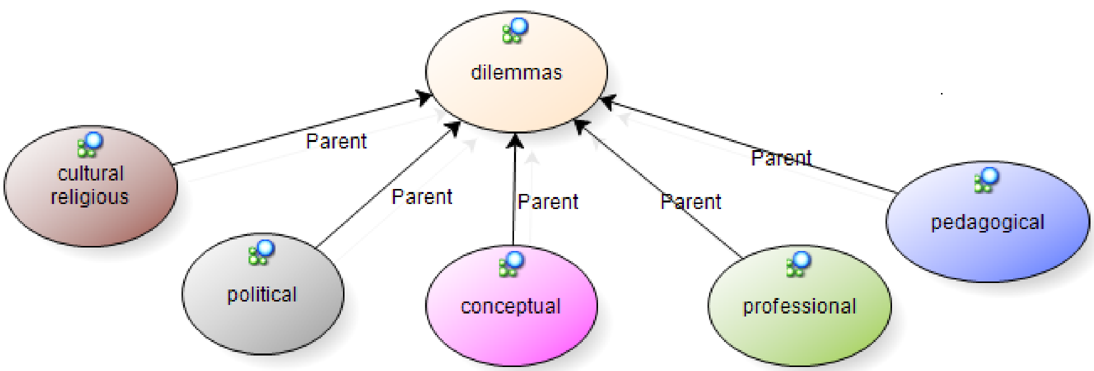
3.4 **Document showing the instance:** if the document is selected, NVivo then shows the relevant section of the document

<Internals\Interviews\initial interviews\Anne DS300021 16.05.2007> - § 1 referenc
Coverage]

Reference 1 - 4.19% Coverage

S	So do you think being a geographer influences the way you teach tec
A	Ja. Definitely. A I've got the knowledge. B I've got the resources. C available to me.
S	It's the way you think as well.
A	Ja. Um So, so there will be a large chunk you know. Whereas before spending time making the design and that component is still there bu it. So there's a much larger area which is now open to and the way I' in terms of creating a number of scenarios and getting the kids to de Research and debate

3.5 An example of a model



APPENDIX 4
Inventory of data files

Questionnaire codes

The codes given for the questionnaires responses correspond to the respondent codes: for example respondent 1's code will be RQ1, respondent 2's code will be RQ2.

Initial individual interviews:

Name:	Date:	Digital Recorder No:	Code:
Anne Nettleton	16.05.2007	DS300021	II1
Judith Clare	06.06.2007	DS300028	II2
Karen Durandt	25.04.2007	DS300017	II3
Vivien McAlpine	03.09.2007	DS300037	II4
Vincent Mangope	14.08.2007	DS300035	II5

Final individual interviews:

Name:	Date:	Digital Recorder No:	Code:
Anne Nettleton	04.08.2009	DS300198	FI1
Judith Clare	30.03.2009	DS300151	FI2
Karen Durandt	09.03.2009	DS300052	FI3
Vivien McAlpine	10.11.2009	DS300202	FI4
Vincent Mangope	30.08.2009	DS300201	FI5

Focus group discussions

Name:	Date:	Digital Recorder No:	Code:
Focus group discussion 1 with selected group of technology teachers	20.03.2007	DS300014	FG1
Focus group discussion 2 with selected group of technology teachers	11.10.2007	DS300039	FG2
Focus group discussion 3 with selected group of technology teachers	06.08.2008	DS300045	FG3
Focus group discussion led by Andrew Feenberg at PATT-18 conference, Glasgow, 2007	22.06.2007	DS300032	FGS

APPENDIX 5
SHULMAN'S TABLE OF LEARNING

Engagement and Motivation	Being engaged in worthwhile tasks
Knowledge and Understanding	The ability to restate in other words ideas learned from others
Performance and Action	Acting in and on the world
Reflection and Critique	Critical reflection
Judgment and Design	Exercising understanding as well as applying skills under constraints and contingencies, by considering multiple factors according to values and standards
Commitment and Identity	Internalise values by moving inward and connecting outward

(Independent Examinations Board, 2008, p. 8)