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**Papua New Guinea primary school technology teachers: The
impacts of support materials on their perceptions and
practices**

A thesis

Submitted in partial fulfilment

Of the requirements for the degree

Of

Master of Education

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By

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Abstract

This thesis explores the perceptions of technology and technology education held by six primary school teachers in Papua New Guinea, and their views of the materials developed to use as a support for teaching technology and the impacts on their perceptions and their teaching practices of technology. Based on the interpretivist paradigm, a case study approach and qualitative data collection methods were used to explore the teachers' views of technology and technology education and how the support materials influenced these perceptions and practices. One to one, semi-structured interviews with the teachers, and an analysis of their planning documents were used to collect data.

As part of the curriculum reforms, technology education was introduced as a new subject into primary education in PNG in 1994. However, no formal professional development was provided for helping the primary teachers implement technology education. Instead, curriculum materials were developed and distributed to teachers in 2005 as a support for their technology teaching.

This thesis supports the idea that teachers need support to help them learn. It also argues that teachers' beliefs about subject areas, teaching, their students, and curriculum materials influence how they interact with these support materials. The findings show that the support materials were very useful in enhancing the teachers' knowledge of technology and effective teaching of technology.

There were changes to teachers' perceptions of technology and technological practices when they began to use the support materials. Changes included the views of technology as more than modern artefacts to include traditional technology, that technology was more than just practical. It also has a knowledge base. However, not all aspects of technology as advocated in the support materials have been taken up by these teachers. Problem-solving and design aspects have received marginal attention.

Other factors were at play including subject subcultures, subject backgrounds, past hands-on experiences and ownership of personal technological artefacts. To be even

more effective technology teachers, it is advocated that teacher professional development is required for Papua New Guinean primary teachers to implement the technology successfully.

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DEDICATION

This thesis is dedicated to;
My beloved late father Hagunama Ujepa
And my mother, Hayo Hagunama

My wife and children
Everlyn Hagunama
Wrightson, Jason and Arnold

My brothers
Ligifane, Sikoro and Peterson

My sisters
Mary Eron, Mirriam Ismael, Mere Jason and Joycelene Hagunama

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My Tribesmen
People of Kuru, Kagu and Henagaru

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Chapter One

Introduction

1.1 Introduction

Technology as a subject was introduced into the Papua New Guinea primary education curriculum in the 1996 education reform. This provided a unique opportunity for me to investigate primary teachers' perceptions of technology and technology education. It also provided an opportunity to investigate the impact of teacher support materials developed to guide them in teaching the new curriculum.

The need for this study arose out of my personal experiences (as a teacher trainer in the primary teacher training college in PNG) with pre-service teachers and primary teachers. I was involved in developing technology curriculum support materials and was one of the co-authors of the technology students' textbooks 1 & 2, the teacher's resource book and was the sole author of student and teacher resource books; *Basic Maintenance* and *Basic Building*. These books are currently in use in all primary schools as support materials for the teaching of technology. This study has enabled me to explore and examine the use of these support materials and their influence on teachers' understanding of technology and their practices in the classrooms.

Section 1.2 outlines the background to this research. This is followed by discussion on the education reforms in section 1.3. Technical Education is described next in section 1.4, followed by discussion of technology education in section 1.5. The descriptions of technology support materials are presented in section 1.6., followed by the researcher's background in section 1.7. The rationale of the study is presented in section 1.8, supported by the research questions in section 1.9. The chapter concludes with the thesis overview in section 1.10.

1.2 Background

Papua New Guinea (PNG) is part of the Pacific Ocean group of islands and occupies the eastern half of the larger portion of New Guinea and its associated off-shore islands between the Coral Sea and the South Pacific Ocean, east of Indonesia and north of Australia. (See map Figure 1.1).

Figure 1.1

Map of Papua New Guinea



Source: CIA Fact book

The country of Papua New Guinea is characterized by extremely high local relief with the land surface being covered by tropical land forest, except for some coastal areas and valleys in the highlands. The total land area is about 462.860 km² which is mostly mountainous with coastal lowlands and rolling foothills. The population was estimated to be about 6.1 million in 2007 with annual growth of 2.7 per cent. Although there are 800 plus different languages, Hiri/Police Motu and Melanesian Pidgin (Tok Pisin) are the national languages and English is the official language.

Before European colonization, the adults in each tribal society in Papua New Guinea educated their children on practical skills, social behavior and spiritual beliefs. In 1873, the London Missionary Society established the first school to teach islanders to read scripture. After 1884, German and English missionaries established primary schools to teach Western concepts of morality, the German and English languages, arithmetic, and Christian doctrine. During the early 1900s, the British government encouraged missionaries to develop vocational education programs in Papua New Guinea to produce better farmers, crafts people and skilled laborers. In 1914, Australia took control of the German colony in northeastern New Guinea with both

Papua and New Guinea under its reign. Australia established English as the official language of instruction and laid the foundation for modern education in Papua New Guinea. Papua New Guinea's education system has three levels; primary, secondary, and tertiary. Schooling is compulsory schooling from six to fourteen years of age. The academic year runs from January to December.

The education system in Papua New Guinea is currently in the process of implementing a major education reform that started in 1994. This reform is a response to the research report, called the "Matane Report" (MoE, 1986). One of the significant findings in this report was that the previous schooling system did not adequately prepare young Papua New Guineans to fit into their respective traditional societies. School activities seemed to be reinforcing the idea of securing paid employment in cities and towns. This impression encouraged young people who were unable to make it through the school system to leave home for towns and cities hoping to find jobs. This was not always possible. Most of them ended up getting involved in criminal activities and became part of the increasing population of the unemployed squatter settlers. Therefore, the 1994 reform was intended to introduce some measures to help improve this situation.

Papua New Guinea's curriculum reform sparked many changes to the national education system affecting many aspects of compulsory schooling. These changes included the revamping or rewriting of many learning areas and creation of new ones, such as the Technology curriculum and Personal Development curriculum. The Technology curriculum was not previously included in the primary schools.

1.3 Reforms in Education in Papua New Guinea

Education reforms was about restructuring of the system and reforming of curriculum. The education reforms in Papua New Guinea were implemented in 1994. While the reforms applied to all sectors of schooling, for the purpose of this thesis, only the changes to the primary system is addressed.

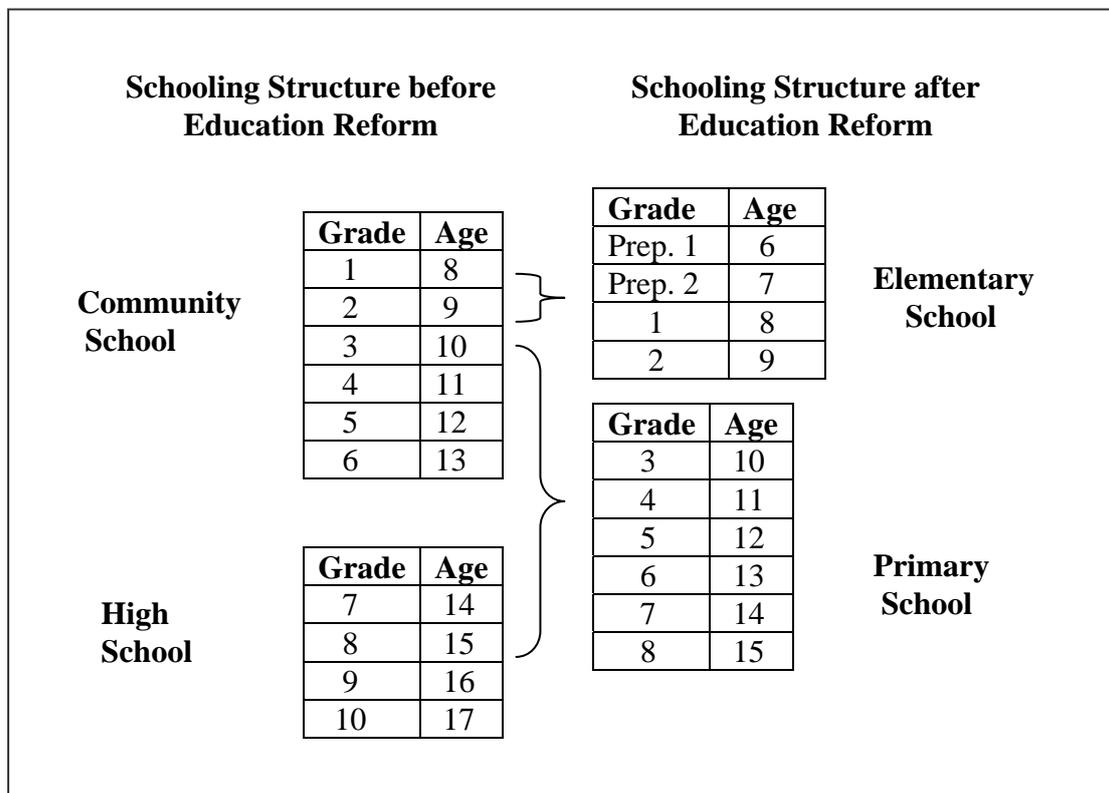
1.3.1 Structural reforms

One of the aspects of the 1994 reform was related to structural reform, which involved shifting, and relocating of grades, and renaming of the schooling system in

the country. The previous schooling sectors such as community schools (Grades 1-6, ages 8-13); high schools (Grades 7-10, ages 14-17) and national high schools (Grades 11-12, ages 18 -19) were required to change into Elementary Schools, Primary Schools and Secondary Schools under the current education reform. Elementary schools included Prep.1 (age 6), Prep.2 (age 7) and Grade 3 (age 8) as a transitional class where children from elementary classes move into primary schools. At the lower part of the primary levels were Grade 3 (age 9), Grade 4 (age 11) and Grade 5 (age 12). The upper primary were Grade 6 (age 13), Grade 7 (age 14) and Grade 8 (age 15).

Figure 1.2

Structure of schooling system – Before and after Education Reform.



The restructuring involved transferring the first two grades of primary schools to Elementary schools and lowering the school entry age to six years. Similarly, the high school system has been divided into two. Grades 7 and 8 had been transferred to existing community schools which are now known as Primary schools with Grade 3 to Grade 8 (age 10-15).

Structural reforms under the education reform involved the creation of a foundation level schooling with the establishment of separate elementary schools with three levels; Elementary Preparatory class (EP), Elementary 1 (E1) and Elementary 2 (E2), set in local settings. The removal of Grades 1-2 from community school and addition of two 'top up' classes after Grade 6 from high schools to create Grades 3-8 primary schools thus provided for nine years of universal basic education (DoE, 2001). The new level created under the structural reform at the primary level was called upper primary school, consisting of Grades 6, 7 and 8. The Technology subject referred to as Making a Living (MAL) was implemented at the upper primary school level. This research was undertaken at this level.

1.3.2 Curriculum reforms

The Papua New Guinea national curriculum was changed from a subject-based curriculum to an outcome-based curriculum under the education reform (DoE, 1986). The reform redirected the school curriculum towards education for integral human development rather than meeting work needs only. The reformed curriculum aims at developing a relevant curriculum better suited to the Papua New Guinea context, giving value and status back to the community by giving support to appropriate community attitudes, knowledge and skills relevant to community development (DoE, 2001). The new technology curriculum focuses on the development of technological skills and technological literacy

1.3.3 Outcome-based curriculum

Papua New Guinea adopted an outcome-based curriculum that identified the knowledge, skills, attitude and values that all students should achieve or demonstrate at a particular grade in a particular subject.

The outcomes-based curriculum identified what students will demonstrate as a consequence of following the national syllabuses developed for Elementary Prep to Grade 12. Each subject syllabus identifies a set of outcomes that students are expected to achieve for each grade. Each outcome is accompanied by a list of indicators that identify examples of the knowledge, skills, attitudes and values that students will need to demonstrate in order to achieve the learning outcomes. Teachers use the outcomes and indicators to write learning objectives when planning programmes and lessons.

These objectives identify the learning steps to be completed in order to achieve the learning outcomes.

The national curriculum for Papua New Guinea made explicit the knowledge, skills, attitudes and values that students should achieve for each grade of schooling from Elementary to Grade 12 in all subjects. The learning outcomes are student-centered and written in terms that enable them to be demonstrated, assessed and measured. Teachers are able to teach and students are able to learn more effectively when the outcomes of learning are made explicit and are shared (DoE, 2003).

1.4 Technical Education

Papua New Guinea's past technical education in the secondary schools was predominantly focused on the technical aspect. It was offered in various levels of schooling, in high schools, vocational schools, and technical colleges. The past technical education curriculum provided a very limited view of technology and was structured along gender lines for example, woodwork for boys only and home economics for girls only. The technical education in high schools covered a wide range of subjects including industrial arts (woodwork, metal work, technical drawing), home economics (food and textiles, food and nutrition), and agriculture (livestock, gardening). The technical education in high schools in Papua New Guinea was developed out of a perceived need to provide vocational training and other necessary skills for some school leavers who may not have the opportunity of getting a technical education. However, these technical education subjects in the high schools such as Practical Skills, Home Economics, Business Studies (Commerce) and Agriculture were only provided as an alternative to highly valued academic education subjects such as English, mathematics, social science and science.

Technical education has been replaced by technology education in high schools under the 1994 reform. At the same time as this was occurring, Technology education was introduced into primary schools at the upper school level.

1.5 Technology Education

The new reformed technology combined the technical aspect as well as technological literacy and societal aspects of technology; together these equip students with

practical knowledge and skills and attitudes that will enable them to contribute meaningfully in their local communities and societies. The present economy in Papua New Guinea makes it difficult for most students to gain formal employment after they leave school; so the Technology subject aims to provide lifelong technological skills and knowledge equipping students to be useful and productive members of their communities.

Technology Syllabus referred to as Making a Living (MAL) for Grades 6, 7 and 8, also called the upper primary, was developed during the 1994 curriculum reform programme undertaken by the Department of Education in Papua New Guinea, and was implemented in 1996. The development of the Technology Syllabus was in response to the educational reform policy *Relevant Education* (DoE, 1994) which focussed on development of life skills and knowledge, The Papua New Guinea education system's approach to technology was based on the 1985 UNESCO definition of technology:

The know-how and creative processes that may assist people to utilize tools, resources and system to solve problems and to enhance control over the natural and made environment in an endeavour to improve the human condition. (in Tetaga, 1995, p.9)

The technology curriculum combines the concepts of technological literacy with the technological design process. The aim of the new technology curriculum is to develop technological literacy through an on-going learning process and solve problems through the design process approaches. The design process involves students in identifying problems, needs or opportunities in real life situations within a Papua New Guinean context. The ultimate aim of the technology curriculum is to educate students to become knowledgeable and technically skilful, and to be aware of the social impacts and effects of technology and society within Papua New Guinea as well as a global context (DoE, 1996).

Table 1.3 shows the overview of the technology education where the technology education in Primary education was developed.

Table 1.1

An overview of the technology programme in the Papua New Guinea education reform 1996.

Elementary E Prep E1 & E2	Lower Primary Grades 3, 4 & 5	Upper Primary Grades 6, 7 & 8	Lower Secondary Grades 9 & 10	Upper Secondary Grades 11 & 12
Culture and Community (has Agriculture, Technology and Commerce Components)	Agriculture Community Life (has Technology and Commerce Components)	Technology subject is called 'Making a Living' (has Agriculture, Technology, Commerce, Home economic Components)	<ul style="list-style-type: none"> • Agriculture • Technology • Commerce 	Technology (has Agriculture, Rural/Urban , Applied Technology and Business Studies strands

(Source: Tetaga in 'Tetaga in 'Technology Curriculum Statement for Grades 11-12,' Draft for discussion, Curriculum Unit, Waigani, June, 1995, p. 1)

The focus of this study is based on the upper primary technology subject – Making a Living (MAL). The Technology curriculum in primary schools was divided into three technological strands; managing resources, better living, and community development, which were further divided into sub-strands and learning outcomes. It also outlined many possible contexts to choose from when developing a technological activity. These contexts include personal, home, school, socio-cultural, community, business, agricultural, horticultural and fishing and aqua-cultural contexts. Each unit or technological activity incorporated one or more of the technological learning areas and were performed within the chosen context. As Papua New Guinea is divided into urban and rural communities, the specific context in which the technological activities were developed should be appropriate in either the urban or rural community (DoE, 2003).

1.6 Technology Curriculum Support Materials

The following support materials were developed and distributed to primary schools to be used as a support for teaching technology. These included all the materials listed in Table 1.2.

Table 1.2

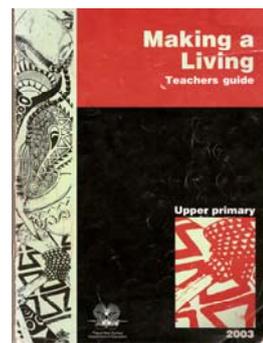
Publication details of the technology curriculum materials in Papua New Guinea.

<i>Materials</i>	<i>Author</i>	<i>Date of Publication</i>	<i>Publisher</i>	<i>School level</i>
MAL Syllabus	Department of Education	1996	Papua New Guinea Department of Education	Upper primary (Grades 6,7 & 8)
Teacher Guide	Department of Education	2003	Papua New Guinea Department of Education	Upper primary (Grades 6,7, & 8)
Teacher Resource Book	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper primary (Grades 6,7,& 8)
Student Textbook 1	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper primary (Grade 6)
Student Textbook 2	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper primary (Grades 7 & 8)
Resource Books: . <i>Basic Cooking</i> . <i>Basic Maintenance</i> . <i>Basic Building</i> . <i>Basic Gardening</i> . <i>Basic Livestock</i>	Authors: Hagunama, Eron Tawali, Cecellia Potek, Steven	2006, 2007	Oxford University Press, Melbourne, Australia.	Upper primary (Grades 6,7,& 8)

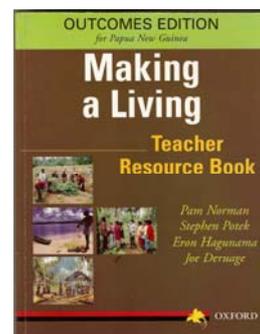
There were five types of publications produced to help primary teachers teach the new technology subject Making a Living. Making a Living is commonly referred to as MAL by all teachers. The publications include MAL syllabus, a teacher guide, a teacher resource book, two student textbooks (Textbooks 1 & 2) and five student resource books. The resource books included *Basic Cooking*, *Basic Maintenance*, *Basic Building*, *Basic Gardening*, and *Basic Livestock*.

As can be seen from the Table 1.2., all these publications focused on the upper primary schools. The *MAL Syllabus*; was published by the Department of Education in 1996. It provides a framework for teachers to develop teaching and learning programmes and assessment. The course content is written as learning outcomes. It describes a continuum of learning across Grades 6, 7, and 8. The learning outcomes were organised under three major strands; Managing Resources, Better Living, and Community Development (DoE, 1996).

The second publication was *MAL Teacher's Guide* published by the Department of Education in 2003. The *MAL Teacher's Guide* was used in conjunction with the MAL syllabus and the *MAL Student Textbooks 1&2*. It helped teachers to develop units of work relevant to student needs and to select appropriate teaching and learning strategies and monitor student learning and achievement of learning outcomes (DoE, 2003)

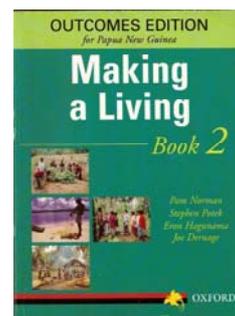
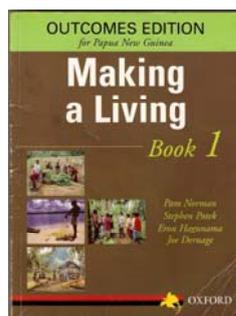


The third publication was *MAL Teacher Resource Book* published in 2005 by Oxford University Press, in Melbourne, Australia. It was used in conjunction with the *MAL Student Textbooks 1 & 2* and helped teachers to implement the MAL syllabus for upper primary students by providing relevant information for planning school-based programming. It provided selections of teaching and learning strategies, ideas



for assessment, and topics for cross-referencing to other curriculum areas for the development of integrated units of work. It also provided additional information to help teachers develop their own units of work for teaching technology.

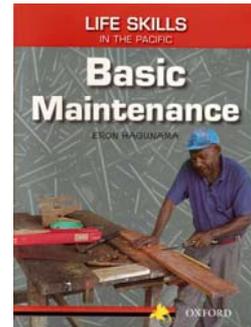
The third and fourth publications were *MAL Student Textbooks 1 & 2*. Both student textbooks were published in 2005 by the Oxford University Press in Melbourne, Australia. *Student Textbook 1* was used by Grade 6 students and *Student*



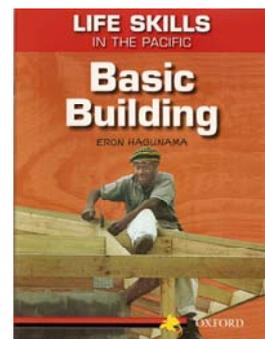
Textbook 2 was used by Grades 7 and 8 students in the primary schools. These textbooks provided direct support for the achievement of the MAL syllabus outcomes through a range of materials, including student activities, advice to teachers, reference information and assessment ideas. They were intended to facilitate flexible learning activities for teachers and students and to be modified and amended to suit local circumstances (DoE, 2005)

Finally, was the publication of five *Student Resource Books*, published in 2006 and 2007 by the Oxford University Press in Melbourne, Australia. These were published as *Life Skills in the Pacific* under titles such as; *Basic Cooking* (Tawali, 2006), *Basic Maintenance* (Hagunama, 2006), *Basic Building* (Hagunama, 2007), *Basic Gardening* (Potek, 2007) and *Basic Livestock* (Potek, 2007). These resource books were used as supplementary resource material to the student textbooks and teacher resource book.

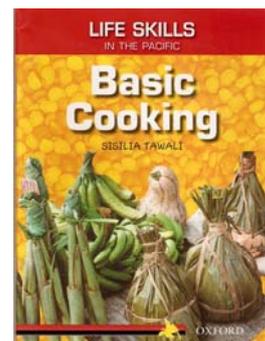
The first student resource book - *Basic Maintenance* - was developed to complement the MAL syllabus. It was about carrying out maintenance and repairs in homes and buildings. It contained step by step procedures for carrying out repairs and maintenance on roofs, walls, floorings and furniture. It also covered plumbing repairs such as leaking water taps, blocked sinks, toilets and broken pipes.



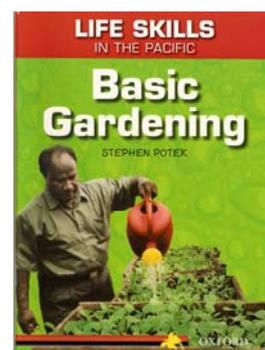
The second student resource book was *Basic Building*, a companion book to *Basic Maintenance*. It was a step-by-step instructional book about safe building practices, preparation of traditional building materials and construction of simple building structures and use of common bush materials to build traditional houses in Papua New Guinea.



The third student resource book was *Basic Cooking* aimed at providing students with basic cooking skills for living a healthy life style. It contained recipes for preparing delicious and nutritious meals using basic ingredients that every one has at home in Papua New Guinea.

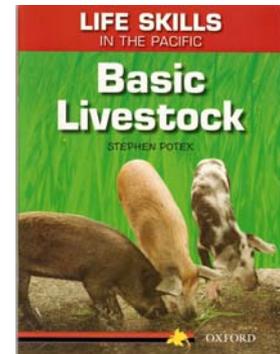


The fourth student resource book was *Basic Gardening*. It was about how to set up a food garden and grow food for the family. It contains instructions on how to prepare a garden plot, planting and harvesting methods and how to deal with



pests and diseases. The last chapter discusses how to make money by growing food in the garden and selling it.

The fifth student resource book was Basic Livestock. It is about raising and caring for animals such as pigs, chickens, and fish as a source for nutritious food for the family. It is also about using livestock as a source of income selling these animals at the market. This resource book contains instructions on how to raise these animals, including construction of their housing, feeding requirements, information on diseases that affect specific animals, and how to make money by selling animals and animal produce at the market.



These books complement the upper primary syllabus, *Making a Living*. These support materials were all available in primary schools and teachers used these in their teaching in technology.

This research is the first to investigate the views of Papua New Guinean upper primary school teachers towards technology and technology education since the subject was made compulsory for implementation in upper primary schools. The study further investigates how technology curriculum materials have impacted on teachers' perceptions of technology and technology education. It also explores how these materials have influenced how they implement technology education in their classrooms. When upper primary teachers use appropriate technology curriculum materials over time, these curriculum materials impact on their perceptions of technology and technology education and on how they implement technology in their classrooms.

1.7 Researcher's Background

I was trained as a secondary school technology teacher and had ten years of teaching experience in Papua New Guinean secondary schools. I hold a diploma in teaching and specialised in teaching traditional craft subjects such as woodwork, metalwork and traditional crafts. I completed a Bachelors degree in Design and Technology in 1998. Then, I proceeded to lecture in a primary school teachers' college as a Basic

Technology lecturer for five years. I took an active role in developing lecture programmes and producing support materials for use in primary school teachers training college when Technology education (referred to Basic Technology Course in primary school teacher training colleges in PNG) was included with other teacher training programmes. I was also involved in providing in-service training programmes to teachers teaching with the new technology curriculum at the in-service and pre-service levels. Remillard (2005) notes that amidst difficulties in implementing a new learning, one of the major supports to teachers is the use of curriculum materials, which include textbooks, teachers' guides and students' activity guides, as these plays an important role in guiding teachers' planning and teaching.

1.8 Rationale of the Study

Technology Education was introduced as a new subject into primary schools in Papua New Guinea in 1996 under the curriculum reforms (DoE, 1996). Since then, there has been a lack of sufficient professional development to help the primary teachers implement technology education. To address this, and to provide a substitute professional development, technology curriculum materials were developed and distributed to teachers in 2005 as a support for their technology teaching.

This thesis supports the idea that upper primary teachers need support to help them teach technology. Appropriate curriculum materials are able to support teachers to understand technology and technology education to implement technology in their classrooms. They require extended time for doing this in their classrooms (Schneider & Krajcik, 2002). This thesis argues that teachers' beliefs about technology and technology and teaching technology are influenced by how they interact with curriculum materials (Gunckel & Vandenbelt, 2006).

1.9 Research Questions.

Consistent with the aims of the study, the following research questions will be posed for investigation:

- 1. What are primary school teachers' perceptions of technology and technology education in Papua New Guinea?*

This question leads to an investigation of primary school teachers' understanding, views and ideas of technology and technology education.

2. What effect and influence do the technology support materials have on teachers' concepts of technology and technology education?

This second question focuses on the impacts of the new technology curriculum materials on the teachers' perceptions of technology

3. How do the technology support materials influence the teachers' classroom practice in teaching technology education in Papua New Guinea?

This question examines both the quality and relevance of the technology curriculum materials used as support for teachers' understanding of the technology subject matter and pedagogy which enhances students' learning.

1.10 Thesis Overview

This thesis explores the technology teachers' perceptions in upper primary schools in Papua New Guinea and the impacts of technology curriculum materials on teachers' perceptions and practices. It describes how these materials were used as a substitute for teacher professional development programme in Papua New Guinea.

Chapter Two sets the theoretical framework in which the research findings are substantiated. This chapter is divided into several sections and includes a review of relevant literature on the nature of technology and technology education curricula, teachers' perceptions of technology and technology education and factors influencing teachers' perceptions, a review of technology teaching and teacher professional development in which the role of curriculum materials is examined, positioning the new technology curriculum as a substitute professional development in Papua New Guinea.

Chapter Three presents the research methodology and discusses the ethical issues associated with this research. This chapter begins by re-presenting the research questions and outlining the researcher's theoretical framework. The case study approach and the reason for choosing it are discussed along with data collection methods, their advantages and their limitations. The research design is outlined by presenting the profile of schools involved and the participants. Issues of validity and reliability are discussed and how they are related to this thesis is explained. The data analysis techniques are outlined, and the researcher's role described. Finally ethical considerations are presented.

Chapter Four presents the research findings. The chapter begins by examining teachers' perceptions of technology and technology education. The factors influencing these perceptions are outlined. Teachers' views on the technology support materials and the impacts of these materials on teachers, perceptions and practices are described. Finally the analysis of documents and teachers' plans and how these show their use of the curriculum materials are presented.

The fifth and final chapter presents a discussion of the research findings and the relevant literature. The impacts of the support materials and other factors affecting participant teachers' views of technology and technology education and their pedagogical technological practices and future implications are discussed successively and the chapter concludes with a final summary and suggestions for further development of Papua New Guinea technology.

Literature Review

2.1 Introduction

In Papua New Guinea, technology education was introduced in 1996 for the first time at the upper primary school level. For teachers to effectively teach technology they need a robust concept of the nature of technology and technology education (Jones & Carr, 1992). In addition to having a robust understanding of technology and technology education, teachers require a comprehensive knowledge base of how to teach technology (Shulman, 1987; Jones & Moreland, 2000). Literature shows that in order to build that knowledge base for effective teaching in technology, teachers need support, and one way of supporting them is the use of well-designed curriculum materials (Ball & Cohen, 1996).

This chapter investigates the literature related to the nature of technology and the development of technology education. Against this, the background of Papua New Guinea's technology curriculum is examined. A review of teachers' perceptions of technology and technology education is described along with factors influencing these perceptions. Also literature relating to learning and teaching of technology is highlighted. The chapter concludes with a review of literature highlighting the use and role of curriculum materials as a support for teacher professional development and the impact they have on teachers' perception and practice of technology in the classroom.

The chapter is divided into three major sections. Section 2.2 discusses the literature on the nature of technology and is followed by the development of technology education in section 2.3. Section 2.4 presents literature on primary teachers teaching technology. The section is divided into two sections. The first section examines teachers teaching being influenced by their perceptions of technology and technology education and various factors influencing teachers' perceptions.

A summary of literature relating to primary teachers teaching technology is presented in section 2.4.2. This section begins by establishing an understanding of technological knowledge along with literature examining teachers being knowledgeable through construction of a knowledge base. A teachers' knowledge base includes subject

content knowledge, curriculum knowledge and pedagogical content knowledge, in addition to the pedagogical content knowledge in technology. A section summary is presented in 2.5.

Section 2.6 presents literature pertaining to teachers' support materials in professional development. Curriculum materials as teacher support are discussed in teacher professional development in section 2.6.1 Curriculum materials as support in teachers learning and some of the roles of the curriculum materials and limitations are highlighted in section 2.6.2. A review of technology syllabus materials currently being used in Papua New Guinea primary schools is presented in section 2.6.3. Finally a chapter summary is presented in section 2.7

2.2 Nature of Technology

It has been argued that for effective teaching in technology, teachers need to have a robust understanding of the nature of technology (Moreland, Jones, & Chambers, 2001). The nature of technology includes various dimensions such as concepts of technology; technology as artefacts, technology as knowledge, technology as a process, technology as volition,; technology as organization, and technology as value laden (Mitcham 1994).

Concepts of technology

Technology is of critical importance to our everyday lives. It influences individuals and communities and the wider communities and the wider society. Therefore, an understanding of the nature of technology is essential before any discussion can be made on technology education, because for teachers' effective implementation of technology, they need a broad understanding of the concept. The nature of technology as a concept varies according to different perspectives and interpretations. Johnson (1989) for example, defines technology as the "application of knowledge, tools, and skills to solve technical problems" (p.2). Naughton (1992) shares a similar view but relates technology to the work of engineers, inventors and technologists when they apply knowledge from scientific theories or other sources of knowledge and sometimes from experience, to create and commercialize devices and systems to meet human goals. However, Mitcham (1994) argues that technology is more than

engineering and incorporates philosophy, since all technology has been developed by people to satisfy needs and wants. This view supports Cutcliff's (1981) definition that:

Technology is a social process in which abstract economic, cultural, and social values, shape, develop and implement specific artifacts and techniques that emerge from the distinct technical problem-solving activity called engineering which is embedded in that process. (p. 36)

Based on his argument, Mitcham (1994) identifies four dimensions of technology: (1) technology as artefact, (2) technology as knowledge, (3) technology as activity or process, and (4) technology as volition. Cluster (1995) comments that to better understand the term technology, the concepts of technology as artefact, knowledge, activity or process, and volition with both the human and social dimensions, also need to be considered when conceptualizing technology. These dimensions enable the concept of technology to be much clearer, more complete, and simpler to understand, although that complexity is acknowledged as technology moves from artefacts through volition. The four dimensions of technology are now discussed in turn.

Technology as Artefacts

Mitcham (1994) describes technology as artefacts in terms of all products fabricated by human engineers, and Devore (1980) likewise acknowledges that technology is made up of physical elements invented or created by human beings. Typically this means that technology is seen to consist of machines such as computers, lasers, supersonic aircraft, and so forth (Wright, 1996).

Technology as Knowledge

Lux (1983) shares a similar view with Adam (1993), describing technology as a 'praxiological knowledge;' in other words, knowledge of practice. Adam (1993) for example, explains the origin of the word technology in Greek as *tekhne*, which means art or skill, and *logia*, which means science (knowledge) or study. Thus technology implies knowledge (science) of practice that involves the practicing of an art or skill.

Technology is sometimes viewed as being mostly associated with applied science. This view embraces the outlook of the 'Science Technology and Society' (STS) movement, popular in the USA. However, Staudenmaier (1989) identifies technological knowledge as independent of science, from a historical point of view; technological tasks were done without scientific knowledge. Williams (1992) supports this view, and adds: "technological knowledge is organized, coherent and intelligible, and is different from scientific knowledge" (p. 84). Naughton (1994) argues that not all technological knowledge is scientific. He points out that technology as knowledge sees technology to be the application of scientific and other knowledge to practical tasks, to be relevant solutions and meet the needs of society. Technology has its own knowledge base, normally the practical knowledge that is applied in human activities. Cluster (1995) argues that technological knowledge predates scientific knowledge; practical knowledge has been used throughout history, long before the relevant explanatory science theories were formulated. For example, the identification of the right type of stone for a stone axe is practical knowledge, and this knowledge was in existence prior to the development of mineralogy or geological science that might be used to explain the reasons such materials were useful for tools.

However, there is a relationship between science and technology. For scientific knowledge to be made appropriate to meet the specific demands of a design problem, it has to be transformed and restructured to meet practical ends. Science and technology work in a collaboration of knowledge to find practical solutions to the world's problems, through a range of complex forms of human activity (Jones, 1997).

Technology as a process

Gardner (1994) views technology as a process. Technology as a process is accepted by two distinct groups of educators. The first group believes that the process of technology involves invention, design, innovation, dissemination, and improvements. In this view, technology is seen as an elusive phenomenon without content, and if individuals master the design process, they will then understand technology. The second group of educators sees the process of technology as a productive system, which involves a complex network of artefacts, processes and people. In this view, technology is seen as a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to

extend the human potential for controlling and modifying the natural and human-made environment (Mitcham, 1994). Consequently, technology provides a comfortable life style for individuals and society (Wright & Lauda, 1993).

Technology as volition

Mitcham (1994) also identifies technology as volition. This refers to the social impacts technology has on humans as individuals and organizations, and *vice versa*. However, Custer (1995) argues that instead of defining technology as volition, it is more proper to refer to technology as having volitional qualities, as technology has the power or tendency to either push or pull in its influence and impact on human values, cultures, institutions, societies and nations, for better or worse (Custer, 1995; Staudenmaier, 1989).

Technology as an organization

Technology is also sometimes viewed as an organization. This view of technology means it is the way people structure themselves to produce products and services. Burns (1997) shares this view and suggests that the way a given society is organized impacts on technological developments. She further adds that technology is a part and parcel of society; therefore technology is a reflection of society and the way in which a society manages its technological developments. Educators holding this view of technology consider people developing and implementing technology as industrial or managerial organizations, are responsible for the problems of technology to society (Wright, 1996).

Technology as being value- laden

Technology is also viewed as value-laden. Layton (1988) argues that the knowledge and beliefs people have are affected by what they value. Values are visible when technology is viewed from the perspective of transfer, from one cultural context of origin to a different cultural context, and when technology is also viewed from the position of adoption. Technological activity does not occur without the involvement of people and their requirements and values. For students, it is important that they investigate how different ideas contribute to technology, including technological developments. Concern over the control of technology has been one of the strongest motivations for the increased effort to understand technology (Layton 1988).

Technology and technological practice are very much part of society. Pacey (1993), for example, sees technology in three dimensions: a cultural aspect, an organizational aspect and a technical aspect. Burns (1997) explains that the cultural aspect takes into account people's values and beliefs. The organizational aspects take into account the way in which each society manages technological development. The technical aspects take into account the knowledge and skills which contribute to technological problem-solving. Pacey (1993) further points out that technology is not only technical in nature, but also influenced by culture and the role of people and organizations in the society, and *vice versa*.

In sum, technology is multi-dimensional in nature (Petrina, 1998). Technology is a multi-faceted concept, as evident in the broad definitions of technology. For teachers to understand multi-faceted concepts of the nature of technology, teachers need to view technology from a holistic approach rather than viewing technology from one aspect, which will limit their broader understanding of the nature of technology.

Given these aspects related to the nature of technology, the Papua New Guinean technology curriculum also viewed technology from a multi-dimensional approach.

2.3 Nature of Technology Education

In addition to teachers needing a robust understanding of the nature of technology to be effective technology teachers, they also require a comprehensive understanding of the nature of technology education. The nature of technology education has been described in a variety of ways. McCormick (1992) for example, identifies various traditions influencing the study of technology education. These include craft, design and art, science, productive work and education, and science, technology and society. These traditions have influenced the development of technology curricula in different countries. Technology education is seen to be very important internationally for a variety of reasons, including educational and economic (Jones & Carr, 1993).

Technology education is now included as an essential key learning area in the curricula of many countries. However, technology education curriculum frameworks

differ from country to country. Rasinen (2003) argues that it is not only the technology curriculum content that varies from country to country, but, also the curriculum format. He explains that some countries developed a more prescriptive curriculum document with specific details of what and how it should be taught, and other countries developed a less prescriptive curriculum document, which only specify the goals that should be met.

Black (1994) reiterates the diversity with 'between – and sometimes within', countries regarding the 'definition' of technology and 'its educational purpose'. He explains five different perspectives of technology as a school subject. These five perspectives can be summarized as follows:

1. Technology as craft skills: this concept focuses on the narrow view of technology as primarily making things, which is a vocationally orientated education;
2. Technology as design and make: this concept is basically an expansion of the first, with design as an additional element that is distinct from making from prescription and, again, vocationally oriented education;
3. Technology as science: the concept of technology in this perspective is essentially applied science, which is basically physics. This could also be vocational but linked with general education specifically for preparing future citizens for technological society;
4. Technology as design and make, and the application of scientific principles: this concept focuses on the process of design and manufacturing, and exploring purpose and value. The educational focus is to educate future citizens;
5. Technology as practical capability: this concept focuses on a complex process of co-operation, defining of needs, designing, implementing and evaluating solution. The educational focus is a broad vocational and intellectual development of a person's whole being. (pp. 114-115)

Jones and Carr (1993) argue that many of these views of technology are narrow views of technology and do not reflect the broader views of technology curricula. To enhance a better understanding of technology they argue for the inclusion of social, economic and cultural aspects in forming the content of a technology curriculum. “Technology education must be defined within a social, education, and economic environment. Community values, socio-cultural and economic activities, as well as individual needs for knowledge, skills and experiences, played a significant role in determining the content of technology education” (Jones & Carr, 1993. p.2).

Petrina (1998) argues that technology education is multi-dimensional. The adoption of a multi-disciplinary approach to technology education is one way of avoiding the restricted views between different perspectives. Learning in technology education therefore needs to be multidimensional. Jones (2001) shares a similar view and adds that technology education is multi-dimensional in nature, and is “based within a philosophical, historical and theoretical context” (Jones, 2001, p. 4). This means a more holistic approach needs to be taken in the development of a technology curriculum incorporating all aspects of technology.

Rasinen’s (2003) investigation into the technology education curriculum rationale of six countries (Australia, England, France, The Netherlands, Sweden and United States), showed that technology is an integral part of our society. It is important for all students to know about it, and so it should be taught in schools. The technological rationale shared by all six countries in Rasinen’s study advocated the need to prepare students to live in a rapidly changing technological world. Daker (2005) points out that a technologically literate person understands the relationship between technology and society and will participate actively, in controlling technological decision-making. Technologically literate people make rational and justified choices and become contributing members of society once they leave school (Rasinen, 2003). They become empowered decision-makers within their learning communities as well as in future communities in which they may participate (Compton & Harwood, 2003). Technological literacy for all has now become the trend in which technology education is developed globally. Consistent with this view, the United States of America developed a technological literacy curriculum for all, which advocates that it is important for all students to be technologically literate (ITEA, 2000).

Papua New Guinea has adopted a multi-dimensional approach to technology education. The development of technological literacy is seen to be the major focus in the Papua New Guinean technology curriculum. The technology subject in the primary school aims to assist students to become technological literate and become empowered decision-makers, making justified choices and becoming contributing members of their societies once they leave school.

2.4 Primary Teachers Teaching Technology

Teachers' perceptions of technology affect what and how they teach (Jones & Carr, 1992). Teachers' perceptions of technology can be influenced by a variety of factors. Teachers need to be aware of these influencing factors in order to implement technology successfully in their schools. This research focused on the primary teachers' perceptions of technology and technology education.

2.4.1 Influences of perception.

Primary teachers' perceptions of technology and technology education have been explored by researchers such as Jarvis and Rennie (1996), Jones and Carr (1992), Moreland (2003), Rennie (1987), Sade and Coll (2002) and Symington (1987). These studies revealed that teachers held a diverse range of views on technology and technology education. Symington (1987) found that most primary teachers viewed technology as modern and sophisticated hardware, like computers, lasers and kidney transplants, while other teachers associate technology with a much broader definition. Rennie (1987) suggests that science teachers perceive science and technology to be related. Some teachers, for example, talked about technology as the application of scientific knowledge and others considered technology education to be the use of machines, making things to fulfill a need, or investigating how things work (Jarvis & Rennie, 1996). According to Rennie (1987), teachers considered technology to be artifacts, services, processes and techniques, problem-solving, improving of the quality of life, and environment control.

Prior to the implementation of Technology in the New Zealand Curriculum (TNZC) document, Jones and Carr (1992) found that many primary school teachers viewed

technology education in terms of computers and the use of computers. Some saw it as a way to solve problems, whereas others viewed technology education as finding out how things work. Moreland (1998) also found that teachers' existing concepts of technology influence the way they carry out technology activities in classrooms.

Another study by Sade and Coll (2002) on primary teachers' perceptions of technology and technology education in the Solomon Islands prior to the introduction of technology education revealed that primary teachers viewed technology as consisting of artifacts and skills. Their views of technology as artifacts included both the indigenous artifacts and cultural practices. Their views were more predominant with new modern and foreign artifacts, especially those associated with information and communication technologies. The Solomon Islands primary teachers viewed technology education as learning about how to use technological artifacts.

On the whole, literature on the primary teachers' perceptions of technology and technology revealed that among a diverse range of views, the commonly held view by primary teachers was technology as artifacts. This includes both the modern and traditional artifacts. Thus, technology education may be seen as learning about how to use the technological artifacts.

Factors impacting teachers' perceptions

Teachers' concepts of technology are influenced by many variables such as their subcultures, background experiences, and perceived need for change, teacher support, and personal attitudes towards change (Jones, 2001; 2005). For the purpose of this study, only three factors will be examined. These are subcultures, teachers' background experiences and teachers' perceived need to change.

Subcultures, according to Paechter (1991), represent reasonably consistent views about the role of teacher, the nature of their subject, the way it should be taught and expectation of students' learning. Paechter pointed out that teachers' beliefs about what was important for students to learn in their existing subject areas such as craft design and technology, home economics or arts were transferred to technology education. Thus, teachers' subcultures had a significant influence on teachers' perception of technology and technology education. In Sweden, Lindblad (1990)

found that primary school teachers formulated technology classroom experiences based on their past experiences. For example, art teachers made the technology curriculum into a design course and science teachers made it into a laboratory course.

Jones (1997) points out that teachers' perceptions have a direct influence on the way technology education is developed, interpreted and implemented. He identifies subject subcultures and background experience as influencing teachers' views. He states that these different perceptions affect implementation at all levels, national, school, and classroom, and must be taken into account when planning for implementation.

In the early 1990s, there was no shared subculture of technology education in New Zealand (Jones, Mather & Carr, 1994) instead there was a multitude of subcultures impacting on technology. Because of this lack of a technology subculture and shared understanding, the subcultural impact on technology classroom practices became very complex. Their study found that teachers' concepts of technology influenced what they taught and what they thought students should be learning. Although they had a broad view of technology, when identifying the learning that was important, teachers often focused on those aspects they were traditionally comfortable with.

Jones (1996) also noted that subject backgrounds had a direct influence on how the teachers structured lessons, and the strategies teachers developed to teach technological concepts and processes in the classroom. He found that teachers developed strategies to allow for learning outcomes that were often more closely related to their particular teaching practice than to technology. This was particularly noticeable when teachers entered areas of uncertainty when they often reverted to their traditional teaching approaches. Jones and Compton (1997) also found that teachers new to teaching technology relied heavily on already established understandings of teaching approaches often emanating from particular subject subcultures. In primary schools, where subject subcultures are not as identifiable as in secondary schools, teachers still turned to teach technology in ways that seemed more like other areas of the curriculum, often those with which they felt comfortable (Lindblad, 1990).

Another factor is the teachers' perceptions related to the need to change. Teachers' response to change is an important dimension in the development and implementation of any new curriculum. Literature suggests that teachers are not generally receptive to implementation of new curricula. For example, teachers who have already been in a climate of pressure may not see change as a solution but rather view it as a further problem (Jones & Carr, 1992). According to Claxton and Carr (1991), any changes undertaken without the commitment of teachers may fail to convey the spirit anticipated, and instead the curriculum changes may be implemented only in a rigid mechanical way. McRobbie and Tobin (1995) also point out that beliefs about curriculum change are viable only in a limited context. In other words, changes may be viable in one context, but not in another. Consequently, a new curriculum may necessitate changes or adjustments in the teachers as they work through curriculum development and implementation.

Subject subcultures are seen to be strong influential factors in the development of teachers' perceptions of technology education. Thus, the development of appropriate concepts in teachers is a crucial factor for successful implementation of technology education.

In sum, primary teachers' perceptions of technology have significantly affected what and how they teach (Jones & Carr, 1992). Teachers' concepts of technology are influenced by many variables such as background experiences, subject subcultures and teachers' perceived need to change (Jones, 2001, 2005). The subcultures are seen to be a strong influential factor on teachers' perceptions of technology education (Jones, 2001; Jones & Moreland, 2004). Moreland (1998) affirms that teachers' existing concepts of technology influence the way they carry out technology activities in classrooms. Thus the development of appropriate concepts in teachers is crucial for the successful implementation of technology education.

The next sections examine what teachers need to know and do in technology in order to implement technology curriculum successfully.

2.4.2 Teachers being knowledgeable

For teachers to be effective teachers of technology they require a comprehensive knowledge base about teaching, learning and assessing technology. Teacher knowledge is pivotal for effective teaching. This section explains ways in which teachers construct their knowledge base for teaching technology. Specific technological knowledge is described and pedagogical content knowledge is positioned as a key.

Establishing an understanding of technological knowledge

Technological knowledge is described as having multiple and numerous interpretations of the meaning drawn from a variety of sources (Layton, 1988). However, researchers such as McGinn, (1978), Hansen and Froelich (1994) and Jones (1997) argue that there is a specific technological knowledge. McGinn described three components of technological knowledge: knowledge of how to do some things; knowledge of resources used in technological activity; and knowledge of methods used in reaching the desired results of technology. Cluster (1995) shared a similar view and argues that technology has its own knowledge base, normally the practical knowledge that is embedded in human activity. Hansen and Froelich (1994) argue that technological knowledge can be developed through the exploration and solving of interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables. Jones (1997) explains that much of technological knowledge has risen from practical application or reasoning. Hansen and Froelich (1994) describe technological knowledge as conceptual, procedural and societal knowledge of technology.

Conceptual knowledge, as explained by McCormick, is “concerned with relationships among items of knowledge” (1997, p. 143). That is, the focus is on the relationships in order to explain. While conceptual knowledge is often linked to explicit knowledge, conceptual knowledge could be tacit. McCormick (2004) further explained that conceptual knowledge is very abstract and gave an example of conceptual knowledge as system concepts.

Procedural knowledge has been defined as “know how to do it” (McCormick, 1997, p. 143). Procedural knowledge is often equated with tacit knowledge. However, it is argued that not all tacit knowledge is procedural, not all procedural knowledge is tacit. Procedural knowledge includes such things as design, problem-solving, planning, system analysis and strategic thinking (McCormick, 2004). McCormick (2004) states that most national curricula for technology deal with a limited range of kinds of procedural knowledge mainly the design and problem-solving. Design is an inseparable part of technological capacity. Jones and Carr, (1993, p. 9) state that “Technological capability involves the formulation and solving of technological problems in response to a need or an opportunity” (Jones & Carr, 1993 p. 9). A good design considers the needs of people and the environment. Design is also seen as an inseparable component of technological literacy (Jones & Carr, 1993).

Problem-centred knowledge is useful in developing both teachers’ and students’ concepts of technology (Moreland, 1998). Moreland (1998) points out that problem-solving is seen as a powerful tool in learning in technology. Bereiter (1992) identifies two types of problem-centred knowledge, which he defines as knowledge organised around referents or reference point and knowledge organised around problems. He argues that problem-centred knowledge arises from active learning and should be the principal objective of instruction as this kind of knowledge is helpful in understanding a phenomenon or solving persistent problems of explanation so that they become organised points of knowledge. The processes of problem-solving and design are universally recognized as critical elements of learning and instruction in technology education (Sharpe, 1996, p. 29). Consequently, Johnson (1997) states that the ability to think conceptually, critically and creatively is fundamental to problem-solving in technology. Glaser (1984) for example, explains that students are led through a problem-solving process and at appropriate points are required to state the problem in their own words, formulate questions, analyse information, generate new ideas, test a hypothesis and evaluate possible course/s of action.

Societal knowledge is also important as technology impacts on peoples’ lives. The societal aspect of technology needs to be taken into consideration when constructing technological knowledge. Moreland, (1998) affirms that learning in technology involves the social construction of knowledge through engaging in authentic

technological activity and the development of problem-solving strategies. This is in support of the constructivist's viewpoint, that knowledge is socially constructed (Resnick, 1991). Socio-cultural theory suggests that knowledge emerges through social and cultural activity during cultural participation (Dalton & Tharp 2002). Socio-cultural views describe learning as apprenticeship occurring through guided participation in social activities with knowledgeable others, who guide students' understandings to use the tools of a culture (Vygotsky, 1986). Moreland and Jones (2004) state that knowledge is developed at a higher level than would have been when the learner learned on his/her own. Thus, shared ways of interpreting information become crucial in facilitating the social construction of knowledge.

Compton and Jones (2004) argued that technological knowledge is constructed. They reason that social and cultural values of particular groups of people influence the technological advances. Accordingly, technological activity is embedded in the 'made world' and is influenced by social, cultural, environmental, economical and political influences. Daker (2005) shares a similar view and states that effective classroom technology education takes a socio-cultural view of learning where human mental processes are situated within their historical, cultural and institutional setting. All aspects require consideration in technology curriculum design and technology education development

In sum, technology education is concerned with complex and interrelated problems that involve multiple conceptual, procedural, societal and technological variables (Jones, 1997; Hansen & Froelich, 1994,). Teachers need to develop a broader understanding of technology from a wider range of technological aspects to effectively implement technology in schools. A teacher's ability to understand and interpret the conceptual, procedural and societal knowledge in technology reflects that he/she is knowledgeable in technology (Jones, 1997).

2.4.3 Constructing teachers' knowledge

Teachers' construction of a knowledge base forms the mechanism for successful implementation of technology education. Shulman (1987) strongly emphasizes the need for teachers to build a knowledge base for teaching. His comprehensive, minimal framework includes knowledge of content, general pedagogy, curriculum, pedagogy

content, learners, educational contexts and educational ends. Pedagogical content knowledge is acknowledged as important as it identifies the distinctive bodies of knowledge for teaching. A blending of content and pedagogy represents how particular topics are organized for learners.

Further to Shulman's (1987) work on teachers' construction of a knowledge base, Grossman (1990) identifies four general domains of teachers' knowledge, which are seen as the cornerstones of teacher knowledge: 1) knowledge and beliefs about the goals for teaching a subject at different grade levels; 2) knowledge of pupils' understanding and conceptions of particular topics in a subject matter; 3) curricular knowledge, that is the knowledge about the subject content and the supporting materials; and 4) knowledge of instructional strategies and representations for teaching that particular topics (Grossman, 1990). From the Shulman's (1987) and Grossman's (1990) work on teachers constructions of a knowledge base for teaching, three aspects will be examined as they form the basis for this research. These are the content knowledge, the curriculum knowledge and the pedagogical content knowledge.

Content Knowledge

Firstly, teachers must know and understand the subject that they teach. Schulman (1987) refers to this knowledge as content knowledge. It is the knowledge about the actual subject matter that is to be learned or taught. Content knowledge of a subject includes knowledge of central facts, concepts, theories, and procedures within a given field. Teachers having a deep understanding of the subject matter helps them to teach the subject confidently in the classroom which leads to students understanding of the subject. Teachers are seen in a classroom as facilitators of knowledge in students. Teachers become the sources of students' learning. How effectively the content of the subject is presented to the students is a reflection of the teachers' knowledge in the subject matter. How much understanding of the subject content teachers require is determined by factors such as teacher's passion for the subject (Schulman, 1987). The teacher's passion for the subject can be formed through the teacher's specialization in the subject through pre-service training; through professional development programmes; and through actual teaching of the subject in the classroom over a length of time or personal interest in the subject related

literature. Shulman (1987) argues that content knowledge is central to the knowledge base required for teaching. These means of developing teachers' content knowledge will be described further in the literature.

Curriculum Knowledge

Secondly, curriculum knowledge, which includes an understanding of materials and programmes that serve as the tools of trade, is required. In order to build the knowledge base to teach students, teachers need an understanding of curriculum materials.

Ball and Cohen (1996) argue that curriculum materials are a potential vehicle to support teacher learning, both in the construction of subject content knowledge and the teacher's pedagogy. The use of subject support materials such as the teachers guides, textbooks and other subject resource materials used in planning and teaching add to teachers' content knowledge. These support materials contain subject content information; information on how to plan for teaching, activities for learning, and strategies to use in teaching (Remillard, 2005).

Pedagogical Content Knowledge

Finally, pedagogical content knowledge (PCK) is described as a teacher's understanding of how to help students understand specific subject matter. PCK exists at the intersection of content and pedagogy. It represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction (Shulman, 1987). Teachers need to have the pedagogical content knowledge which is a blending the subject content and pedagogy in a way that makes possible for students to learn that content. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding.

2.4.4 Pedagogical content knowledge in Technology

The construction of a technological knowledge base for teachers is pivotal for effective technology teaching and for expecting teachers to add technology teaching to the existing learning areas that they are required to teach (Moreland, Jones, & Norhover, 2002).

While it is important for teachers to know what and how to teach in the field of technology education, it is equally as important for teachers to have sufficient knowledge of technology and technology education. Moreland, Jones and Chambers (2001) emphasize the importance of teacher interactions and feedback for effective teaching and learning. They pointed out that there was a need for assisting teachers to gain broader understanding of technology for effective teaching and learning in technology. They identified three dimensions of knowledge required by teachers to be effective: knowledge about the nature of technology and technological practice, knowledge of technological concepts and procedures, and general technological pedagogical knowledge.

Jones and Moreland (2004) also highlight the need for assisting teachers to gain broader understanding of technology. This was of paramount importance for effective teaching and learning in technology. They argue that student formative interaction becomes distorted if there is a lack of subject knowledge and its construction. They reason that teachers' understanding of the nature and purpose of the discipline strongly influences their pedagogical content knowledge. Therefore, to be effective in technology, teachers will need to develop the dimensions of knowledge in technology. These are knowledge about the technology, knowledge in technology and technological pedagogical knowledge (Moreland & Jones, 2000, p. 288). Teaching begins with an understanding of what is to be learnt and what is to be taught. This includes knowledge of content, general pedagogical knowledge. Consequently, they identified characteristics or features of pedagogical content knowledge that were important for effective teaching and learning in technology. These were:

- Enhanced teacher knowledge about technology, including the nature of technology, areas of technology and specific technological knowledge;
- Changes in pedagogical approaches including conceptual, procedural and technological approaches; enhanced teacher-students interaction;
- Knowledge of relevant technology curriculum goals and objectives and refinement of appropriate learning outcomes and planning frameworks;
- Knowledge of students' learning progress and negotiated intervention;
- specific teaching and assessment practices of technology leading to improved teacher confidence;

- appreciation of context setting for, and role of, technological problem solving and critical decision making; and
- an appropriate and creative classroom environment with appropriate resources (Moreland & Jones, 2000).

In sum, Jones and Moreland (2004) found that having a broader understanding of curriculum aims and objectives of the subject and having a wide range of pedagogical strategies with sound knowledge of the subject content enhances effective teaching in technology education.

In summary, technology was identified as having a knowledge base of its own. Much of this has risen from practical human activity and reasoning. Technological knowledge can be developed through exploration and solving of interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables (Jones, 1997). For effective implementation of technology in classrooms teachers require a knowledge base. Three major areas of knowledge base were identified in this research to enhance effective teaching. These are the content knowledge, the curriculum knowledge and the pedagogical content knowledge (Shulman, 1987). For a new curriculum area such as technology, the challenge is for teachers to construct a coherent technological content base, because teachers' understanding of the nature and purpose of the discipline strongly influences their pedagogical content knowledge. The three dimensions of knowledge identified by Jones and Moreland (2000) as knowledge about the nature of technology and technological practice, knowledge of technological concepts and procedures, and general technological pedagogical knowledge are required by teachers to be effective in teaching technology. Consequently, for technology education to be effectively implemented in Papua New Guinean primary schools, teachers need to develop the three dimensions of knowledge in technology (Jones & Moreland, 2000)

The literature presented in section 2.4 has argued for the importance of a knowledge base for teaching. How that knowledge base may be developed is presented in the next section.

2.5 Teachers and Professional Development.

For teachers to build their knowledge base, they need support of well designed, appropriate, support materials and an effective professional development programme. However, in Papua New Guinea, there is no on-going professional development in technology education in primary schools. Instead, support curriculum materials were developed and used as an alternative for professional development

In this section, literature pertaining to the use of support materials for teacher professional development is presented in section 2.5.1. It includes curriculum materials as support in teachers' learning, and ways educative curriculum materials can help teachers' pedagogical practices. Limitations of the curriculum materials and influences on the curriculum are also indentified. Section 2.5.2 presents descriptions of support materials used in Papua New Guinea primary schools. A summary and the relevance to the study is presented in section 2.6.

2.5.1 Support for professional development

Professional development, in itself, is a form of teacher support (Bell, 1993). Jones and Compton (1998) suggest that a professional development programme on technology education that considers the importance of the teacher developing a robust concept of technology education, technological pedagogy and technological practice would aid an effective curriculum implementation and result in a successful technological classroom practitioner. Among other factors of teacher support in professional development such as teachers talking to each other, school-based support, and administrative support, curriculum materials support is one of the major supports to addressing teachers' difficulties in implementing a new learning (Bell, 1993; Bell, 2005; Bell & Gilbert, 1996).

Bell (2005) points out that an effective professional development should empower teachers to try out something new by themselves, even well after the professional development finishes. Jones (2003) says that long-term teacher development which is based on an ongoing process is crucial for effecting change in a classroom. The long-term, on-going professional development in technology education in New Zealand has enabled technology teachers to have a much broader view of technology and

technology education consistent with the technology curriculum (Jones, 2003). Curriculum materials remain with teachers in the classroom and enhance that continual professional development. Curriculum materials serve as a substitute for face-to-face one-off professional development through workshops and in-service on the new curriculum.

Teachers need support for developing their knowledge base for teaching. According to Ball and Cohen, (1996) well-designed curriculum materials support development of teacher knowledge. Among other factors of support in teacher professional development programmes, curriculum material support was identified as one of major supports to addressing teachers' difficulties in implementing new learning. Remillard (2005) pointed out that curriculum materials play an important role in guiding teacher planning and teaching. Curriculum materials offer representations for concepts, tasks, procedures, and instructional approaches for teachers and students in classroom (Ball & Cohen, 1996). Concepts may refer to the nature of the subject, in other words the content knowledge of the subject (Shulman, 1987; Grossman, 1990). Grossman (1990) identifies knowledge about the subject matter as one of the domains of teachers' knowledge. Tasks may refer to activities and procedures may refer to steps or sequence of processes involved in performing the task or activity, which Grossman (1990) identifies as knowledge and beliefs about the goals for teaching a subject at the different levels. And instructional approaches may refer to teaching strategies used in teaching that subject, which Grossman (1990) also identifies as knowledge of instructional strategies for teaching that particular topic.

Curriculum materials promote teachers' learning (Ball & Cohen, 1996; Davis & Krajcik, 2005; Remillard, 2005). Ball and Cohen (1996) point out that curriculum materials are a support in teachers' learning. Curriculum materials that were intended to promote teachers' learning were referred to as educative curriculum materials (Davis & Krajcik, 2005). Teachers need strong subject knowledge, but must also develop pedagogical content knowledge (PCK), the knowledge to of how to teach the content (Shulman, 1986). Teachers need to make connections between ideas, in addition to adding new ideas about subject concepts and instructional approaches (Davis & Krajcik, 2005). Educative curriculum materials help teachers to develop more general knowledge that they can apply flexibly in new situations. Curriculum

materials are an integral part of teachers' daily work. Putnam and Borko (2000) point out that teachers' learning is situated in their daily practices. This means that teachers learn knowledge during their teaching and classrooms and through the use of support materials. Teachers' practice includes classroom instruction, contact with students, with other teachers, parents and the outside communities and the use of curriculum materials (Davis & Krajcik, 2005). Putnam and Borko (2000) state that educative curriculum materials are a counterpart in teachers practice, they serve as a cognitive tool for teachers' learning. Consistent with this view, Linn et al. (2004) argue that educative curriculum materials can serve as cognitive tools to help teachers make connections between general principles and specific instructional moves to integrate their knowledge base and begin to use their knowledge flexibly in the classroom.

Curriculum materials include textbooks, teachers' guides, and student activity guides and other resource materials that assist teachers in teaching. Curriculum materials such as the syllabus, teacher's guide and students textbook provides instructional guide to teachers in their lesson preparations and teaching (Remillard, 2005). Consistent with this view, Davis and Krajcik (2005) note that teachers new to a subject view curriculum materials as a source of knowledge and a tool for instruction. This means that curriculum materials help teachers in developing their content knowledge as well as the instructional guidelines to teach subjects confidently and effectively in classrooms.

Ways educative curriculum materials help teachers

Ball and Cohen (1996) believe curriculum materials are designed to address teacher learning as well as student learning. They suggest some specific areas in which educative curriculum material can promote teachers learning.

First, educative curriculum materials could help teachers learn how to anticipate and interpret what learners may think about or do in response to instructional activities. Consistent with this view, Schneider and Krajcik (2002) suggest that educative curriculum materials could add additional support for teachers' pedagogical content knowledge. This includes support for knowledge about instructional representations such as analogies, models or diagrams.

Second, curriculum materials could support teachers' learning of subject matter (Ball & Cohen, 1996). Schneider and Krajcik (2002) found that teachers read, understood and adopted ideas from the subject supports in the curriculum materials that they were using, in addition to learning the facts and concepts within the subject.

Third, curriculum materials could help teachers consider ways to relate units during the year (Ball & Cohen, 1996). Consistent with this view, Wang and Paine (2003) found that teachers benefited from the objectives provided in the text of a mandated curriculum. The objectives provided in the text reflect a larger curricular picture to the teachers. In looking at the first three roles of educative materials, Davis and Krajcik (2005) note that educative materials can help teachers add new ideas to their repertoires and help teachers to develop their knowledge base.

A fourth role that educative curriculum materials could play is to help teachers make pedagogical judgments (Ball & Cohen, 1996). Educative curriculum materials help teachers to make decisions about how they should adapt curriculum materials, and help teachers to integrate their knowledge base. Educative curriculum materials could also help teachers to make connections between theory and practice, and apply their knowledge flexibly.

Finally, Davis and Krajcik (2005) suggest that educative curriculum material promotes teacher's *pedagogical design capacity*. This mean that individual teachers are given the freedom to use their personal resources and support materials embedded in curriculum materials and decide how to contextualize lessons in reality rather than merely implementing lessons from a set of given curriculum materials.

Remillard (2000) argues that curriculum materials should "speak to teachers about the ideas underlying the task rather than merely guiding their actions (p. 374). In doing so, the materials should educate teachers while promoting their freedom to make decisions about how to adapt curriculum materials.

In terms of relevance and contextual aspects of knowledge for effective teaching and learning, Squire et al., (2003) argue that the influence of the local classroom and

school culture needs to be considered. Accordingly, they suggest that all curriculum materials must assimilate into the cultural context in which they are being used.

Limitations of using Educative Curriculum Materials in place of professional development

Gunckel and Vandebelt (2006) argue that while educative curriculum materials help teachers to add new ideas to their repertoires, how to relate or connect those ideas to other ideas still remains a challenge for teachers. It is also hard for teachers to be able to put those new ideas into the actual practice of teaching. They reiterate that the effectiveness of educative materials at promoting teacher learning will be limited by three factors. First, curriculum materials must be of high quality in terms of content and pedagogy. Curriculum materials should not only contain teaching strategies, but should also provide comprehensive concepts of the subject. Second, the effectiveness is limited by characteristics of the teachers themselves, such as their knowledge, beliefs and dispositions toward reflection and improving their own practices (Collopy, 2003; Schneider & Krajcik, 2002). Third, educative curriculum materials should not serve as only one means of support in teachers' learning but must include other supports for effective learning. Individual teachers interpret, use and learn from a curriculum in different ways (Collopy, 2003). This means that educative curriculum materials are not likely to support the learning of every teacher. Davis and Krajcik (2005) argue that educative curricula can be more effective if used in conjunction with other forms of support.

Another limitation of the curriculum materials is the amount of guidance the curriculum materials provide for teachers. Most teachers do not have time to read extensively, no matter how useful the materials might be. They want only instructions on teaching the subject. However, other teachers thrive on studying the curriculum materials more and want to know the reasoning behind the suggestions that were being made. Teachers who rely on textbooks for instructions are text bound, they lack the ability to draw ideas from one source at hand to another and make productive changes to curriculum materials (Brown & Edelson, 2003). Similarly, Remillard (1999) argues that curriculum material being too descriptive may deprive teachers of having the freedom to be flexible in planning and integrating ideas from one source to another, making the curriculum materials less effective.

Newsome (1999) argued that novice teachers were more text bound, that there was no flexibility in their teaching and that their ability to integrate ideas and knowledge with other learning areas was restricted. She also argued that experienced teachers held tightly to techniques and methods that had worked well for them in the past, valuing these materials for the pedagogical efficiency, making their teaching easier in the classrooms. She reasoned experienced teachers' holding onto past knowledge and teaching techniques was due to newness of the subject and the lack of subject matter knowledge. Newsome (1999) further argued that while curriculum materials can be help to teachers who lacked knowledge of the subject matter, much reliance on the use of curriculum material may also constrain teachers' opportunities to learn or change.

Teachers' use of curriculum and responses to professional development may be influenced by several factors. These are, the context in which teachers work, teachers' belief and knowledge. Teachers, for example, may decide whether or not to alter their teaching practice in light of students' responses to instruction in classrooms. Teachers may also alter their teaching to what they see as a need for their students. This may imply that learning outcomes stated in the curriculum materials can be altered to suit context and need for learning. Teachers' beliefs and knowledge about subject matter, pedagogy and learners may also influence teachers' responses to curriculum materials, including how they use the materials and what they learn from them (Davis & Krajcik, 2005). Collopy (2003) notes that teachers hold some beliefs, particularly those formed through their own experience as students, these beliefs may have a great influence on teachers' perceptions and decisions on curriculum materials. Teacher's beliefs and knowledge about subject, teaching and learning are interconnected. In addition, a teacher's goals and interest, values and expectations of curriculum materials are also factors that may influence the teacher's use of and learning from materials. For example, a teacher who likes practical work would emphasize teaching on practical aspects, giving very little attention to theoretical aspects. Responses to professional development may also be influenced by teachers' beliefs about themselves and the curriculum materials (Collopy, 2003).

2.5.3 Curriculum materials and Papua New Guinea

In Papua New Guinea, curriculum materials were used as a substitute for teacher development. No teacher workshops were undertaken, instead teachers support materials were distributed to all primary schools. These included all the materials listed in Table 2.1

Table 2.1

Publication details of the technology curriculum materials in Papua New Guinea.

<i>Materials</i>	<i>Author</i>	<i>Date of Publication</i>	<i>Publisher</i>	<i>School level</i>
MAL Syllabus	Department of Education	1996	Papua New Guinea Department of Education	Upper primary (Grades 6,7 & 8)
Teacher Guide	Department of Education	2003	Papua New Guinea Department of Education	Upper primary (Grades 6,7 & 8)
Teacher Resource Book	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper primary (Grades 6,7,& 8)
Student Textbook 1	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper primary (Grade 6)
Student Textbook 2	Authors: Deruage, Joe Hagunama, Eron Norman, Pamela Potek, Steven	2005	Oxford University Press, Melbourne, Australia.	Upper Primary (Grades 7 & 8)
Resource Books: . <i>Basic Cooking</i> . <i>Basic Maintenance</i> . <i>Basic Building</i> . <i>Basic Gardening</i> . <i>Basic Livestock</i>	Authors: Hagunama, Eron Tawali, Cecellia Potek, Steven	2006, 2007	Oxford University Press, Melbourne, Australia.	Upper primary (Grades 6,7 & 8)

There are six types of publications produced to help primary teachers teach the new technology subject Making a Living, commonly referred as MAL by all teachers. The publications include the *MAL Syllabus*, a teacher guide, a teacher resource book, two student textbooks (1 & 2) and five student resource books. The resource books are *Basic Cooking*, *Basic Maintenance*, *Basic Building*, *Basic Gardening* and *Basic Livestock*.

As can be seen from the Table 2.1., all these publications focused on the upper primary schools. The first publication was a *MAL Syllabus*, published by the Department of Education in 1996. The syllabus provides a framework for teachers to develop teaching and learning programmes and assessment. The course content is written as learning outcomes. It describes a continuum of learning across Grades 6, 7 and 8. The learning outcomes were organised under three major strands; Managing Resources, Better Living, and Community Development (DoE, 1996).

The second publication was a *MAL Teacher's Guide* published by the Department of Education in 2003. The *MAL Teacher's Guide* was used in conjunction with the *MAL Syllabus* and the *MAL Student Textbooks 1&2*. It helped teachers to develop units of work relevant to student needs and to select appropriate teaching and learning strategies and monitor student learning and achievement of learning outcomes (DoE, 2003)

The third publication was a *MAL Teacher Resource Book* published in 2005 by Oxford University Press, in Melbourne, Australia. It was used in conjunction with the *MAL Student Textbooks 1 & 2* and helped teachers to implement the syllabus for upper primary students by providing relevant information for planning school-based programming. It provided selections of teaching and learning strategies, ideas for assessment, topics for cross-referencing to other curriculum areas for the development of integrated units of work. It also provided additional information to help teachers develop their own units of work for teaching technology.

The third and fourth publications were *MAL Student Textbooks 1 & 2*. Both textbooks were published in 2005 by the Oxford University Press in Melbourne, Australia. *Student Textbook 1* was used by Grade 6 students and *Student Textbook 2* was used by Grades 7 and 8 students in the primary schools. These student textbooks provided direct support for the achievement of the MAL syllabus outcomes through a range of materials, including student activities, advice to teachers, reference information and assessment ideas. They were intended to facilitate flexible learning activities for teachers and students and could be modified and amended to suit local circumstances (DoE, 2005).

Finally came the publication of five *Student Resource Books*, published in 2006 and 2007 by the Oxford University Press in Melbourne, Australia. These were published as *Life Skills in the Pacific* under the titles *Basic Cooking* (Tawali, 2006), *Basic Maintenance* (Hagunama, 2006), *Basic Building* (Hagunama, 2007), *Basic Gardening* (Potek, 2007) and *Basic Livestock* (Potek, 2007). These resource books were used as supplementary resource material to the student textbooks and teacher resource book. These books complement the upper primary syllabus *Making a Living*.

These support materials were all available in primary schools and teachers used these in their teaching in technology.

2.6 Summary of the chapter: Relevance to this study

The various perceptions teachers hold for the concept of technology illustrates the broad, multifaceted nature of technology. The adoption of a multi-approach to technology education is one way of avoiding the restricted views between different perspectives.

Teachers' perceptions of technology have been examined and found to be very influential in the implementation of technology curriculum in schools (Jones & Carr, 1992). Among many variables such as background experiences, subject subculture, perceived need for change, that influence teachers' perceptions of technology, subculture is seen to be a strong influential factor in teachers' perceptions of technology education.

For teachers to teach technology effectively, they require a robust knowledge base. Technological knowledge has multiples of interpretations and meanings; however, technology has a knowledge base of its own –developed through exploration and solving of interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables (Jones, 1997). For effective implementation of technology education in schools, teachers not only need content knowledge but also pedagogical knowledge. Jones and Moreland (2000) identify three dimensions of knowledge that enhance effective teaching in technology: knowledge

about technology, knowledge in technology, and general pedagogical knowledge (Moreland & Jones, 2000).

The construction of the teachers' knowledge base does not occur on its own, some form of professional development support is needed. Curriculum materials were identified in this thesis as a major support in the construction of teachers' knowledge (Ball & Cohen, 1996). Curriculum materials are on-going and can serve as a substitute for face-to-face professional development programmes.

The next chapter describes the research methodology used in this inquiry.

Chapter Four

Research Methodology

3.1 Introduction

This chapter will describe the methodology and the methods used by the researcher in order to provide the framework within which this research has developed.

Methodology describes and analyses the methods used and their limitations, making explicit the basis upon which inferences and interpretations are made (Cohen & Manion, 1994). It provides not only all the technical details of how and why the problem was investigated (Bell, 1993), but also makes explicit the social context and the theoretical views and assumptions of the researcher (Cohen & Manion, 1994). Describing the methodology in detail will provide an audit trail which will allow the reader to determine the researcher's perspective and provide the means by which they may judge the authenticity of the findings.

Section 3.2 outlines the researcher's theoretical framework. This is followed by the research questions in 3.3 and the research methods are described in 3.4. Section 3.5 presents the research design, and data analysis is described in section 3.6. Discussion of validity and reliability is presented in section 3.7 and followed by a discussion on gaining participant's consent. Section 3.9 introduces the role of the researcher, followed by an explanation of ethical considerations for the research in section 3.10. Finally, the summary of the chapter is presented in section 3.11.

3.2 Theoretical Framework

The view that one holds of social science is underpinned by a series of assumptions about reality, knowledge and human nature. These assumptions will have direct implications for the methodology used in this research and are a concern for the researcher (Cohen & Manion, 1994). Burrell and Morgan (date) classify these assumptions into two contrasting groups or perspectives. First, there are the assumptions of the ontological kind which encompass the view that knowledge is personally constructed and humans are the creators of their environment. This is in contrast to the second, epistemological assumptions that consider human beings to be

the product of their environment, conditioned by their external circumstances. The former, based on anti-positivist theory, implies the need for understanding the interpretations of individuals, requiring qualitative inquiry methods. The latter, based on positivist theory, seeks universal knowledge and generalised explanations through quantitative methods of data collection.

Keeves (1988) identifies two major paradigms in educational research: “the scientific, which seeks causal explanations and the interpretive which seeks understanding in terms of intentions, motives and the stated reasons” (p.593). Cohen and Manion (1994) referred to these as ‘normative’ (positivist) and ‘interpretive’ (anti-positivist). The interpretive paradigm considers the research as an integral part of the inquiry; therefore the real issue lies with finding ways in which the inquiry can be enhanced with the researcher’s presence taken into account. Research undertaken in the interpretivist approach can be collaborative, participatory and qualitative and is contextual. Such features of the interpretive paradigm fit the small-scale nature of research undertaken by a single researcher.

This research was based on the interpretive paradigm, where the researcher focused on exploring the participant teachers’ personal experiences and perceptions with the aim of “understanding their interpretation of the world around them” (Cohen & Manion, 1994, p.37). The main focus of the interpretative paradigm is to understand the world of human experience and how individuals are actively or directly involved in this world (Cohen & Manion, 1994). Banister et al. (1994) add that the interpretivist approach views the world through the medium of interpretation.

This research has used an interpretative approach, seeking to understand the perspectives of the various participants from within their individual contexts. Individual schools are unique social settings and, as such, the contextual nature of the research setting will be different for each participant. Qualitative methods of data collection are considered necessary for understanding and interpreting the meanings and perspectives of individual participants. The aim of this of this research is to understand and interpret primary teachers’ perceptions of technology and practices in classrooms in Papua New Guinea. This is the first research study since technology implementation in primary education. The emerging theory will be the researcher’s

interpretation and reconstructions of those meanings. In this approach, it is acknowledged that the theory is context bound and therefore not intended to be universally applicable. However, there may be issues or insights derived which may be applicable to similar contexts or transferable to other contexts.

3.3 Research Questions

The technology subject was introduced and implemented into the primary education curriculum under the latest reforms in education in Papua New Guinea in 1996. The technology curriculum has long been established in the secondary curriculum but had never been part of the primary school curriculum until the current reforms in education. These reforms provided a unique opportunity to investigate teachers' perceptions of technology and technology education in the early implementation stages. They also provided an opportunity to investigate both the impacts of the newly developed curriculum materials on teachers' perceptions and their impact on teachers' practices in the classrooms. A research study was carried out in two primary schools involving six technology teachers who were teaching technology and using the support materials. The findings reveal these teachers' perceptions of technology and practices in classroom and the support materials' use in construction of teachers' knowledge base for effective technology teaching in classrooms.

The key research questions were:

- What are primary school teachers' perceptions of technology and technology education in Papua New Guinea?
- What effect and influence do the technology support materials have on teachers' concepts of technology and technology education?
- How do the technology support materials influence the teachers' classroom practice in teaching technology education in Papua New Guinea?

3.4 Research Methods

A case study approach was used in this research and the main techniques used for data collection were interviews and document analysis. Interviews were audio taped, transcribed and validated by the participants. In addition to this, analyses of the documentation collected from the participant teachers in the participant schools were

used. The methods and techniques, the reasons for their selection and their limitations are described in this section.

3.4.1 The case study approach

A case study approach was chosen because of the in-depth focus of this research and the relatively small number of participants, six teachers from two schools. The case study approach is concerned with depth rather than breadth, and focuses on social situations, where the embeddedness of the social truths is recognised (Cohen & Manion, 1994). Therefore, it provides an ideal method for this research situated in the context of technology education. The features of case study research making it suitable for this study are that it allows the formation of a relationship between the researcher and the participants, it allows access to a richness of data, it is informal and flexible, and takes place in the natural setting of the participants and the phenomenon being studied. Case studies are strong in reality and down to earth; they allow the researcher to pay close attention to the subtleties and complexities of the case (Cohen & Manion, 1994).

As the aim of this research is to investigate the true perspectives of the participants and the influences leading to the implementation of the new technology curriculum including the impacts of the new curriculum materials on the participants' perceptions, the formation of a trusting relationship between the teacher participants and the researcher was essential. It is important that the participants are comfortable sharing their understandings and feelings because the depth of information the participants are prepared to share depends on the relationship. Three of the six teachers interviewed were known to the researcher as his students during their teacher training.

To gain access to richness of data, a thorough understanding of the participants' social and cultural context and their relationships within the school community is necessary. The researcher's involvement with the development of the technology curriculum materials, the researcher as a primary teacher trainer, and the participant schools' situation within the researcher's home district were seen as a real advantage in this study, as many of the subtleties were known and the relationships already established.

Another feature of a case study is its informality and flexibility. This research was flexible and informal and maintained a friendly tone, with interview sessions allowing the participants and the researcher to collaborate freely. The researcher had the freedom to alter, devise and prompt questions during the interview. The instrument of data collection used was semi-structured interview as such an interview method offers more flexibility for the format of the questions.

The research was carried out in the natural setting of the schools, hence reflecting the reality of the teachers' situation (Merriam, 1988). The teachers were in their natural teaching environment surrounded by all the relevant teaching documents such as the new technology curriculum materials, which all contributed to stimulating discussion and viewing of authentic materials and teachers' work. This also made the collection of relevant documents for document analysis easy. Times for interviews were negotiated and these were conducted during the teacher's non-teaching period so individual teachers could be prepared and feel relaxed. Again, flexibility in this regard was important.

Some of the problems associated with these types of data collection are that they take a large amounts of time and a huge amount of data can be collected, which in turn requires huge effort by the researcher in transcribing interviews and analysing data. Bell (1999) has suggested some methods by which to control the interviews and keep them on the topic as much as possible. Another problem is that teachers could feel threatened by being involved, and it is important to take account of this when selecting participants. In this study, the school principals were asked to select the participants. Knowing their staff well, the principals were able to sense who might be interested in being involved and would be willing to share and would also have relevant information on the topic.

There are many methods of data collection in case study research but, according to Creswell (1994), "Data collection procedures in qualitative research involve four basic types: observations, interviews, documents, and visual images" (p.149). However, for the purpose of this study, two methods were used: interviews and document analysis. The use of these two methods was influenced by the research purpose and the major research questions posed in this study.

3.4.2 Interviews

An interview is regarded as a social interaction, or a conversation between two or more people. The interview has been described as a conversation with a purpose (Bell, 1993; Cohen & Manion, 1994; Kvale, 1996; Powney & Watts, 1987), where the direct interaction continually provides new insights into the subject's lived world (Kvale, 1994). Interviews have many purposes with many variations in a wider context. Cohen and Manion (1994) stated that:

Interviews may be used as a means of evaluating and assessing a person in some respect; for selecting and promoting an employee; for effecting therapeutic change, as in the psychiatric interview; for testing or developing a hypothesis; for collecting data, as in surveys – in experimental situations or for sampling respondents' opinions, as in doorstep interviews. (p.271)

Regardless of all these variations, the common denominator identified by Cohen and Manion (1994) is that an interview is a transaction that occurs between the interviewer who is seeking information, and the interviewee who is supplying information. Although, the purpose of the interview in the wider context of life is varied, the particular the interview technique discussed here is confined to interviews used for collecting data in qualitative inquiries.

There are many different types of interview with each one suited to particular purposes, situations and researchers. Cohen and Manion (1994) describe four types of interview: structured, unstructured, non-directive and focussed. Kvale (1996) describes different types of interviews as ranging on a continuum from the very structured survey type at one end of the scale, to the completely unstructured and informal at the other. The more structured interview tends to be more tightly controlled by the interviewer whereas the unstructured interview allows greater flexibility and control for the interviewee. For this research, semi-structured interviews were used.

Semi-structured interviews

Semi-structured interviews were chosen for this research because this approach allowed for some flexibility in the interviewing process. The interviews were one-to-one and were carried out by the researcher. The semi-structured interview falls somewhere in between the two extremes on the continuum and assumes the benefits

of interviews, the structured interviews and the unstructured interviews. It generates rich discussions of ideas and feelings and also provides opportunities, through flexibility and informality, for the researcher to build an in-depth understanding of the participants under investigation (Maykut & Morehouse, 1994). Having the some freedom to probe for detail, clarify meaning, and follow up on unexpected points adds richness to the data and provides the interviewer with a clear understanding. However, some degree of structure is necessary.

Negotiating the interview time between the researcher and the participants is very important. The participants in this inquiry were teachers who were occupied with their teaching lessons and carried a heavy workload. Uncompromised timing between the researcher and the participants can cause inconvenience. If it becomes a burden to the participant, this could affect the relationship with the researcher and consequently also impact on the openness and depth with which the interviewees would respond to questions. Therefore, the researcher and the participants negotiated a suitable time and place for the interviews. This was done so that the participants' teaching time was not affected and their teaching duties were not disturbed in any way.

Establishing and maintaining a positive and trustful relationship with the participant is important when using the interview technique. Powney and Watts (1987) highlight that the strength of the relationship between the researcher and the participants will affect the validity and the depth of information that the participants are prepared to divulge. For this research, a time of thirty to forty minutes was decided on for each interview and agreed to by the participants. This time length fitted into non-contact periods and after lunch breaks. Interviews were held at selected places at the school. Interview schedules and times were made known to the principal of the school. Cohen and Manion (1994) suggest that preplanning and recording of the questions to be asked is also necessary as well as preparing some prompts to use if the answers are not forthcoming or lack depth and clarity. For this study the interviewer was the researcher and these preparation guidelines were followed.

Skill in questioning is another attribute an interviewer requires as this will influence the quality and the validity of the information obtained. Selecting the most

appropriate types of question is vital for obtaining relevant information. In this study the researcher used open questions when depth of information and meaning were required. Other questions were more specific and included those seeking facts and opinions from the participants. Care was taken to avoid the bias resulting from leading questions (Bell, 1993; Kvale, 1996). Leading questions may be a problem in semi-structured interviewing when probing for information, as these questions are formulated on the spot. It is, therefore, advisable that questions for probing are kept very general to avoid leading participants to a particular response. For example, in this study questions such as ‘So tell me more about it; what makes you think like that?’ ‘Would you like to explain that for me?’ were used.

Finally, semi-structured interviews generate large amounts of data. This can be daunting, confusing and very time consuming for the researcher to sort through, organise, analyse and report. In this research, the researcher provided the participants with the questions in advance to allow for thinking time, in order to allay any fears or nervousness they had about the interviews. It helped them to feel more relaxed and allowed them time to prepare in advance. This maximised the data gathered and encouraged an open, trusting relationship. It also helped keep the timeframe of the interview shorter as the participants had already prepared how they might answer.

3.4.3 Document analysis

Document analysis was another research method used to collect data for this research. Documents can be collected for analysis as an additional data source to supplement information obtained through interviews, to support trustworthiness of findings. Documents refer to a wide range of written, visual and physical materials relevant to the study at hand (Bell, 1987; Merriam, 1998). Documents can be either primary or secondary sources. Primary sources include documents that come into existence during the research period and secondary sources are interpretations of events of that period based on primary sources (Bell, 1987). In this study primary sources were used.

Document analysis is concerned with the interpretation of written texts, artefacts and visual images. Bell (1993) and Yin (1994) state that such documents may include policies, letters, curriculum materials, anecdotes, letters, memoranda, agendas,

meeting minutes, written reports of events, multiple reports on the same subject, progress reports and newspaper clippings that might appear in the print media. The kind of documents used in this study ranged from national curriculum policies, curriculum materials such as syllabi, textbooks, teachers' guides, students' activity guides, school-based programmes such as schools' yearly and term programmes, teachers' daily teaching lesson plans and other teaching aids in the classroom. Other public documents such as national and provincial government policies and regulatory requirements for school-based private programmes and/or documents were also included. All documents were available from the schools and were collected during the research period.

An ideal situation for document analysis is when the researcher is in direct dialogue with the participant as this circumvents some of the difficulties a researcher may have in interpreting the documents. When using documents, it is useful to understand the context in which the text was written and whether it was a first-hand description, an original piece of work, or a secondary source, i.e., the analysis of someone else's work. Teachers' conceptions of the subject content are reflected in their teaching plans and pedagogical practices (Gunckel & Vandenbelt 2006; Remillard, 2005). Therefore in this study, participant teachers' teaching plans were examined as these reflected their interpretations of the syllabus lesson objectives and aims.

Documentary analysis provides useful evidence that can be used effectively alongside other evidence. Gillham (2000) argues that "document search and analysis ... epitomizes the case study research strategy" (p.43). However, the researcher should seek full permission or consent from people responsible for the documents, the 'gate-keepers' (Bouma 1996). The gate-keepers in this study were the participating teachers.

3.5. Research Design

This research was an in-depth case study undertaken in two primary schools and involved six technology teachers, three from each school. The aim of the research was to identify teachers' perceptions of technology and technology, and to investigate the impact of new technology curriculum materials on their perceptions and practices in

their classroom as they went about implementing the new technology curriculum. The two schools have different settings, School A was in a suburban setting while School B's was rural. The technology teachers selected ranged from senior teachers or coordinators to junior teachers. Three teachers were trained technology teachers while the other three teachers were not trained to teach technology but were selected to teach technology lessons when the new technology curriculum was implemented. This provided a range of perspectives and contributed to a valid triangulation of data. This further provided greater validity and a broader comparison between teachers' perceptions of technology as well as their practices.

The schools were selected because the researcher knew the schools well, although not all participants were known to the researcher. Knowing the schools made access for the researcher easier and data collection was more convenient and less time consuming. The original aim, to select three participants from each school, was because the technology curriculum was being implemented in the upper primary school level, consisting of three grades (Grade 6, Grade 7 and Grade 8). One technology teacher teaches technology across each grade. There were four female participants and two male participants. This helped to provide a balanced gender view of technology teaching.

The research was carried out over a period of one year, between February 2007 and February 2008. The data were collected over the first six months of 2007 and data analysis and writing were undertaken in the following six months.

3.5.1 Schools and Participants

This section describes the two schools involved in the research. To protect the anonymity of the participants, the schools are coded School A and School B and the participants are given pseudonyms. The six participants are linked to their respective schools by the first letter of their pseudonyms, for example Andrew is from School A and Betty from School B. Three participants were from School A and the other three were from School B.

School A was a large, town primary school with 530 students and 16 teachers. The upper primary level consisted of four Grade 6 classes, four Grade 7 classes and four Grade 8 classes. The school draws students from many different parts of Papua New Guinea. It was one of the first schools in the country to be selected to trial the education reform programmes before the whole nation was called upon to implement the reforms. The new technology curriculum materials, such as teacher’s resource books and students’ textbooks and other resource books, were distributed to schools in 2005. The teachers who participated in the research from this school were given the pseudonyms Andrew, Angela, and Antonia.

School B was a large rural primary school with 420 students and 12 teachers. This school was declared a model rural school in the province as it has effectively implemented the structural and curriculum reforms as stipulated in Papua New Guinea Education Reformed Policy (DoE, 1989). The upper primary level consists of two Grade 6, two Grade 7 and two Grade 8 classes. The new technology subject referred to as Making a Living (MAL) was implemented at the upper primary level in primary schools. The new technology curriculum materials, a teacher’s resource book and students’ textbooks and other resource books, were distributed to the school in 2005. The teachers who participated in the research from this school were given pseudonyms Betty, Bex and Bobby. Table 3.1 presents the profile of the participating schools.

Table 3.1

Profile of participating schools

School	Students	Teachers	Participants
School A	530	16	3
School B	420	12	3

3.5.2 Participants’ Profiles

While the focus of interest for this research is on the views held by teachers of technology and technology education and the impact of the new technology curriculum materials on teachers’ perceptions and practices, the inclusion of information about their school, teaching background and situation is important in

order to identify the culture and subculture in which the teachers were working. Likewise, the information regarding previous experience in technology and teacher development programmes highlights preconceptions and experiences of teacher development.

These profiles were compiled from information collected through interviews with each of the six participants in their respective schools. Each interview took about thirty to forty minutes to complete. A list of interview questions was provided for the participants prior to the interview. This enabled the participants to reflect on the questions and prepare their responses in advance, (see Appendix D for key predetermined questions). However, within the timeframe there was opportunity for the participant and the interviewer to explore ideas and engage in open dialogue. Interviews were conducted in their school environment with teachers during their non-contact hours.

The profiles are presented in alphabetical order, as the interviews were conducted.

Andrew – School A

Andrew is a male technology teacher, recently graduated. This is his second year of primary school teaching. He holds a diploma in primary school teaching and is a trained technology teacher. The researcher was Andrew's technology course lecturer at the pre-service teacher training college.

Angela – School A

Angela is a female technology subject co-ordinator (Making a Living) for the upper primary level in School A. She holds a certificate in primary school teaching and is now a senior teacher with 19 years of primary school teaching experience. Angela had been teaching in the school for ten years and had been a subject co-ordinator in other subjects. She was a science subject co-ordinator at the time she was asked to co-ordinator technology in 2005. This is her third year of co-ordinating the subject. Angela was never trained as a technology teacher, as she had graduated from teacher training college well before the basic technology course was introduced into the teachers' college programme. Angela is a capable person. The school administration called upon her to co-ordinate the new technology subject when the school could not

find any senior teachers with a technology background. She was one of the first teachers to have trialled the technology curriculum in 1996. Angela teaches other subjects in Grade 6 as well as co-ordinating technology.

Antonia – School A

Antonia is another female technology teacher, teaching Grade 7 technology classes. She graduated with a certificate in primary teaching and has been teaching for eleven years in this school, since the beginning of her teaching career. She had been teaching agriculture and home economics when assigned to teach the new subject in 2005. This was her third year teaching the new subject at Grade 7 level. She had never trained as a technology teacher; however, her enthusiasm in practical activities in agriculture and home economics lessons had led her to teach the new technology subject recently introduced into the primary curriculum.

Betty – School B

Betty is a female technology teacher, graduating with a diploma in primary school teaching in 2004. This is her third year of teaching in the school and she is a trained technology teacher. She taught technology to Grade 6 classes in her first year of teaching, taught Grade 7 in her second year and is currently teaching Grade 8 this year (2007). She also teaches other subjects as well as providing school in-services to other teachers teaching the new technology subject in the school. The researcher had been Betty's technology lecturer at the pre-service teacher training college.

Bex – School B

Bex is a female assistant teacher who taught technology to Grade 8 classes. She is a university graduate in applied science. This is her second year of teaching in the school. Bex was not a trained teacher but was planning to enrol at the teacher training university get her teaching diploma. She was also teaching science and technology to Grade 8 classes. She was assigned to teach the technology subject as the school administration's perception was that technology is part of science.

Bobby – School B

Bobby is a male teacher. He was the technology subject coordinator for the upper primary school and has a diploma in primary school teaching. He is a trained

technology teacher and has been teaching in the school for three years. Despite having only three years of teaching experience, he was already a capable teacher when Technology became a newly introduced subject. Bobby was seen as a trained, capable technology teacher and the obvious choice to co-ordinate technology. He provides school in-services to other teachers teaching technology and programmed assessments for technology.

3.6 Data Analysis

According to Birley and Moreland, (1998) the combination of data analysis and data collection is the real essence of the research process. The analysis of the interview uses three processes: interaction, transcription and interpretation (May, 1996). The first process was taken into account during the data collection discussion; the other two processes are discussed in this section. This analysis procedure also helps to address and justify the key questions in this research.

The responses of the participants were taped onto a cassette using a tape recorder, and then transcribed. All the interviews were conducted in English; however, 'Tok Pisin', a common language in Papua New Guinea, was allowed to be used in cases where certain concepts were difficult for teachers to explain in English. The interviewer translated into English and checked with the teachers to confirm whether the translations matched the interviewees' meaning. This is to ensure that the interviewer did not influence the responses in any way. After the transcribing was completed, all teachers' responses were written under each question and coding of names of schools and participants was employed to preserve anonymity. After transcribing the interviews, participants' responses were categorised into commonalities and differences. Then, a thematic approach was used to analyse responses under themes. This is what Yin (1989 cited in Creswell, 1998) called a holistic analysis, where data were categorised into specific aspects of themes. Most of the themes used in the analysis come from the literature.

Document analysis was another research method used to collect data for this research. The document analysis was carried out at the conclusion of the interviews. The documents were analysed through their relationships with the themes corresponding

to the themes identified through the interview analysis. The process of integrating data from two methods of data collection and interpreting meanings and synthesising findings is what Creswell (1998) and Maykut and Morehouse (1994) call cross-case analysis. After all the data have been generated and collected and the analysis completed, the research is written up. In writing up the research, additional analytical work is required, as analysis through writing further clarifies themes. Thinking about how to report the substance and sequence of findings requires rethinking the data and may reveal new insights and understandings (Maykut & Morehouse, 1994).

The documents analysed were mainly teachers' technology teaching programmes; yearly teaching plans, term teaching plans, daily lesson plans and the support materials teachers used in their planning and teaching. Support materials include *Technology Syllabus*, *Teacher's Guide*, *Teachers Resource Book*, *Student Books 1 & 2*, and *Student Resource Books*. See descriptions of these support materials in Chapter One.

Individual teacher's teaching plans were examined for commonalities and differences in their teaching programmes and to see how their planning matches their perception of technology. The plans also show the impact of support materials influences on teachers' perceptions which may, in turn, influence their practices in teaching technology in classrooms.

Finally, this leads to the reporting of findings and discussions in Chapter Six.

3.7 Ensuring Research Validity and Reliability

Validity lies with the ability of the researcher to understand and represent people's meanings. This means that in qualitative research, the researcher must have confidence in the quality of the data and the ability to generalise the research findings (Coll & Chapman, 2000; Cohen & Manion, 1994). The quality of data and the ways used to ensure credibility of this research are described in the research design.

The researcher used triangulation to ensure that findings agreed and corresponded to each other. The triangulation process involved the use of multiple interviews and

document analysis. Triangulation allowed for the verification and validation of the quality of the data analysis by checking the consistency of the findings of the study using the two different methods of data collection (Cohen & Manion, 1994). Triangulation is commonly known as a multi-method approach and is designed to add richness and depth to data by studying it from different angles and points of view. Data triangulation is about collecting data from different participants at different stages in activity and in different sites or settings. Data triangulation involves the use of a variety of different data sources; these include time and space, an individual person or groups of people as combined levels of triangulation.

The following processes were used to achieve the credibility of this research. The first process was the selection of schools with different settings. The first school was an suburban school situated in suburban community and the second school situated in a rural community. The views of technology and practices by participant teachers in a suburban school (which also represent the suburban community's view) were compared and contrasted with those of the teachers in rural primary school (which would also represent rural community's view of technology and practices).

The second process was the selection of participants with different teaching experiences and views. Participants fell into two categories; trained technology teachers and untrained teachers. Their views were compared and contrasted for differences and commonalities in their views of technology and their practices in the classrooms. Finally, validity is achieved through the use of two techniques to collect data in this research – interviews and document analysis.

In this research, data triangulation has been achieved by gathering data from a diverse range of participants in terms of their teacher training, hierarchical position in school, and different local settings of schools. It has also been achieved by gathering data from two different schools. The research also used two different techniques to collect data – interview and documentation.

The second strategy for ensuring validity is for the researcher and the participants to check information with each other for accuracy and credibility. The participants were provided with the transcriptions of their interviews and were invited to modify or

discuss these. Lincoln and Guba (1985) suggested that member checking be undertaken continuously throughout the study, as this openness helps to establish a trusting relationship between the researcher and the participants, which then results in more open communication.

The third strategy for ensuring validity is the researcher's worldview and theoretical orientation. The researcher needs to provide a detailed account of his/her position and beliefs, methodology, relationship with participants, problems and how these were dealt with. The reader then has all the information needed to interpret and apply the reported findings.

The other issue that needs to be considered is the reliability of the data collected (Merriam, 1988). In the current study, reliability was maintained by triangulating the data collection, by clearly describing how the study was conducted and by showing how the findings were derived from the data, that is by creating an "audit trail" (Creswell, 1994, p.158). In addition, using the two schools as separate cases, a comparative analysis was made to identify similarities, trends and distinctive features of how teachers' perceptions about technology influence their classroom practices.

3.8 Gaining Consent

The researcher gained access to the research participants by way of writing to them. However, before that, initial permission to conduct this research was obtained through the Director of National Research Committee responsible for overseeing research associated with institutions outside the country, based in Port Moresby (see Appendix A for a copy of the consent document). Then, the provincial education division in which the two schools were located was informed of the study (see Appendix B for a copy of this letter). Letters requesting permission for the study were sent to the principal of each school, seeking their full consent to conduct the research in their schools. Finally, the research participants, six technology teachers, three from each school, were informed of the proposed research directly through their principals (see Appendix C for a copy of this document).

Upon receiving ethical approval from the various authorities involved in this research, the researcher travelled to PNG from New Zealand to collect the data. Once in the schools, the researcher informed research participants of the importance and benefits of the study (see Appendix E for a copy of this information) then each individual research participant was asked by the researcher to voluntarily take part in the study. The participants then made their choice as to whether or not to take part in the study. They all gave their consent and signed the participant's consent form.

3.9 Role of the Researcher

The researcher's background as a technology teacher, a primary school teacher trainer and in-service facilitator in the focus schools meant that there was familiarity with the research settings. This familiarity provided easier access to the research participants and other members of those communities. As an experienced teacher, college lecturer and curriculum material writer, he was familiar with the realities of the everyday life of teachers in Papua New Guinea. This enabled him to be sensitive to the pressure and demands facing the participants in their work. Some of the research participants (surprisingly) had previously been the researcher's college students. Moreover, the researcher had been the co-author of technology curriculum textbooks and other resources currently in use in the focus schools. This established a friendly relationship between the researcher and the teachers and helped to ensure there was free and open communication.

This relationship was enhanced as School B is situated in the researcher's local area, and the participants in School A were previously known to the researcher through contact at one of the technology curriculum workshops the researcher facilitated. These links and common subject interests allowed for a relaxed and trusting relationship.

Despite the researcher's familiarity and relationship with the participants, the researcher was largely a non-participant. The focus was on collecting and interpreting the participants' thoughts and recollections. The researcher did not influence or lead their responses in any way. Although the interviews were relaxed and informal, the researcher had a clear agenda in terms of the scope of information required, and lists

of interview questions to be asked were given to the participants prior to the interview. The researcher's participation was restricted to what was necessary to prevent any deviation from the topic. However, the researcher sometimes prompted in between questions to clarify meanings, for extra details, to follow up relevant information and to probe any unexpected points of interest.

3.10 Ethical Considerations

The main ethical concern for this research was to protect the rights and welfare of the participants. This was achieved by gaining informed consent, retaining open communication, and making it clear that participants were free to withdraw their participation at any time. Participant anonymity was ensured by using code names for the schools, and pseudonyms for the participants, as explained in the research design (section 3.5).

When gaining written consent from the participants, it was clearly stated that the data would remain confidential and participants' identity would be protected through the use of pseudonyms. In order to avoid any misrepresentation of the participants' views or inaccurate reporting, all interviews were audio taped, transcribed and returned to the participants for verification. At this point, participants were free to alter or delete any information which was inaccurate or which they were subsequently unhappy about having recorded. Audio tapes and written manuscripts are to be retained securely by the researcher for a period of three years after completion of the research, after which time, they will be destroyed.

The names of the schools were coded and the participants given pseudonyms in the report to protect their identities. Considerable care was taken in selecting and reporting comments or quotes that were considered by the researcher to be potentially harmful to the reputation or career of any participant.

This research was undertaken within the guidelines and procedures outlined in the Handbook on Ethical Conduct in Research (2001). Permission to undertake this research in Papua New Guinea was obtained from the National Research Committee responsible for overseeing research associated with institutions outside of the country.

3.11 Summary

Methodology is seen as the overall strategy used to guide a research inquiry (Guba & Lincoln, 1998). A qualitative approach within an interpretivist paradigm was considered the most appropriate for this inquiry as it seeks to gather rich descriptions and detailed explanations to gain deeper understanding of the key factors influencing teachers' perceptions and their classroom practices. A case study approach was used in this research, using two techniques in data collection – interviews and document analysis. The issues of validity and credibility of the research were achieved through triangulation. Respect for research participants' rights was considered important and consent for their participation in this research was sought. The research was conducted in line with the University's Ethics of Conduct in Research (2001).

The next chapter presents the data findings.

Chapter Four

Research Findings

4.1 Overview of the Chapter

Because teachers' perceptions of technology and technology education influence how they know and teach technology, the six teachers' perceptions are presented. The research findings related to primary teachers' perceptions of technology and technology education, their views on the technology support materials, the impacts of the technology support materials on teachers' views of technology and technology education and support materials' impact on teachers' practices in the classroom and views on the roles of the support materials in teacher professional development programmes are presented. Examinations of teachers' plans in teaching technology are also discussed.

This chapter is divided into seven sections. Section 4.2 describes Papua New Guinea primary teachers' perceptions of technology followed by a description of the teachers' perceptions of technology education in section 4.3. Section 4.4 examines the factors influencing teachers' perceptions of technology and technology education. Section 4.5 describes views of Papua New Guinea primary teachers on the new technology curriculum materials, followed by the description of the new technology curriculum materials' impact on the teachers' perceptions of technology and technology education and teachers' practices in section 4.6. Finally, section 4.7 describes technology curriculum materials' role in teacher professional development.

4.2 Primary Teachers' Perceptions of Technology

Papua New Guinea primary teachers hold a wide range of views on technology. Teachers did not fit into one category only; instead they held broad concepts of technology. These diverse views and ideas are arranged into five categories: technology as artefacts; technology as practical skills-related activities; technology as everyday activity; technology as knowledge; and technology as process. The details of these views are discussed below.

4.2.1 Technology as artefacts

Five out of the six primary teachers interviewed considered technology to consist of artefacts such as tools, machines, and computers. These teachers perceived technology as modern tools and machines that are now used in their society. Andrew, for example said:

When I think of technology, I think of new modern tools and machines that are now in use in our society.

He explained that when he talked about technology he thought of modern tools and machines such as the computers, TVs, radios and other sophisticated and modern technologies. Antonia shared a similar view, and made specific reference to tools and machines that are powered by the electricity. She said:

I think of technology as modern tools and machines that are powered by electricity like computers, TVs, radios, mobile phones, cars and other electrical tools and machines.

She commented further that:

Modern tools makes jobs faster and easier than jobs that were usually took long hours and energy to make.

The teachers who perceived technology as modern artefacts talked about technology as foreign things, with no origin in Papua New Guinea. As Angela noted:

When I think of the word technology I think of the new things that we have in our time today, like the TVs, radios, computers and other things made from overseas that we did not have them before and they are new to us.

Two of the teachers who considered technology as artefacts also included traditional tools used in their rural communities before the arrival of modern tools as technology. For example, Bobby said:

I think of traditional stone axes and digging sticks as part of our traditional technology. Because, before the arrival of modern tools like spades and steel

axes, traditional digging sticks and stones performed a similar jobs as modern tools are doing today.

Similarly, Betty commented:

I think of machines and computers as technology, but I think they are modern technologies. Here in rural areas, we do not associate them, so I only talked about what we have with us, about tools we use in our everyday lives.

Angela and Antonia, who perceived technology as new modern artefacts, related new artefacts directly to their own teaching practices. As Angela noted:

Technology is new equipment like computer and photocopier we now have in our school. These equipments make jobs easier and faster as it was hard to teach from blackboard before.

Likewise, Antonia related to the modern artefacts used in her classroom for teaching and commented:

Before the arrival modern technologies like computers and photocopiers, teachers used blackboards to write test and exams, but now with these machines in the school, its very easy to print test and exams on papers and give to students in class.

The teachers who perceived technology as artefacts commonly related technology to modern artefacts expressed satisfaction on how things were done fast and how this made jobs easier. However, teachers serving in the rural primary schools, for example, Bobby and Betty, considered traditional artefacts alongside modern artefacts because they came in contact with traditional artefacts in their daily activities and these were more accessible in their rural settings.

4.2.2 Technology as practical skill-related activities

Three of the six teachers considered technology to be practical skills-related activities. They talked about technology as the application of practical knowledge and skills in the use of technological tools. This concept of practical activities encompassed both modern and traditional processes. As Betty, for example, noted:

Technology involves a lot of practical works and skills to develop a product. Some examples of these are building a house, making clay pots, weaving fishing nets. Even a local fisherman, who is mending fishing net, also requires some level of skill.

She talked more about hands-on practical activities that also involved skills in carrying out activities in the rural communities in Papua New Guinea for survival.

Similarly, Bex talked about technology as practical skills and knowledge to make something and said:

When I think of the word technology, practical knowledge and skills which involved in making something comes into my mind.

She went on to include the use of tools alongside the practical skills and knowledge to make something and commented:

Technology is about people applying their practical skills and knowledge in using the tools, machines and materials to make something for us to use.

Andrew shared a similar view and considered technology as practical skill-related activities. He made specific reference to practically oriented subjects that were taught in high schools in Papua New Guinea and said:

Technology involves subjects like Practical Skills, Home Economics Arts and Agriculture; you know ... I mean practical subjects that involve a lot of practical skills and knowledge to do practical projects and activities.

All the three teachers considered technology to be practical skills-related activities. They also talked about the practical knowledge and skills that they will use to make something useful.

4.2.3 Technology as everyday activities

Three of the six teachers considered technology as everyday activities. Antonia, for example, believed that all activities people do for living are technology:

I believe technology is the tools, skills and knowledge and processes that are involved in everyday activities.

She made specific reference to hands-on practical activities that provide food and clothes for survival:

Everyday activities like gardening, fishing, working in offices or manufacturing products in factories to all kinds of people engaged in daily for their survival.

Betty shared a similar view but from a broader perspective, including knowledge, skills and tools used in the daily activities. She pointed out that:

Technology is involved in activities that are carried out daily by people. It requires some forms of processes that require knowledge and skills and tools to use.

Bobby also shared a similar view, but considered the abstract aspect like the knowledge involved rather than focusing on practical or technical aspect of technological activities, saying:

Technology is what we do and use everyday. It is the skills and knowledge we use everyday in life to make a living.

These teachers believed that technology is present in all daily activities. They emphasised people's endeavour for survival as the ultimate for engaging in daily activities.

4.2.4 Technology as knowledge

The two teachers who considered technology to be knowledge made direct reference to the technological knowledge people are required to have to cope with the changing world and to understand the impacts of the technologies. Bex, for example, commented:

We are now living in a technological changing world; we need technological knowledge to understand the technologies and its impacts on our lives.

Betty shared a similar view. She talked about her former understanding of technology as tool and machines. She talked about her changed and broader understanding of technology as knowledge, as reflected in her comment:

Before when I think of technology, I used to think of tool and machines involved in practical activities. But now I see that technology is not only about tools and practical activities, it's also about knowing, understanding and reasoning the impacts of technology on our lives and environment.

Betty went on to talk about the importance of technological knowledge to cope with new technologies. She noted:

Everyday things are changing, new technologies, new inventions; we are living in a fast changing world. It is important that we need technological knowledge to cope up with the changes.

Both teachers emphasised the need for people to be technologically literate to make informed decisions about the impacts of technology on people's lives.

4.2.5 Technology as process

Only one teacher considered technology as a process. The term process refers to the way in which activities are carried out. Andrew commented that:

Technology is a process of doing things with tools and machines to satisfy people's needs and solve problems.

Andrew went on to talk about positive aspects of technology but also raised concerns about the negative social and environmental effects of technology on people's lives, and its impacts on society. He noted:

Although modern tools and machines speed up and make things fast and easier in less time, our natural resources are destroyed at a faster rate than before the arrival of modern technologies. Take for example, our forests are destroyed faster than before through logging. Our rivers, streams were polluted and all living things like fish, crabs and prawns were poisoned by the chemical wastes from mining and other industries.

It can be seen that Andrew’s view highlights concerns about the social and environmental impacts of technology on people and their natural environment.

4.2.6 Summary of primary teachers’ perceptions of technology

Table 4.1 presents a summary of primary teachers’ perceptions of technology discussed in previous sections.

Table 4.1
Teachers’ perceptions of technology

Teachers	Technology as:				
	Artefacts	Practical skills-related Activities	Everyday Activities	Knowledge	Process
Andrew	✓	✓			✓
Angela	✓				
Antonia	✓		✓		
Betty	✓	✓		✓	
Bex		✓		✓	
Bobby	✓		✓		

Five of the six teachers viewed technology from multiple perspectives. These teachers viewed technology as a broad concept with multiple facets. The only teacher to see technology from a single perspective was Angela, who viewed it as artefacts only. Technology as artefacts was the most predominant perception of technology with five of the six teachers having this view. Artefacts included both the modern and traditional artefacts used in everyday life such as the tools and machines to make something. Technology as skills-related practical activities was another commonly held view of technology. Three teachers viewed technology as skills-related practical activities. Two teachers considered technology as knowledge. Andrew was the only teacher to see technology as related to processes.

4.3 Primary Teachers’ Perceptions of Technology Education

The teachers’ range of views about technology was similarly reflected in their views of technology education. These diverse views and ideas were classified into four categories: as knowledge of modern artefacts; as the development of life-long skills and knowledge; as learning about practical activities; and as the development of technological knowledge. The details of these views are discussed below in turn.

4.3.1 Technology education as knowledge of modern artefacts

The view of technology as modern artefacts held by teachers was reflected in their concept of technology education. Four of the six teachers considered technology education to be learning about developing skills and knowledge related to modern artefacts. As Betty pointed out:

Technology education is learning about modern technologies and how to use them.

Likewise, Antonia stated:

Our children are constantly coming in contact with and are exposed to modern technologies. Teachers need to teach students to use these machines and tools and make some things.

Angela shared a similar view, noting that:

Technology education is learning about new technologies that makes lives easier than before. For example, telephones, computers and other new technologies.

Angela also pointed out the advantages and disadvantages of the modern artefacts. She said that:

While modern artefacts make life easier, these tools and machines are powered by electricity and are very dangerous, students need to be taught safety measures in using the machines. And also these modern tools are too expensive to be maintained.

She talked about equipping students with knowledge and skills that would enable them to use the modern tools and machines. She saw technology education as learning about the application of modern artefacts.

Bex also considered technology education to be learning about how to use both the traditional and modern technologies. She said:

Technology education is learning about how to use both the traditional and modern technologies and the skills that are involved in both technologies.

With this view she felt that teaching technology should start with teaching students things that they are familiar with before moving on to modern technologies. She also recommended the involvement of the local experts in both traditional and modern technologies in schools. She related the idea to her own teaching practice and said:

In my technology lessons, I invited local experts like village elders to come and teach students in traditional activities like basket weaving or mat weaving. And I also invited modern experts like health workers to talk about health issues to students.

Bex felt that technology education includes education about things in the community. She felt that the experts in the communities should be utilised at schools.

4.3.2 Technology education as development of life-long skills and knowledge

Three out of the six teachers considered technology education to be a subject that aimed at developing the skills and knowledge useful for students in after school life. Andrew, for example, pointed out that:

Technology education is about teaching students skills and knowledge that will help them to make a living when they finish school.

Andrew talked about the inclusion of both the modern and traditional or local skills and knowledge. Angela shared a similar view. However, she pointed out that the skills and knowledge students learn in the classroom must be related to real situations, for example, career or for basic survival. She went on to talk about teaching students technological skills and knowledge as preparing students to cope with the changing world through education. She said:

When we talk about teaching our children with skills and knowledge for making a living after school, we need to prepare our children with skills and knowledge to cope with the changing world... I mean equipping children with basic modern skills and knowledge.

Similarly, Betty agreed that technology education is a subject where students learn life-long skills and knowledge. She pointed out the importance of students learning technology.

Technology education is a very important subject because in this subject students are taught practical skills and knowledge applicable to everyday activities. Majority of the students will be leaving school and go to their villages after primary education in Grade 8. Students will use these skills and knowledge learnt to be come productive and useful members in their communities.

Betty made reference to the Papua New Guinea education system where the basic primary education stops at Grade 8. At the end of Grade 8, examinations are set to determine the academically able students who will continue their education into high schools and vocational schools while those students who failed to pass the examinations return to their communities.

Angela shared a similar view. She believed that the development life-long skills and knowledge will help students to become useful members in the communities where they choose to live after school. She noted:

Students need to be taught the skills and knowledge to use in their lives after school and become useful members of their communities.

She went on to relate to an economic aspect and said:

Today, everything seemed to be revolving around money. In technology education, students need to be taught the skills and knowledge to make something not only for their use but also to sell at the market to make money.

These teachers emphasised the development of life-long technological skills and knowledge as an important aspect of technology education. They also emphasised the idea that involvement of students in technology education would assist them to develop the technological skills and knowledge that they can use, so they will become useful and productive members of their communities. The idea of students utilising skills and knowledge learnt in technology education to make something for personal use and also to sell for making money was highlighted in Angela's comment.

4.3.3 Technology Education as learning about practical activities

Three of the six teachers considered technology education as a subject that has to do with practical activities. For example, Bex, who related practical activities, especially with hands-on practical activities to make something, said:

Technology education is learning about how to make things. It involves lots of practical activities like cooking, sewing, making furniture and handcrafts making.

Similarly, Andrew believed that students learn about technological skills and knowledge through involvement in technological practical activities. He said:

Students' involvement in practical activities helps them to learn technological skills and knowledge to make a living after school.

He went on to talk about involvement of students in practical activities arousing students' enthusiasm and creativity in their learning. He related to his experiences with his students and said:

I found out that engaging students in practical activities motivates students' learning in technology. Students are very creative and innovative. I showed them one method of making something and students came up with many other ways of to approach the same activity.

Bobby shared a similar view but from a technical aspect, specifically related to Papua New Guinea, saying:

Modern technical skills and knowledge are very important for the development of Papua New Guinea.

It can be seen that Bobby was more specifically concerned about Papua New Guinea's development. He viewed modern technical skills and knowledge to be important for Papua New Guinea's development.

The dominant view these teachers held was that through their involvement in practical activities, students acquired practical skills and knowledge. These teachers also

believed that an education that involves students in a practical manner or hands-on experience activities is technology education.

4.3.4 Technology Education as development of technological knowledge

Two teachers viewed technology education as a subject that prepares students for a career in a modern technologically based society, by providing them with practical skills and knowledge to participate in the technologically changing world. As Bobby said:

It is important to help students develop technological skills and knowledge so that they can prepare for the future.

He also pointed out that the most important factor is to help students to be technologically literate, saying that:

Technology subject prepares students to be technologically literate citizens, to make informed decisions on the impacts of the modern technologies on their lives and their environment.

Antonia shared a similar view and highlighted the significance of students' learning in technology education and the impacts of technology on people's lives:

Technology Education is very important field of learning because the younger generation needs to make informed decisions, as they are moving towards a fast technological changing world. Technology has impacts on our lives in one way, or the other. We are now moving towards using modern technologies more than our traditional technologies. I believe technology education addresses our need to be technological literate.

Both teachers emphasized the importance of teaching children to be technologically literate.

4.3.5 Summary of primary teachers' perceptions of Technology Education

Table 4.2 presents a summary of the primary teachers' perceptions of technology education discussed in previous sections.

Table 4.2
Teachers' perceptions of technology education

Teachers	Technology Education as:			
	Knowledge of Modern Artefacts	Development of Life-Long Skills and Technological Knowledge	Learning about Practical Activities	Development of Technological Knowledge
Andrew		✓	✓	
Angela	✓	✓		
Antonia	✓			✓
Betty	✓	✓		
Bex	✓		✓	
Bobby			✓	✓

All the six teachers viewed technology education from multiple viewpoints. Four of the six teachers considered technology education as knowledge of the use of modern artefacts. Three teachers considered technology education as the development of life-long skills and technological knowledge, three teachers perceived technology education as learning about practical activities. Only two of the teachers viewed technology as knowledge.

In summary, the dominant view of technology held by the teachers was of technology as artefacts. Artefacts included both the modern and traditional artefacts. Other views of technology held by teachers were technology as practical skills-related activities; technology as everyday activities and technology as knowledge. Technology as processes was the least dominant view held by teachers. Technology education as knowledge of modern artefacts was the dominant view held by teachers. The less widely view held by teachers was the view of technology education as development of technological knowledge. Other views of technology education held by teachers were technology education as the development of lifelong skills and technological knowledge; and technology education as learning about practical activities.

4.4 Factors Influencing Teachers' Perceptions

The six teachers' perceptions of technology and technology education were influenced by factors such as subject subcultures, past school experiences, previous hand-on experiences from work or outside personal interests, and personally-owned technological products. These are discussed in turn.

4.4.1 Influence of subject subcultures

Four of the six teachers considered subject subcultures to be influential in their perceptions of technology and technology education. Andrew, for example, said:

I see Technology Education as more to do with practical subjects in high schools. Practical subjects like Agriculture, Practical Skills and Home Economics, you know, practical subjects. I planned most of my practical activities from these subjects for technology lessons.

Similarly, Bobby viewed technology subject as related to science and said:

I like teaching science subject. Technology subject is more like science. So I used to teach science and technology alongside each other. I am interested in innovation of machines and how things work, and I sometimes take my students to the science lab to teach technology lessons.

It can be seen that Bobby was strongly influenced by his science teaching experience when he thought of technology education. That he even used the science lab to teach technology is a further indication of a science influence on his technology teaching practice.

Likewise, Bex talked about the relationship between the subjects of science and technology, referred to the new technology building and said:

Our school's technology building was built in adjacent to the science lab so that science and technology equipment can be shared; you know science and technology education have a very close link with each other.

The teachers also reflected on their prior teaching experiences in other subjects and related their experiences with what they considered technology education. As Antonia commented:

In my social science lesson, I was teaching a unit on the effects of development on our natural resources. Then, in my technology lesson I was teaching how to manage our natural resource in a sustainable way. Both the social science and technology lesson linked well so when I am teaching social science lessons I

think I am teaching technology as well. I taught the social science unit first so when I came to this unit in technology subject, it was very easy to teach.

Likewise, Angela related to her experience in developing technology teaching programmes and explained:

Teaching technology is made easier when you integrate technology lessons with other subjects. In our school, we use the theme approach in planning technology teaching programme. We choose a theme from technology subject and identify linking learning outcomes from other subjects and develop a teaching programme for a term.

It can be seen that technology education is integrated with other subjects. And teachers planned and taught technology subject in an integrated approach.

4.4.2 Influence of past school experiences

Three teachers reflected on their past school experiences and talked about things they had learned in high schools as technology education. Betty commented:

When I learned about food and nutrition in high school, I think that is technology education.

Likewise, Antonia said:

I learned how to sew a pillow case in high school and that I believe is technology education. I have planned the same kind of pillow case I had learned to sew in my high school home economic subject, for my students to sew in their technology classes for this term.

Andrew shared a similar view and commented:

In high school, I used tools and machines to make furniture, and to me, that's technology education.

It can be seen that these teachers' view of technology education was influenced by their high school experiences. The practical experiences they had in their high schools practical subjects like Practical Skills, Home Economics, Agriculture, Arts and Crafts appeared to have influenced their understanding of technology and technology.

4.4.3 Influence of previous hands-on experiences

Three teachers talked about teaching technology education from their past hands-on experiences and what they had learned from their interests. These teachers talked of having limited knowledge about technology education teaching technology and so had taught technology from their past experiences. As Andrew for example said:

I taught my students how to weave baskets from the skills and knowledge I learnt from my grand father back in my village.

Similarly, Betty said:

I enjoy cooking, so sometimes I bring my own recipes into technology classes and teach my students.

Betty's response can be seen as teachers teaching technology education from their own outside interests what they perceived to be technology education.

Likewise, Bex related technology education to hands-on activities like handcrafts and said:

I taught my students how to make string bags, I learned the skills of making string bags from my mother and I had passed that skill onto my students so that they can use in their lives as well.

It can be seen that teachers who perceived technology education as hands-on activities use their prior knowledge and skills, and experiences that they thought of as technology education in their technology teaching.

4.4.4 Influence of personally owned technology products.

Another factor influencing the teachers' perceptions of technology was personal items owned by teachers. Three teachers perceived technology as the modern artefacts they have. As Angela noted:

Modern technologies like radios, digital camera and mobile phone I have in my house are technology to me.

She went on to comment that these modern technologies she has make life very much easier.

I used to travel many hours into towns to use telephones to make calls to my families. But now I bought myself a mobile phone and I can call my families from anywhere.

Similarly, Antonia said:

My husband bought me a micro-wave oven; it is very interesting how very fast the food can be cooked. It used to take hours cook food in the past. With the modern technology like this micro-oven, I can get the meal ready in few minutes.

Bobby was impressed with the use of modern technologies and made specific reference to his lawnmower. He said:

I am impressed with use of my new lawnmower. It cuts the grass smooth at the same time picking up the cut grass into its rubbish bag. The job cutting the grass first then cleaning later was done altogether ... quite interesting, but you need to have the technological know how to operate and maintain the machine. To me learning the knowledge on the use of modern technologies is technology education.

These teachers talked about their experiences with the new household things and personal artefacts that they own, as technology. They associated technology with artefacts that improved and influenced their quality of life or that made their lives easier. They viewed technology education as a learning area where they can learn the skills and knowledge in using the modern technologies.

4.4.5 Summary of factors influencing teachers' perceptions of Technology and Technology Education Technology

Table 4.3 presents a summary of the factors that influenced the teachers' perceptions of technology and technology education discussed in the previous sections.

Table 4.3
Factors influencing teachers' perceptions of technology and technology education

Teachers	Influence of:			
	Subject Subcultures	Past School Experience	Hands-on Experience	Personally Owned Technological Products
Andrew	✓	✓	✓	
Angela	✓			✓
Antonia		✓		✓
Betty		✓	✓	
Bex	✓		✓	
Bobby	✓			

The factors influencing teachers' perceptions of technology education identified were subject subcultures, past school experiences and hands-on experiences. Subject subcultures were the dominant influential factor in teachers' perceptions of technology education. Only two teachers viewed personally owned technological products as an influencing factor in their perception of technology.

4.5 Teachers' Perceptions of the Support Materials

Teacher professional development is very important for any curriculum change. Technology education is a new subject area in the primary curriculum in Papua New Guinea and needs a teacher development programme that will assist the teachers to broaden their concepts of technology and technology education. The result of professional development in technology education should help the teachers to be more confident and competent in their technological knowledge, technological practice, and subsequently, classroom practices in technology education.

However, in Papua New Guinea there was very little professional development for all teachers at the introduction of the technology education curriculum. And also, due to Papua New Guinea's geographical setting with many scattered islands and with great isolation, decentralised teacher professional development programmes had failed to reach every teacher in every school. It is also very expensive to present teacher development programmes to all teachers. To overcome this problem, and offer a viable substitute, new support materials were developed.

Section 4.5.1 investigates primary teachers' views on the new technology support materials. This is followed by the new technology support materials' influence on

teachers' perceptions of technology and technology education and their practices in section 5.4.2. Finally, the role of the new support materials in professional development programmes in Papua New Guinea primary schools is discussed.

4.5.1 Teachers' evaluation of the support materials

Data from the interview transcripts on the teachers' views of the new technology curriculum materials are classified under several categories. These are support outcome-based learning; support teachers lesson planning; promote subject integration; support for pedagogical content knowledge; promote gender equity and encourage students' independent learning. These views are discussed in turn.

The term MAL is used frequently in this section. MAL is a short form for Making a Living. The technology subject in the primary schools in Papua New Guinea is called Making a Living subject. From now onwards, MAL and Technology subject will be used interchangeably.

Support Outcome-Based Learning

Two teachers agreed that the new support materials were developed in line with the current Papua New Guinea Education Reformed Outcomes-Based Curriculum. (See section 1.3.2 for the description of outcomes-based learning). As Andrew explained:

The new technology curriculum materials were outcomes-based edition, I mean the curriculum syllabus, teacher's guide and students' textbooks were written out clearly under major strands and sub-strands, with precise learning outcomes and units of work. The learning outcomes stated in the teacher's guide matched with activities in students' textbooks. And the units of work were developed to achieve the learning outcomes stated in the syllabus. All of these materials, the syllabus, teacher's guide and student's textbook linked up well that the new concept of outcomes-based learning is very easier to understand and implement.

Three teachers, Angela, Betty and Andrew, talked about their difficulties understanding the new outcomes-based learning when it was first introduced to them. They made comparisons to the workshop they had attended on the concept of the

outcome-based curriculum to the understanding they gained from the use of the new technology curriculum material. These were reflected in these comments:

I was totally confused with the new idea of outcomes-based curriculum during a workshop held on the new reformed outcomes-based curriculum in technology education. But now looking at the new technology materials the idea of outcome-based curriculum is very clear to me. (Angela)

I have had attended two-day workshop on the outcomes-based curriculum It was very confusing and I did not understand the concept of outcome-based learning during the workshop. When the new technology materials were made available at the school in 2005, I can see clearly what the outcome-base learning is all about. I can now plan my teaching lessons based on the learning outcomes in the MAL syllabus. (Betty)

During the workshop, the curriculum officer from the National Curriculum Unit told the participants to plan outcomes-based teaching programmes using the new MAL syllabus. It was hard because the MAL syllabus had broad learning outcomes. Other technology curriculum materials such as the teachers guide and student textbook were not developed yet to show the links to plan units of work in line with the learning outcomes. But it is easy to plan and teach, now that the teachers' guides and students' textbooks were made available to my school. (Andrew)

These teachers agreed that the new support materials were developed based on the new outcomes-based curriculum. The teachers believed that the new support materials described the notion of outcomes-based learning clearly. They also agreed that they were gaining better understanding of the outcomes-based learning through the use of these new support materials than from the training they got from the one-off workshop conducted by the officer from the National Curriculum Unit of Department of Education in Papua New Guinea.

Support teacher's lesson planning

All six teachers considered the new support materials to be instructional guides for teachers in their lesson planning and teaching. Betty, for example, said:

I looked at the learning outcomes in the teacher's guide and linked those learning outcomes to suggested activities in the student textbook. I then developed my teaching plans and teach, aiming to achieve those learning outcomes with the students.

Bobby made a specific reference to the idea of teacher and curriculum materials participating together in the design of technology lesson plans. He said:

In my lesson planning, I consult both the teacher's guide and student's textbook and also consulted my knowledge and experiences and plan lessons that are related to real life situation.

He went on and commented:

Although, the new MAL curriculum materials suggested technological learning outcomes for students to achieve, I just see them as guides only. I like contextualizing the learning outcomes to address real life situations and real life issues.

Antonia shared a similar view, but made reference to the recent education reform's emphasis on the notion of 'Relevant education system' (DoE, 1986) which aimed at providing education applicable to the Papua New Guinea context. She said:

I always think of activities that will impart skills and knowledge that will be applicable and useful to students in their lives after school in my planning and teaching of technology lessons.

Likewise, Andrew talked about taking cultural and contextual aspects of the community into consideration when planning and teaching technological activities.

He said:

In my planning, I think of the skills and knowledge that students learn in the classroom will be relevant and applicable to their communities.

He explained:

It is not suitable to teach students from the highlands of Papua New Guinea, how to grow cocoa because cocoa do not grow in the highlands but on the lowlands of Papua New Guinea. If the lesson suggested in the students book is

on planting cocoa, I changed and planned my lesson to teaching students about planting coffee because coffee grows well in highlands of Papua New Guinea and a cash crop for the living there.

Angela also shared a similar view, but made specific reference to the student textbook. She highlighted the new technology curriculum materials, providing flexibility for teachers to plan out of the textbook. She noted:

What I like about the new MAL materials is that, in the student textbook section 'For You to Try,' the activities are left open for teachers to create their own activities. This encourages creativity and flexibility for teachers to plan lessons out of the textbooks.

All the three teachers from School A agreed that they used a thematic approach in planning their terms and yearly teaching programmes. The themes approach in planning was emphasised in the new technology curriculum. Andrew, for example, explained this approach:

Thematic planning and teaching linked other subjects together well. In the beginning of the year, teachers teaching the same grades came together to draw up themes by working through other subjects along with the MAL subject and sorted out units or learning outcomes to match the themes for each terms. The themes were sorted out into term programmes, then into weekly programmes and finally led to the development of daily lesson plans.

These teachers said that they followed the thematic planning for term programmes as suggested in teacher's guides (DoE, 2003, p.69) Teachers teaching the same grades worked together through themes set in the MAL Teachers guide and also other learning areas and matched all relevant and related learning outcomes together to draw up the teaching programme. Bobby makes a comparison with other subjects' curriculum materials saying:

Unlike other subjects' textbooks that required both the teacher and students to stick to the activities set in the textbooks; the new MAL curriculum encouraged teachers to be flexible and paved ways for teachers to be creative in their planning and teaching.

However, Bex pointed out that the strands in the new technology strands were too broad and difficult to plan and teach. The 'strands' here refers to the new technology course content which is written as learning outcomes. The learning outcomes are organised under three strands; Managing Resources; Better Living and Community Development. And she made a specific reference to the technological strand in the MAL syllabus and said:

The strand, 'Managing Water, Land and Sea Resources' is a very broad strand and is difficult to plan. Development of some supplementary resource materials based on the broad technology subject strands would help in planning and teaching.

It can be seen that the new support materials help teachers in planning and teaching. They encourage flexibility for teachers to plan and teach lessons from the text or out of the text in their technology lessons

Encourage Subject Integration

Three teachers talked about how they used the support materials by integrating them with other subjects. Antonia, for example, made specific reference to students' textbook contents showing integration with other subjects and said:

The new technology curriculum materials make links with other subjects. These links are indicated on the lesson topic content information page of the student's textbook indicating link with other subjects like Personal Development subject (PD), Social Science (SS), mathematics (M), Science (S) and so on.

Likewise, Betty made reference to her planning and teaching in technology and said:

The clear links between the materials make my lesson planning and teaching so easier.

Bobby, who shared a similar view, felt that the thematic planning and teaching approach suggested in the new support materials enhanced subject integration with other subjects. He said:

Our school emphasised thematic teaching approach. Thematic planning and teaching encouraged subjects' integration. The MAL curriculum materials showed clear links with other subjects.

These teachers felt that the new technology curriculum encouraged the themes approach in developing teaching plans. Thematic teaching is a planning and teaching approach whereby teachers carry out a unifying idea from another curriculum area to technology. Antonia, for example, said:

I taught a lesson on ratio in mathematics first, then taught a cooking lesson in technology on a cooking recipe on baking cake, so that students know right amount of water part to cup of flour and yeast.

Angela made a specific reference to the technology project that she was making in her school. (See the teaching plan on the sawdust stove project in Table 4.9). She commented:

I taught a social science unit on people and environment, asking students to identify needs in their communities. Then, the MAL lesson, I ask the students to design a practical project based on the needs identified in their social science lesson. This was how we identified our technology project, Sawdust Stove.

Likewise, Betty related to her teaching experience on subject-integrated planning and teaching in MAL lessons. She noted:

I taught a personal development unit on personal health before teaching a MAL unit on healthy living. I saw that the units in both subjects linked up well.

These teachers reason that students would transfer knowledge and understanding gained in the previous unit to the current.

All teachers agreed that they found the theme approach very effective in teaching technology and such an approach broadens teachers' and students' understanding of technology.

Develop pedagogical content knowledge

Three teachers viewed the new technology curriculum materials as a support for developing their pedagogical content knowledge. Angela, for example, pointed out that:

The new technology curriculum materials help teachers to integrate their knowledge base to make connections between theory and practice.

She went on to explain that she developed her technology lessons based on a technology project (See her sample of lesson plan in Table 4.9). She felt that engaging students in the practical activities and at the same time explaining the theoretical aspects in between the practical activities provided a better understanding of and reasoning for the technological practices. She gave an example:

I demonstrated the proper positioning of body and sawing practically at the same time explaining and reasoning with students why such proper positioning of body and correct methods of sawing are needed to be considered when sawing wood.

Bobby shared a similar view and explained the connection between theory and practical lessons in technology:

Before engaging students in practical activities, I teach the theoretical part of the lesson first so that students can use the knowledge when engaged in the practical activities.

Betty also talked about making connections between practice and theory in technology teaching practices. However, she did not agree with the idea of teaching the theoretical lesson first and the practical lesson later. She preferred combining both theory and practical work together in teaching a technology lesson, and said:

The new approach suggested in the new technology curriculum teacher's guide is to combine both theory and practical, slotting in theoretical lessons to help students in their practical work.

Andrew made reference to the notion of subject integration and related his experiences with the new technology curriculum. He said:

The new curriculum materials served as cognitive tool and helped me to make connections between general principles and specific instructional moves to integrate knowledge base and begin to use my knowledge flexibly in the classroom.

The idea was to strike the balance between knowing and doing rather than separating knowing from doing. The three teachers saw the integration of the theoretical lesson with the practical lesson as knowing and doing. The integrated approach in technology teaching, both in the practical and theoretical, as well as integrating other subject areas into technology, promotes flexibility in their pedagogical practices in technology.

Promote Gender Equity

All the six teachers agreed that all activities set in the technology lessons encouraged gender equity not gender bias. All boys and girls were involved in all activities together. Teachers believed that they promoted gender equity. As Andrew stated:

Gender Equity is promoted in the recent Education Reform in Papua New Guinea, in line with the National Directive Goals which emphasise, equal participation in all levels of schooling by both girls and boys. The former curriculum that emphasised boys for woodwork and girls for home economics was done away with. The new technology curriculum promotes gender equity.

Betty recalled her teaching experiences and commented on how she provides the same activities for boys and girls. She said:

I make sure that both boys and girls participate in the same activities and not setting different activity for boys and girls with another activity. The new technology curriculum encourages collaborative learning.

Bex shared a similar view of engaging both boys and girls in the same activities but from students' cooperation viewpoint said:

Involving both boys and girls in the same task help students participating together and learn from each others' experiences. In most of my technology activities, I set group works.

Antonia also made reference to her teaching and experience, and talked about both boys and girls being co-operative in learning. She commented:

I involved both boys and girls in the same activities so that girls and boys can help each other in learning. For example, all students go for cooking or sewing lessons. Girls help the boys in this home economic lessons and when we move over to do activities like carpentry or woodwork, the boys then become very helpful to girls.

Angela considered the students' prior knowledge and experiences. She commented:

Students are not empty vessels; they come to school with many different prior knowledge and experiences learnt outside of the school. Grouping and engaging students in technological activities, regardless of the gender helps students to share their prior knowledge and experiences with each other and build on further knowledge. Not only do the students learn from each other, but I do learn from them too.

Angela admitted learning also from students. This confirmed that idea that teachers as learners do learn from students' prior knowledge and experience that they have brought to school from their outside engagement in technological activities. Bobby shared a similar view, but talks about gender equity from broader perspectives saying:

The trend for men's jobs only and women's job only is changing. Already a lot of Papua New Guinean women are being trained to do jobs reserved for men-only and also men are trained also to do jobs reserved for women-only.

All the teachers had indicated that they encouraged gender equity in all technology learning as was emphasised in the new technology curriculum. They believed that collaborative learning through group activities promotes both students' and teachers' technological learning. They perceived that technology is present both in the school and outside the school activities. The teachers built on students' prior knowledge. Students' prior knowledge was considered while planning and teaching technology.

Encourage student's independent learning

Out of the six teachers, one teacher talked about how the support materials supported students' learning. Betty made a specific reference to student textbooks and resource

books, where step-by-step guidelines are provided for how to make something. She said:

The students' textbooks contained very informative content notes and step-by-step practical activities that students can do without much teacher assistance. The textbooks' activity sections that suggest 'For You to Try' activities helps students to be creative and innovative in designing activities or projects that they can make at home. Really, I believe the textbooks and resource books promote student independent learning. The Technology subject provides opportunities for students to explore their natural talents, creativity and make some things own their own.

She has indicated that the support materials were influential in promoting students' independence and developing their creativity.

4.5.2 Impact on teachers' perceptions and practices

This section describes the impact of the new support materials on primary teachers' perceptions and their practices in the classroom. Data indicated that change of teachers' perceptions changed their methods in teaching. Finally, the continual use of the support materials enhanced teachers' confidence in teaching technology. These are discussed in turn.

Change of Perceptions

Five of the six teachers believed their perceptions of technology and technology education had changed with the use of the support materials. These changes in teachers' perceptions were reflected in the following comments. As Bobby said:

Firstly, I used to think that technology referred to modern artefacts, such as computers, TVs, machines like photocopiers, telephones and other newly invented sophisticated machines. And for the new technology subject – Making a Living, I used to think that, it is a learning area where students learn the technical skills how to use of the modern artefacts to make something.

Now I see technology includes both the traditional or local artefacts and modern artefacts and technology education as the learning area where students

are taught both the skills and knowledge of the artefacts, especially the modern artefacts and the impacts they will have in their lives.

Angela used to think of technology as:

Modern tools and machines operated by electricity and new things which are made from overseas, foreign artefacts, and technology education, as a learning area where students were taught about these new artefacts and using them to make live easier than before.

However, she said that, after having read through the new technology curriculum materials, she viewed technology from a different perspective. As she noted:

I see technology as knowledge, understanding of new technologies and the technological effect on our lives to make informed decisions. Technology education is to prepare students with the skills and knowledge to engage in sustainable development as mentioned in one of Making a Living Strand, Care and management of Natural Resources is very important, and to me that is technology education.

Similarly, Betty recalled her former perceptions of technology and technology education when she was first asked to teach the new subject. She noted:

It was confusing at first, I did not have a clear idea, but I used to think of technology as modern new skills and knowledge used to make something using the new modern artefacts powered by electricity, but now I see technology also includes both our traditional and modern skills and knowledge as well. After all, in most rural areas in Papua New Guinea do not have electricity yet and the use of these modern artefacts are not much of use in rural places.

Betty used to have a perception of technology as modern artefacts. However, teaching in a rural school (School B) and her association with rural settings and activities carried out daily for survival had changed her perception to technology as including everyday activities and technology subject as knowledge and skills development for making a living after school life, as reflected in her comment:

I used to think technology is about teaching students about using new modern tool to make something. But, now I think technology involves in all activities

carry out daily like gardening, fishing, teaching and learning, you know, every activities involves some form of skills and knowledge and students need these skills and knowledge to use in their rural communities as they leave school after eight grade.

However, for Bex there was no change in her perception of technology and technology education. She maintained that technology is everyday activities that are undertaken in towns or in rural villages. She said:

Whether we teach students to make something using new machines knowledge and skills or traditional tools and knowledge and skills, it's all to do with making products for our survival. Therefore, in technology education, emphasis must be placed on developing life-long skills and knowledge that students can use to make a living in their adult life.

However, she pointed out that the support materials broadened her perceptions of technology education as she now viewed technology from a wider range of perspectives. She commented:

Technology is not only about tools, machines that involved in making things. Technology and technology education need to be perceived from wider range of aspects; the technical, procedural, design, economical and societal aspects.

Andrew maintained his view of technology as knowledge of modern artefacts; he also identified technology as a process used for solving problems to meet the needs of individuals and society. He explained:

Technology is not just about making some things using tools or machines, it is about identifying problems or needs and basing on these needs and problems formulate a plan or design, make something or find solutions, then assesses or evaluate the product or end result. Technology is more of a chain of processes.

Antonia talked about her past perceptions of technology but made specific reference to the new technology curriculum. She also was impressed with the new idea of problem-based learning and finding technological solutions. And she said:

I used to think of technology as application of skills and knowledge in making something, but the idea of identifying communities' needs or problems and

finding possible ways and solutions is interesting, a new aspect emphasised in the new technology curriculum syllabus. I believe technology education needs be viewed from a holistic approach.

It can be seen that the availability of the new technology curriculum materials to primary schools have changed the perceptions of teachers. Other teachers who maintained their past views of technology said that the new technology materials broadened their view of technology and they had adopted a holistic approach teaching technology, considering other aspects of technology rather than viewing technology from one particular aspect as reflected in Bex's comment.

Broadened technological understanding

Four of the six teachers believed that the support materials helped them broaden their understanding about technology. These teachers made direct reference to the support materials as the source of knowledge that broadened their knowledge of the subject matter. As Bobby said:

My understanding about technology has broadened by reading through the new technology (Making a Living) curriculum materials, and using the materials in my daily teaching planning and teaching.

Similarly, Betty made specific references to the materials' link between the syllabus and the resource books. As she explained:

The instructional notes in teachers guide and the content notes in students' textbooks are very informative. I am beginning to understand the technology subject better.

These teachers had no training in basic technology in their pre-service teacher training but were asked to teach the new technology subject. They regarded the support materials as the major source of knowledge and tools for instruction. Antonia, for example, reflected this in her comment:

I have graduated long before the introduction of the technology subject into primary teachers training colleges. I have no idea of what technology subject is all about and what to teach to the students when I was asked to teach it. I was still struggling to teach technology subject until the new materials were made

available to my school. To me, the new technology curriculum materials such as teacher's guides, resource books and students textbooks are my source of knowledge – knowledge about technology itself, what to teach and how.

Andrew, who had been trained in technology teaching in pre-service training, believed that the training he received in the pre-service was inadequate. However, he thought that the new support materials had broadened his understanding of the subject better. As he expressed in this comment:

The Technology course was a newly introduced course about the same time it was introduced in the primary schools. The Technology course at the pre-service training was still yet to be recognised as a major subject as in the primary schools. My training in pre-service was not sufficient. My understanding of the subject content, methods of teaching and planning in technology broadened only when I come in contact with the new support materials.

Similarly, Angela talked about the support materials broadening her understanding of technology but related to her teaching experiences in technology through subject integration. By integrating Technology with other learning areas she had broadened her knowledge of technology from different perspectives. She commented:

The new support materials made links to other subjects. When I am teaching mathematics, science, arts and all other subjects I can make links to technology subject. Technology I believe, is involved in all subjects. I can understand technology from wide range perspectives.

Bobby talked about societal aspects of technology and the need for students to be technologically literate. He commented:

Everyday we come into contact with new technologies. Technologies have both positive and negative impacts on our lives. It is important that we need to teach our children to be technological literate to make informed decisions as they come to cope up with the technologically changing world.

Change in technological pedagogical practices

Three teachers thought that changes in their teaching methods were made by the use of the support materials. Bobby, for example, said:

I find myself doing spending more time planning and preparing materials, but when it comes to actual teaching of technology lessons in class, it's usually students who are playing active role... I am finding myself playing more of a facilitator's role than that of a teacher dominating the lessons.

Antonia also related to her experiences of students' learning and said:

The new technology curriculum emphasises that teachers play the roles of a facilitator. I have student-centred learning. I have changed ways of me in control of students' learning to getting students to learn them. I set more group activities ... It is good to see students interacting with each other and helping each other.

Bobby talked about his learning experiences when he changed his former teacher-dominating role in the class to student-centred learning. He commented:

It is interesting to find out that students come to class with many kinds of technological skills and knowledge. I learned a lot from my students. The curriculum materials made suggestions only on activities. Teachers have the freedom to contextualise the learning activities to suit particular settings or relate to major events or selected themes. You do not have to stick to the activities suggested. Teachers need to be flexible and plan a variety of activities for students.

He went on to talk about teachers needing to be flexible and provide opportunities for students to learn through setting varieties of activities for students.

Betty shared a similar view and went on to point out the concept of 'community of learners', a group of learners coming together to share learning. As she said:

The new technology curriculum encouraged teachers and students to interact together in the learning process. Both the teachers and students interact collaboratively and learn together.

It can be seen that teachers thought that support materials guide them to relinquish the 'expert' model and play more of a facilitator role when teaching. The support materials encouraged teachers to organise more student-centred lessons, group activities and projects. They indicated group activities encouraged students to interact with each other, share technological ideas, materials, skills and knowledge and that promoted shared learning among the students.

Encourages Outside Community Involvement

All six teachers said that they had involved experts from outside of the school community in teaching technology lessons. Betty, for example, said:

I have invited a health worker to give a health talk on HIV and showed students how to use condoms.

Similarly, Antonia said:

I usually invite tradesmen such as carpenters, plumbers and computer technicians to demonstrate basic technical skills to the students in my technology lessons.

Angela also talked about inviting personnel from a Non-Government Organisation (Environment and Conservation Foundation) to talk to students about the technological impacts of technology and sustainable development. And Bex talked about inviting local experts to demonstrate, and pass on, local skills and knowledge to students. Betty also expressed concern that the local expertise lacked confidence in formal teaching. She said:

It is a good idea to invite outside community to participate in the education of the children. However, the local experts do not have the confidence in teaching in formal lessons; they became shy in the classroom.

Outside community involvement was also emphasised in the technology curriculum. As Andrew highlighted:

The technology curriculum encourage outside communities involvement in children's education. Children's education is now a shared responsibility with the school and outside communities.

It appeared that the support materials encouraged teachers to be flexible, creative, and able to utilise outside expertise. Emphasis on the utilisation of expertise in technology teaching is in line with the curriculum reform where community participation in children's education is encouraged.

Enhanced teachers' confidence to teach technology

Three teachers believed the support materials promoted teacher confidence to plan and teach technology effectively. Betty, for example, explained her experiences like this:

I was never a trained technology teacher. When I was timetabled to teach the new technology subject, MAL, I was not confident in teaching technology. ... When the new technology materials were made available at my school, my confidence began to grow stronger as I studied the learning outcomes and indicators. My understanding of the technology, too, broadened. I am now enjoying this new subject.

Andrew also agreed that the support materials broadened his technological knowledge and that gave him confidence in his planning and teaching technology. He stated that:

Having built confidence through the assistance of the support materials, I am able to be creative and flexible in my planning and teaching.

Similarly, Bex commented:

When the support materials were not yet developed, I did not have a clear understanding of the new subject. It was only when the new technology materials were made available at the school in 2005, I started to read through and my understanding of the subject broadened. This then, gave me the confidence to teach the subject.

It can be seen that the support materials were acknowledged as a source of knowledge that enhanced teachers' confidence to teach technology.

4.6 Support Materials and Teacher Professional Development.

This section further describes the role of the support materials in teacher professional development programmes. Data demonstrated that the support materials have been very supportive in many ways in professional development programmes for Papua New Guinea primary teachers during the implementation of the technology. The supporting roles of the support materials are categorised under two dominant themes: the support materials as a source of knowledge and as support materials as substitute for professional development.

4.6.1 Source of knowledge

Four of the six teachers described the support materials as a source of knowledge for technology. For those not trained in technology, they were particularly useful. As Antonia said:

I was never a trained technology teacher. I was timetabled to teach the new technology subject because I am kind of a practical person, likes doing practical activities more often than doing academic stuff. I became confused and did not understand what the new technology was all about. Only when the new technology materials were made available in my school in 2005, that was when I began to understand what the subject was all about. To me, the new technology curriculum materials are a source of knowledge.

Similarly, Angela reflected on her past teaching experiences when she was asked to coordinate technology when it was first introduced in her school:

Technology (MAL) was a new to me when I was first asked to coordinate the subject in 2000 in the school. I was only given the technology syllabus to plan from. That was not enough to understand the subject. I sought help from the nearby high school and got practical skills and home economics books and started planning activities to give to my junior teachers to teach when it comes to technology subject lessons. Finally when the support materials were developed in 2005, my understanding of technology was broadened ... the support materials helped me to integrate technological knowledge into other subjects' areas as well.

Though Andrew was a trained technology teacher, he thought that his technology subject training at the teacher training college had been inadequate. However, he indicated that the support materials had enhanced his knowledge about technology. He said:

I have taken a basic technology course in my teaching training, but I feel the training is not enough. It was too shallow and I am not trained well for teaching this technology subject, MAL. However, the MAL students textbooks and teachers resource were beautifully written based on the syllabus outcomes. The textbooks were of great help in my planning and teaching. The information and activities suggested are helping me to know more about technology.

Angela compared her understanding of the technology gained from a two-day in-service workshop she attended to the understanding she got from the new technology curriculum materials about the subject said:

I had attended a two-day in-service workshop on this new technology subject. Frankly speaking, I did not really understand the concept of the new technology subject. After the in-service, I did not understand the subject fully until the new technology materials were distributed to the school. I began to read through and the whole concept of technology and technology teaching became much clear to me. I am really enjoyed teaching this new subject.

Bobby also attended the in-service programme on professional development. The two-day in-service programme delivered by the National Curriculum Unit to selected teachers from each school in the province in his province in Papua New Guinea when the new technology subject was first introduced related his experience. He commented:

The two-days in-service on the new subject was not enough to understand the nature of new subject and how to plan the subject and teach it to students. The participants asked for more in-services on the subject. However, up till now there is no in-services on the subject yet. It is not a problem now anymore to me, I have the support materials and I now understand and can teach technology lessons well than I used to before the materials developed.

However, Betty had not attended any in-service on the technology subject and so she had relied heavily on the support materials for broadening her understanding of the technology subject planning and teaching. Prior to the availability of the support materials, she relied her own past experiences. As she commented:

There were no workshops and in-services conducted in technology so I did not attend any. So I relied heavily on the textbooks for planning and teaching technology lessons to students. Before the support materials were given to me, I was basically teaching from my past experiences.

It can be seen the there was one-off two-day in-service professional development programme conducted during the trial period. However, there has not been no follow-up in-service. Therefore, teachers relied on the support materials as their major source of knowledge on technology and for teaching and planning.

4.6.2 Substitute for professional development.

Two senior teachers responsible for coordinating the technology subject thought that the support materials were a substitute and a major support in the in-school professional development programmes. They heavily relied on the support materials for developing yearly, term and weekly teaching programmes. As Angela explained:

The new technology support materials are the guide to our planning of teaching programmes in technology. They are also resource materials in our school-based in-service programmes. We [referring to her technology teachers and herself] developed our yearly and term teaching programmes based on the strands and learning outcomes from the technology syllabus and teachers' guide. And also the assessment programme.

Similarly, Bobby, who coordinated the technology subject at School B, explained how professional development was carried out in his school and further explained their technology teaching programmes. He said:

There are no in-service conducted for technology subject coordinators, I relied very much on the support materials to plan and run in-service for my fellow technology teachers as a coordinator. My technology teachers and I planned our teaching programmes collaboratively. We used the thematic approach in planning and teaching in technology. We identified themes from the technology

curriculum. Then, using those themes developed the yearly teaching programmes, then to term teaching programmes, using the learning outline relevant to the theme.

It can be seen that the new technology curriculum materials were seen in Papua New Guinea primary schools as major support materials for professional development programme. The materials were made available and accessible in schools, and thus to teachers, as a reliable professional development support for their professional development programmes. With no professional development, the support materials were an alternative source professional development for teachers.

4.7 Document Analysis

So far data has been presented from teacher interviews. Section 4.7 presents the analysis of the documents. Three kinds of documents were analysed: the Making a Living (MAL) syllabus, teachers' supporting materials and teachers' teaching programmes.

Section 4.7.1 presents the aims of the MAL syllabus. This is followed by the examination of major strands in the MAL syllabus in section 4.7.3. Section 4.7.4 presents the description of the support materials and examines the content of the support materials against the views of technology and technology education presented in the literature. Analysis of teachers' teaching programmes are presented in section 4.7.5.

4.7.1 Making a Living syllabus and supporting materials

In the Making a Living syllabus (DoE, 1996) the aims of technology education are described as providing “students with essential life skills and knowledge to become self-reliant and use local resources sustainably to improve their quality of life and contribute meaningfully to their local community and society” (p. 4).

The acquisition of life-long technological skills and knowledge that helps students to use their local resource in a sustainable manner to become self-reliant and become

productive members of their societies in which they chose to live after school is the focus of the MAL syllabus at the primary schools in Papua New Guinea.

4.7.2 Major strands in the MAL

The development of students' technological skills and knowledge are enhanced through three major strands in the MAL syllabus. These are the Managing Resources strand, the Better Living strands and the Community Development strand.

First, the Managing Resources strand is about developing an understanding that people depend on the environment for food, water, shelter and clean air. Both teachers and students need to understand, and value, natural resources and learn ways of managing land and water resources in a sustainable way that benefits people and the environment. They need to learn the basic principles and techniques of managing land to increase the quality and quantity of food production for their own consumption or for sale. The strand also advocates a clear focus upon concepts of ecological and economic sustainability. In this strand, teachers and students undertake environmentally friendly activities to protect and conserve the environment. The Managing Resources strand incorporates three sub-strands. These are Land and Water Management, Environment, and Crops and Animal Management (DoE, 2003, pp.6-7). This strand addresses the aspects of technology as value-laden. Layton (1988) stated that concern over the control of technology has been one of the strongest motivations for the increased effort to understand technology. The strand addresses how technology impacts the environment which in turn affects peoples' livelihood. Under the sub-strand Land and Water Management, technological skills and knowledge are emphasised for sustainable development of resources. Traditional technologies and indigenous technological practices are also encouraged in this strand. The strand also addresses technology as knowledge. It aims to develop technological knowledge so that both teachers and students are knowledgeable in technology, can make informed decisions and undertake safe and sustainable practices in their environment.

The Better Living strand is about developing essential skills and knowledge for effective management of time, money, labour and resources to achieve a safe, healthy and productive lifestyle. This strand focuses on food preparation to meet nutritional requirements, money management and promotes creativity and innovations. Teachers

and students develop problem-solving and decision-making skills, and apply these in practical and real life situations to improve their standard of living. Better Living incorporates four sub-strands. These are Healthy Living, Care and Management, Wise Consumer, and Making Things (MAL Teachers Guide, 2003, pp. 7-8). This strand addresses the aspect of technology as processes (Gardner, 1994). It emphasises the design and make in technology education, and the procedural aspects of technology (McCormick, 1997). It encourages problem-solving as an important aspect in technology education. The sub-strand Making Things involves identifying a problem or need, then designing a possible method or approach (procedure) to solve or meet the need. The strand focuses on developing basic technical skills and knowledge for students to make something and become useful productive members of their society after school

The Community Development strand is about learning how to contribute to, live and work within, the community. Teachers and students create awareness in the community about services available to them and assist in the democratic decision-making processes most appropriate for the community. Teachers and students learn to share their talents and skills to benefit their community. Likewise, they also benefit from the talents and skills from the community. This strand aims to develop teachers and students' necessary skills to liaise and actively participate in community-based projects to build good working relationships and promote effective networking partnerships through effective communication skills. The community development strand incorporates three sub-strands. These are Knowing Communities, Communication, and Community Projects (MAL Teachers Guide, 2003, pp. 9–10). This strand reflects the view of technology as volition, organization and value-laden (Burns, 1997; Custer, 1995; Layton, 1988; Mitcham, 1994). It addresses the societal aspects of technology, by focussing awareness on the technological impact on people's lives, their culture, addressing technological issues, social issues and promoting effective communication that enhances technological literacy (Daker, 2005; Resinen, 2003). This strand also addresses the view of technology as artefacts, both traditional and modern artefacts. Involvement of local experts and community in teaching technology is encouraged. Technology as modern artefacts and learning about modern artefacts in technology education are also addressed in this strand (Mitcham, 1994). For example, the sub-strand Communication discusses the

importance of both the modern and traditional methods. Modern means of communication include knowing and learning how to use computers, fax machines, radio and telephone and other modern technologies are detailed.

All the strands are interrelated. Therefore, various aspects of technology and technology education addressed in each strand are all interrelated. These reflect a broad concept of technology as multifaceted and only a multi-dimensional approach to learning in technology education will foster the broadening of understanding of technology (Jones, 1997; Petrina, 1998).

4.7.3 Support materials

There are five different publications as support materials for the *Making a Living Syllabus* (DoE, 1994). These are a teacher's guide, a teacher resource book, student textbooks (textbook 1 & 2) and five student resource books (for descriptions of these publications see section 1.6). The support materials were analysed by using views of technology and technology education identified in earlier discussions.

Views of technology

The view of technology as artefacts is fostered in the support materials. Both the modern and traditional uses of artefacts are promoted in the support materials. Papua New Guinea is made up of both the rural and urban communities, and therefore traditional or indigenous technologies are still used in everyday activities. Modern tools and machines are expensive to obtain and maintain. Though the support materials encourage the learning of the use of modern artefacts such as computers, fax machines, telephones and TVs, these modern devices need electricity (*MAL Student Textbook 1*, 2005, pp. 94 -96). Many rural communities in Papua New Guinea do not have electricity to operate modern technologies. However, the urban communities in Papua New Guinea have access to modern technologies. Therefore, the support materials promote both types of artefacts to suit both Papua New Guinean communities' needs.

Technology as knowledge is also fostered in the support materials, where two kinds of technological knowledge are being promoted. The most emphasised kind of knowledge is the development of practical knowledge. Practical knowledge is to carry

out human activities for survival (Cluster, 1995). This practical knowledge also includes the view of technology as a practical capability (Black, 1994). For example, the student resource books are aimed at developing practical skills through undertaking step-by-step practical activities in making something. This view also fosters technological knowledge as being procedural (McCormick, 1997). The support materials aim to foster basic practical knowledge. Another kind of knowledge fostered in the support materials is knowledge of understanding of technology – technological knowledge. The support materials promote technological knowledge for teachers and students to make informed decisions on the impact of technologies (Compton & Harvard, 2003; Daker, 2005; ITEA, 2000; Rasinen, 2003).

Technology as volition is also being promoted in the support materials. The support materials discuss the social impacts technology has on individuals and organizations. This aligns with technological knowledge as societal knowledge (Hansen & Froelich, 1994). The support materials, for example, the *MAL Student Textbook 2* (p. 171) discuss the change of social problems caused by modern technologies, such as gambling machines, and health problems caused through improper disposal of modern processed chemicals. The support materials provide both the positive and negative social impacts of technology that may have positive or negative on people's lives, cultures and lifestyles (Custer, 1995; Staudenmaier, 1989). The view of technology as an organization is also included along with technology as volition. As Burns (1997) states, technology is part and parcel of society.

Another view of technology the support materials promote is that technology is a process. This view sees technology as knowledge and actions used by people to apply resources in designing, producing and using products. The support materials emphasise problem-solving as an effective approach for undertaking technological activities. The support materials highlight the following processes as the key features of Making a Living: investigation, planning and designing, making or producing, marketing or using and evaluating (*MAL Teacher's Guide*, 2003, p.5). The support materials also encourage students and teachers to undertake activities in all these processes. This view also fosters the view of technology as design (Jones & Carr, 1993; Sharpe, 1996).

Technology as value-laden is promoted in the support materials. Technology and technological practices are part of society (Burns, 1997). The support materials strongly encourage technological practices to be contextualised to suit the Papua New Guinean context. For example, the resources and activities suggested, content information in the textbooks, the photographs inserted, are mostly of Papua New Guinean contexts. The technological impacts of society are discussed as organization. Technology as value-laden emphasises technical skills and knowledge development relevant and applicable to Papua New Guinean society. The support materials emphasise development of skills and knowledge which contribute to technological problem-solving (Moreland, 1998, Sharpe, 1996). Technological problem-solving skills and knowledge are seen as a powerful tool in learning in technology education as well as identifying ways to solve problem or needs people may be faced with. The view is that technological skills and knowledge help teachers and students to cope with technological changes.

The support materials promote and foster these various technological views and aspects of technology and technology education.

Views of technology education

The support materials recommend several teaching and learning strategies. These include a student-centred approach. A student-centred approach is described in the support material as “learning focussed on active construction of meaning by students and teaching as the act of guiding and facilitating learning” (*MAL Teacher’s Guide*, 2003, p. 60). The support materials emphasised that teachers need to build lessons on students’ prior knowledge. For example, students come to school equipped with other knowledge learnt from outside the classroom, therefore, the teacher uses brainstorming of students’ prior knowledge through class discussions, then develops the lesson so as to develop this prior knowledge to an advanced stage. For example, the students’ suggested activities in the *MAL Student textbook 2* talked about carrying out a survey in the class to find out students who had used telephones, by asking them to share their experiences (2005, p. 90). They also encourage shared learning among teachers and students in classrooms. The strategy of bringing the community and its resources into the school and providing opportunities for students and teachers to go out into the community to learn is advocated. For example, student activities in the

MAL Student Textbook 1 (2005, p. 38) talks about students and teachers going on an excursion to a nearby farm with livestock and asking the farmer questions on how to set up a small school livestock business. The approach also encourages outside community involvement in learning and fostering indigenous technologies and the use of the traditional artefacts in teaching technology. For example, the *MAL Student Textbook 2* talks about the importance of local technical skills in local communities and suggests inviting a skilled local person to school to demonstrate their skills such as weaving a basket or sitting mat, making a fishing spear or carving (2005, p. 75). This also fostered contextualisation of technological activities as being more relevant and applicable to the context and society. It also supports the argument that learning is culturally influenced and embedded within a socio-historical context (Bruner, 1996; Hennessy, 1993; Vygotsky, 2000). The student-centred approach to teaching and learning provides opportunities for problem-solving, decision-making and taking action. This fosters the idea of problem-solving and design being universally recognised as critical elements of learning and instruction in technology education (Johnson, 1997; Moreland, 1998; Sharpe, 1996). The last example of student-centred learning promoted in the support materials is that student-centred learning provides students with opportunities to reflect upon their own learning, knowledge, values, attitudes and skills. This means that teachers must provide real life and relevant learning experiences for students to practice and develop critical and creative thinking. Teachers also need to encourage hands-on teaching experience, provide local and community based projects, and provide purposeful and meaningful learning experiences that promote critical thinking and problem-solving and decision-making. Teachers should also encourage active community participation. For example, the *MAL Student Textbook 2* (p. 176) talks about the importance of working with the community, promoting self-reliance and improving living standards in the community and in the suggested student activities. It talks about inviting a local elder to speak to students about community changes over the years. The *MAL Student Textbook 2* (2005) discusses how to work with the community elders to develop their communities and how both the teachers and students can take part in practical community projects organised by village elders or community leaders (pp. 83 – 87).

Common teaching methods

Student-centred teaching and learning is recommended in the support materials. This style uses brainstorming, surveys, focus group, problem-solving, demonstration, models, field trips, group work, resource people and discussions (DoE, 2003). Brainstorming activities are intended for stimulating discussion among the students. Students share their ideas, beliefs and opinions with others. Brainstorming can be done in small group or as a whole class. For example, in 'students' suggested activity', it talks about generating ideas for an irrigation system that could be developed for cash or food crops grown at their schools (*MAL Student Textbook 2*, 2005, p. 26). In this method, teachers encourage students to generate ideas. Brainstorming is best used when students are considering relevant types of projects and deciding on activities.

Surveying is the next teaching method recommended in the support materials. A survey is described as a type of investigation activity used to gather information and evidence from various sources. Students collect and analyse data from surveys to make informed decisions on what action to take in solving problems or meeting needs. For example, many activities suggested in the MAL student textbooks talk about carrying out a survey of all upper primary students to discover the most pressing needs of their schools and present their findings under the headings of, physical needs, environmental needs and economic needs, then to prioritise these needs and identify the most important (2005, p. 102). The text book also suggests carrying out about price survey in stores in towns and trades stores in villages and compare prices on goods (*MAL Student Textbook 2*, 2005, p.187).

Another teaching method recommended is the use of focus groups. A focus group consists of a selection of people representing the major stakeholders from the community. The discussion in a focus group aims at finding specific information; a group of individuals who are experts in various fields of trade could be part of a focus group. For example, support materials talk about promoting networking community and other community-based organizations such as the non-government organizations (*MAL Student Textbook 2*, 2005, pp. 175, 83;).

Another method in teaching that is promoted in the support materials is projects. A project-based approach is highly recommended for Making a Living as it offers real-life experience for students to develop their understanding and skills. Projects promote experiential learning through practical activities. It is recommended that projects undertaken need to be relevant to student needs and the local context (*MAL Teacher's Guide*, 2003, p. 62). The support materials encourage more project activities in their suggested activities (*MAL Teacher Resource Book*, 2005; *MAL Student Textbook 1 & 2*, 2005).

Problem-solving is recommended in the support materials as one of the preferred teaching methods. Problem-solving encourages students to investigate an area of interest, establish strategies and actions to develop critical and analytical thinking, and apply decision-making and problem-solving skills in relevant situations (*MAL Teacher's Guide*, 2003; Moreland, 1998; Sharpe, 1996).

Another method of teaching is the use of demonstrations. Demonstrations are undertaken by teachers or other specialists to show students the steps and correct techniques for completing an activity. Students are to observe and follow the demonstrations accurately and then apply the skills in given tasks or projects. Demonstrations are recommended because, in being introduced to a new concept or skill, students need to learn to then be able to apply it in their respective projects. The student resource books show step-by-step demonstrations of skills on how to undertake processes in undertaking technological activities to make something. The method promotes technology education as developing procedural knowledge (McCormick, 1997).

Another teaching method recommended is the use of models. Models are used for teaching ideas and demonstrating important skills or concepts. Students refer to the models to visualise a concept, technique, or an idea and then apply these in their projects. The support materials recommend that teachers have their own models to show students the skills and processes to complete a product. For example, samples of teachers' projects are given in the textbooks (*MAL Student Textbook 1*, 2005, pp.110, 111; *Textbook 2*, 2005, pp. 191, 192).

Field trips are promoted because teachers can take students to observe projects or activities that are not available in the school area. These give students firsthand experiences as they observe actual practice and develop ideas on how to use what they observe in the actual practice. For example, *MAL Student Textbook 1* discusses going on an excursion to a radio station and finding out how it works (p.96) and *MAL Textbook 2* suggests taking students on a field trip to a market and stores and listing the kinds of artefacts on sale (p.197).

The other teaching method is group work. Group work stimulates student thinking and creates opportunities for social interaction among students and teachers. Group work encourages the sharing of responsibilities and resources to achieve a common purpose. For example, the *MAL Student Textbook 2* talks about how students in small groups could think about and suggest money-making activities that their class can do to raise money for their picnic (p. 162).

The use of resource people in teaching programmes is also recommended. Resource people are those people who are experts trained in a particular area. Individuals or organizations from the local communities can be invited to share their knowledge and experiences with the students where teachers lack in-depth knowledge or skills about a particular topic. For example, a teacher could invite an agriculture officer to school to talk about crops that are resistant to diseases in the local community (*MAL Student Textbook 1*, 2005, p.41), or a teacher could invite an environment officer to school to explain how the natural environment is managed in local communities (*MAL Student Textbook 2*, 2005, p.164).

Finally, discussions are also recommended as a suitable teaching method. The main purpose for discussion is for the group to orally consider ideas facts and opinions about a particular topic. Mutual understanding and consensus can be reached and decisions made on what action to take. Discussion creates interest, involvement and the exchange of knowledge and experiences and ownership of development. Decisions are reached democratically by consensus through discussion. For example, the *MAL Teacher's Guide* (2003) explains ways a teacher can conduct discussions effectively (p. 65). In addition, many suggested activities in the students' textbooks recommend discussion as a method that promotes interaction among both the students

and teachers. For example, the *MAL Student Textbook 1* (2005) suggests holding a class discussion on the benefits of both traditional and modern farming (p. 45).

All teaching methods recommended in the support materials help implement appropriate technology programmes based on the MAL syllabus. Technology is a broad and multifaceted concept, so various teaching methods need to be employed to teach technology effectively in classrooms (Jones, 1997; Moreland, 1998; Petrina, 1998).

4.7.4 Teachers' teaching programmes

Teachers' plans have been analysed to ascertain the content of all teachers' plans, their lesson sequencing and subject integration approaches and planning in context.

Sources for planning

Data show that primary teachers used technology support materials in their planning. These support materials included a teacher guide, a teacher resource book, two student textbooks, and five student resource books. (See descriptions of these materials in section 1.6.)

Types of teaching programmes

Data showed that three types of teaching programmes were developed by the primary teachers in this study in Papua New Guinea. These were the yearly plan, the term plan and the daily lesson plan.

The first type of teaching programme was the yearly plan. It was referred to by teachers as their long term plan. The yearly plan consisted of the topics to be covered for a year. The topics were then grouped into four groups to match the four terms in a year. Table 4.4 shows Angela's yearly plan for Grade 8.

Table 4.4:

Angela's Grade 8 Yearly Plan

Term	Strand	Sub-strand	Learning Outcomes
One	Managing Resources	. Land and Water . Environment . Crops and Animal Management	8.1.1 Evaluate current practices of land and water resources management 8.1.2 Describe and reflect on economic,, cultural and ecological values of natural resources 8.1.3 Plan, design and implement a crop or animal project
Two	Better Living	. Healthy Living . Care and Management . Wise Consumer . Making Things.	8.2.1 Investigate and implement practical ways to produce and prepare food 8.2.2 Select and undertake a project based on identified needs 8.2.3 Evaluate goods and services provided by a range of organisations 8.2.4 Investigate appropriateness of materials
Three	Knowing your Community	.Knowing Your Community .Communication .Community Projects	8.3.1 Undertake a cooperative plan that provides economic and social opportunities 8.3.2 Apply effective communication skills 8.3.3 Plan and undertake an enterprise project.
Four	Revision Term		

In Angela's yearly plan she used a four column format. Column one shows the terms; column two, the particular strand; column three, the sub-strands; and the learning outcomes in column four. As an elaboration in term one, the strand is Managing Resources and the sub-strands for the strand managing resources are: Land and Water, Environment, and Crops and Animal Management. The learning outcomes are 8.1.1 Evaluate current practices of land and water resources management, 8.1.2 Describe and reflect on economical, cultural and ecological values of natural resources, and 8.1.3 Plan, design and implement a crop or animal project. Strings of links were seen between Angela's plan and the other teachers' plans.

The learning outcomes were organised according to strands, sub-strands and grade levels. Each learning outcome was numbered with three digits such as 8.1.1. The first number referred to the grade (Grade 8); the second to the strand (Strand 1); and the third to the sub-strand (Sub-strand 1).

The next teaching programme after the yearly plan is the term teaching plan. The term teaching plan consisted of an overview of the teaching and learning activities to be covered in each week of the school term. All teachers in the study used a four column

format for planning. Betty's Term Teaching Programme shows the four column format in Table 4.5. below.

Table 4.5
Betty's Grade 7 Term Teaching Programme.

Project: Making Pillowcase Grade 7 Learning Outcome 7.2.4			
Weeks	Student Activities	Resources	Assessment Tasks
1-2	<ul style="list-style-type: none"> . identify and collect samples of pillow . assessment of fabric type . justification and selection of pillowcase and fabric 	<ul style="list-style-type: none"> . pillowcase samples . fabric pieces 	<ul style="list-style-type: none"> . selection of fabrics . types of pillowcase
3-4	<ul style="list-style-type: none"> . design and select pillow case pattern . list of sewing procedures . identify collect resources . estimate cost of production . correct timing of completion . estimate profits of pillowcase 	<ul style="list-style-type: none"> . paper and pencils 	<ul style="list-style-type: none"> . pillow case designs
5-8	<ul style="list-style-type: none"> . collect fabrics tools and equipment . assemble and prepare tool and equipment . measure and cut fabric following specification . neaten the edges by pinning and sewing . do embroidery stitches . fold sides of the pillow case . complete by cutting off unwanted thread 	<ul style="list-style-type: none"> . sewing machines, needle, thread, embroidery . cotton, scissors, tape measure, pattern designs, tacking pins 	<ul style="list-style-type: none"> . measurement and cutting skills . neatening . embroidery stitches . complete project
9-10	<ul style="list-style-type: none"> . display complete pillow case . advertise for sale . correct pricing . sell the product and keep sound records of sale . calculate profit or loss 	<ul style="list-style-type: none"> . paper, pen, pins and table 	<ul style="list-style-type: none"> . advertisement . record keeping

As an elaboration to Betty's term teaching programme format, column one had the weeks for a school term, column two had student activities outlined, resources needed for the student activities were identified in column three, and possible assessment tasks were outlined in column four. Betty's term teaching plan reflected a sequence of student activities closely linked from the previous activities to the next activities and ensured continuity. It also showed that assessment was continuous and task-related.

The final type of teaching plan is the daily lesson plan. Using the term teaching programmes, all teachers created their daily lesson plans. All the daily teaching plans had a detailed sequence for activities in the lesson introduction, the lesson body and

the conclusion of the lesson. As an example, Andrew's daily teaching plan is presented in Table 4.6.

Table 4.6:
Andrew's Grade Six Daily Lesson Plan

Daily Lesson Plan Format

Name: Teacher A Grade: Six (6) Date: 19 / 02/ 2007
 Subject: Making a Living
 Sub-strand: Environment Strand: Managing Resources
 Outcome: 6.1.2 Topic: Natural Elements
 Indicator: Investigate the consequences when an element of local environment is affected.
 Resources/Materials: Teachers Guide, Syllabus, Student textbook 1, Coloured markers, Blank Charts

Time		Teacher Activity	Student Activity	Resources
10 minutes	Introduction	.Play the game 'Hangman' with the word 'Environment' . tell students that the word 'environment' is made up of two elements; Natural and Man made Introduce lesson by saying "In today's lesson, we will look at the 'Natural Element' and identify some important things that make up the natural environment in small groups'	. Guess any letter in the alphabet to make up the word 'Environment' . Guess two elements of environment; (1) natural and (2) Man made Students get into small groups and discuss things that make up natural environment	Flash card with the word 'Environment' written on. Coloured markers and blank charts
30 minutes	Body	Teacher ask questions; What are natural elements? State few examples of natural environment Point out to students that these elements influence each other, therefore, if one element is affected, then it has an effect on the other elements. Group students and supervise students as they work in groups of four students.	Students' possible answer: Things in the environment that are not man made. Possible answers: Soils, vegetation, animals, climate, landforms In groups, students discuss and identify some examples of how elements influenced and affected each other. Write down their findings for group presentations Students present their findings to the class.	

<i>10 minutes</i>	<i>Conclusion</i>	<i>. Write down all student responses</i> <i>. Summarize the lesson.</i> <i>Natural environment consists of soil, vegetation, animals and landforms</i> <i>Set homework.</i> <i>Present the natural environment in drawings on a chart.</i>	<i>Students listen to teacher's lesson summary</i> <i>Take notes on their homework and do the homework</i>
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Lesson evaluation/reflection: _____.

Andrew's daily lesson plan was a well structured lesson with an opening, middle and conclusion with time specified for each section. It provided detailed information by specifying the grade, the date for the lesson to be presented, the subject strand and specified the sub-strand and the lesson topic, indicator and the reference resources and supporting materials needed. The plan also included activities students would undertake in the lesson, possible questions to ask students and outlined what activities the teacher would undertake. All teachers made reflections on the daily lesson presentation outlining the successes and failures experienced in their lessons and made recommendations for improvements in the next planning and teaching.

All teachers' plans, such as the yearly plan, the term teaching plan and the daily teaching plan described, were developed in line with the teaching plans suggested in the *MAL Teacher's Guide* (2003, pp: 45-58). All six teachers used the same lesson plan sequence in all grades in the upper primary schools. All the teachers outlined their lesson sequence in a detailed plan. Details included activities students would undertake within each lesson, possible questions to ask students as well as principles and ideals pertinent to the unit. The assessment was also included. However, the differences in the plans were the different grades, terms in the year with different strands for different terms to be taught. Teachers had the freedom to alter and contextualise teaching to suit the context of learning, events or needs that may arise during the academic year. All the yearly plans and term plans were written collaboratively by teachers teaching the same grade. Only daily lesson plans were planned by individual teachers.

4.7.5 Integrated teaching

Data showed teachers used two ways to integrate teaching, through a theme-based approach and through a technology project-based approach.

The first integrated teaching approach is the theme-based approach. All the six teachers indicated that they developed teaching programmes together in their schools using a thematic approach. A thematic approach in planning was encouraged in the *MAL Teacher's Guide*, (2003, pp. 51–58). For example, teachers would plan together to identify major themes to be covered within school terms and they would identify and cluster linked learning outcomes identified within the technology syllabus along with other subjects' learning outcomes. From the clusters of learning outcomes identified, teachers then developed the term teaching programme. As an example, Andrew's integrated planning is presented in Table 4.7.

Table 4.7
Learning theme clustered with other subject learning outcomes.

School	Theme	Subjects	Learning Outcomes
School A	Environment	Technology (MAL)	7.1.2 Caring for my environment
		Social Science (S/S)	7.1.4 People and Environment
		Language (L)	7.2.1 Skills and Strategies in Reading and Writing
		Mathematics (M)	7.2.7 Space and Shapes

Andrew and his fellow technology teachers identified Environment as the theme for term (three). Subjects of integration and their learning outcomes were Technology, 7.1.2 Caring for My Environment; Social Science, 7.1.4 People and Environment; Language, 7.2.1 Skills and Strategies in Reading and Writing; and Mathematics, 7.2.7 Space and Shapes. Learning outcomes from each subject relevant to the theme were outlined in the learning outcome column. From these clusters of learning outcomes, teachers developed a detailed teaching plan. Table 4.8, below shows Andrew's teaching programme as an example of detailed planning using integrated teaching programmes.

Table 4.8:

*Andrew's integrated teaching plan*School: *School A* Term: *Three (3)* Grade: *Seven (7)* Theme: *Environment*

Subject	Strand	Sub-strand	Learning outcome	Learning and teaching Activities	Resources
Making a Living	Managing Resources	Environment	7.1.2 Investigate and undertake practical ways to reduce, reuse and recycle waste	<ul style="list-style-type: none"> . Describe processes of cleaning village . Read the story in the students textbook and do the activity suggested . Create an item out of the used materials . Make an awareness chart of no damage on environment 	<i>Syllabus Teachers Guide, p.15</i> <i>Student's textbook p. 13</i> Other resource books
Social Science	Environment and resources	People and environment	7.1.4 Describe national and regional sustainable practices related to the natural environment	<ul style="list-style-type: none"> . Describe the local environment . Report on resource in and around the country . Survey the industries in Goroka on damages. . State some policies on land care 	<i>Resource book Social Science syllabus</i>
Language	Speaking, Listening, Reading, Writing	Skills and strategies	7.2.1, 7.2.2, 7.3.2 Use and apply skills and strategies in speaking, listening, reading, writing	<ul style="list-style-type: none"> . Pronounce spelling words . Listen to passage and write the passage . Read a comprehension passage and answer the questions . Write an essay on how to look after our environment 	<i>Create and Communicate Book 1.</i>
Mathematics	Space and Shapes	Capacity	7.2.7, 7.2.8 Investigate, use and draw physical models of	<ul style="list-style-type: none"> . Identify common units for liquid volume . Make estimations of water volume . Make solid cubes and find their volume . Find the volume of prism. 	<i>Maths 7B syllabus</i>

Andrew's plan was a six column plan showing all the integrated subjects in column one followed by their strands in column two and their specific sub-strands in column three. Column four presents the linking learning outcomes from all subjects integrated with the learning activities described in column five and support resource materials were specified in column six. The theme for planning was identified from the MAL

support materials (*Teacher Guide*, 2003. p.15; *Teacher Resource Book*, 2005. p.13) and clustered linking learning outcomes from other subject areas drawing up their teaching programme. It can be seen that thematic planning also encouraged integration of technology with other subjects.

Data also showed that teachers used either a theme-based approach or a technological based approach in planning. In the project-based approach, teachers identified a project to be carried out through a term and developed a teaching plan based on that project. Relevant learning outcomes from technology and other subjects linked to the practical project were identified and then the learning outcomes are selected and matched to the processes involved in making the project. Angela,s example of project-based planning in Table 4.9 shows the project-based integrated planning approach.

Table 4.9:

Angela’s Project Integrated Planning.

School: *School B* Term: *Three (3)* Grade: *Seven (7)* Project: *Sawdust Stove*

Week	Process Skills	Subject	Activities	Resources	Assessment task
1 & 2	Investigation	Language	. Ask questions and collect data . Identify potential markets for the sawdust stove		<i>Note: Select the outcomes from those subjects you want to assess Do not try to assess all the outcomes in the integrated unit of work</i>
		Sciences	. Collect information on how heat is transferred in different materials such as sawdust, air, pot		
		Making a Living	. Identify and select appropriate materials . Identify and select appropriate tools and equipment . Observe different models of stoves used in the community		
		Social Science	. Discuss environmental impacts of using sawdust stove in comparison with open fire and other types of stoves		
3 & 4	Planning and Designing	Making a Living	. Identify list of resources and where to obtain them . Calculate cost of materials . Estimate expected		

			income
		Science	. Design and experiment with different cylinders used for making a sawdust stove
		Language	Write and action plan for constructing a stove . What to do, by whom and when
		Arts	. Draw sketches and a scale drawing of the stove
5 & 6	Implementation	Making a Living	. Collect and assemble all materials in a central location . Observe different models and a demonstration on making a sawdust stove . Work in groups or as individuals to construct a sawdust stove with guided instruction and supervision
		Science	. Discuss different ways heat is generated for cooking
7, 8 & 9	Marketing	Language Making a Living	. Prepare an advertisement . Pricing and selling . Keeping records of sale . Demonstrating how to use a sawdust stove
	Evaluation	Language	. Reflection on the process of making sawdust stove . Identify problems encountered and make suggestions for improvement in the future

Angela's was a six column teaching plan. Column one included the weeks, column two specified the processes and skills. Column three identified subject integration and linking of activities from one subject to another was outlined in column four. Column five noted the support resources materials needed and column six outlined possible areas of assessment. Angela's plan was adopted from the *MAL Teacher's Guide* (2005. p. 58).

Angela clearly outlined the sequence of teaching and learning in her lesson activities. Her teaching programme was project-based. Angela’s technology project was on constructing a sawdust stove. Both the theoretical and practical aspects of technology were included in the teaching programme. Activities for assessment were not fixed but left open for the teacher to decide. Assessment activities were not restricted to being from technology subject alone but could be from other related subjects’ activities as outlined in the teaching programme.

4.7.6 Planning in context

Data also showed that teachers had the freedom to alter learning outcomes and contextualise them for the context of learning environment or to be in line with major events in the community. For example, Betty, Bex and Bobby based their planning on the learning outcome on the MAL syllabus learning outcomes; however, they altered the suggested activities and contextualised them by using a major event in their community. This event was the Papua New Guinea National Election (2007) which was to be held in July, 2002. This contextualized planning is shown in Table 4.10.

Table 4.10
Examples of contextualised planning

	<i>Suggested Learning Activities</i>	<i>Altered Learning Activities</i>
Bex	6.1.2 Investigate social elements friendships, community groups, family, school and clans. (DoE, 2003, p.15)	Carry out a survey in your family, extended family and clan, and count the number of people eligible for voting in the national election (2002).
Bobby	7.1.2 Investigate increase in the number of population and increase in food consumption (DoE, 2003, p.15)	Carry out awareness on the new preferential voting system to be used in the coming election.
Betty	8.1.2 Identify economic, cultural and ecological value associated with natural, built and social environment (DoE, 2003, p.15)	Invite a district administrator to give a talk on the election process to the school and the community

Bex altered and contextualized the suggested the learning activity in learning outcome 6.1.2. “Investigate social elements friendships, community groups, family, school and clans” (DoE, 2003, p.15) to “carry out a survey in your family, extended family and clan, and count the number of people eligible for voting in the national election” (2002). Bobby altered and contextualized the suggested activity in learning outcome, 7.1.2 “Investigate increase in the number of population and increase in food consumption” (DoE, 2003, p.15) to “carry out awareness on the new preferential

voting system to be used in the coming election.” And Betty altered and contextualized the suggested activity in learning outcome, 8.1.2. “Identify economic, cultural and ecological value associated with natural, built and social environment” (DoE, 2003 p.15). These teachers did not stick to the textbook; they were flexible in their planning. Betty’s planning also reflected community involvement in teaching technology.

4.7.7 Summary of document analysis and teachers’ planning.

Three kinds of documents were analysed: the MAL syllabus, teachers’ support materials and teachers’ planning programmes. All six teachers used the technology curriculum to assist with planning school teaching programmes. However, individual teachers were flexible in planning various different activities to achieve the learning outcomes. All the teachers adopted a theme approach in planning teaching programmes. It was evident from the teachers’ plans that all teachers adopted a detailed lesson plan, outlining a clear lesson sequence with a good follow up from the previous lesson. Assessment was planned along with the teaching and learning activities and was an on-going process. Integrated teaching in technology was encouraged through thematic and project-based approaches. Both methods in integrated planning in technology enhanced integration of technology with other learning areas. Teachers had the freedom to alter and contextualize teaching in teaching technology. All the teaching plans identified were adapted from the support materials. It can be seen that teachers relied heavily on the support materials for planning and teaching technology.

4.8 Summary and Relevance to the Study

This chapter has presented a description of the research findings and the data analysis based on the research using the research methodology established in Chapter Three. The following data have been established in this chapter: teachers’ perceptions of technology, teachers’ perceptions of technology education, factors influencing teachers’ perceptions of technology and technology education and their practices, and teacher professional development, specific investigation of the impacts of the new technology curriculum materials on teachers’ perceptions and practices and the role of the new technology curriculum material in teacher professional development

programmes. These data revealed that technology as consisting of artefacts was the most predominant view of technology, with fewer teachers perceiving technology as practical skill-related activities, technology as everyday activities, technology as knowledge and the least held view was technology as processes.

The view of technology as artefacts was also reflected in the teachers' perceptions of technology education. Four of the six teachers interviewed perceived technology education to be teaching the knowledge to enable the use of technological modern artefacts, three teachers perceived technology education as development of life-long skills and knowledge while another three teachers perceived technology education as learning about practical activities. Two teachers considered technology education to be development of technological knowledge leading towards technological literacy.

The factors influencing the primary teachers' perceptions of technology appeared to be subject sub-cultures, past school experiences, previous hands-on experiences from work or outside personal interests and personally owned technological products. The most dominant factor influencing the teachers' perceptions of technology was subject sub-cultures.

There had been very little professional development in technology education since its implementation, technology support materials were used instead. These new curriculum materials were developed and used as a substitute for a professional development programme. The data on teachers' views on the support materials revealed that the support curriculum materials appeared to support outcome-based learning; support teachers' lesson planning; promote subject integration; support pedagogical content knowledge; promote gender equity; and encourage students' independent learning.

The technology support materials on teachers' perceptions of technology and technology education influenced their classroom practices in the following ways; change of teachers' perceptions, broadening technological understanding, change in methods of teaching, encouragement of outside community involvement, and enhancement of teachers' confidence in teaching technology to students.

The examination of teachers' planning documents indicated there were commonalities in all their plans. This could be due to the strong influence of the support materials on which the teachers noted that all their planning was based. All teachers used an integrated approach in teaching technology.

The next chapter is a discussion of the research findings

Discussion and Conclusions

5.1 Introduction

This chapter discusses the findings of the research based on the role of technology support materials in teacher professional development. The impact of the support materials on primary teachers' perceptions of technology and technology education and their practices are discussed. The discussion is focused on the research questions presented in Chapter Three, and links the research findings with the literature review in Chapter Two. The various views held by the Papua New Guinean primary teachers in this study are compared with views of technology and technology education promoted in the MAL syllabus and the support materials and the views discussed in the literature. The discussion also explores the factors influencing the participant teachers' perceptions of technology and technology education and their pedagogical practices. The teachers' views on the support materials and how these materials have impacted on their views of technology and their practices are discussed. The use of these materials as a support for professional development in Papua New Guinea is discussed.

The discussion supports the idea that when technology teachers, who have had little professional development, engage with support materials that focus on the essential elements of technology and technology education, there is an impact on their perceptions and practices. Perceptions and practices change to be more aligned with those advocated in the support materials. When those support materials are closely aligned with the technology curriculum, teachers also interpret the curriculum in that light.

Section 5.2 discusses the views held by the participant teachers on technology and technology education in relation to the international literature and the views of technology and technology education being promoted in the MAL syllabus and the support materials. Section 5.2.1 discusses the perceptions held the study teachers, followed by their perceptions of technology education in section 5.2.2. Summary of teachers' perceptions of technology and technology education is discussed in section 5.2.3.

Section 5.3 presents an analysis of teachers' views on the technology support materials. Section 5.4 presents discussion on impacts of support materials on teachers' perceptions of technology and technology education and their pedagogical practices. Section 5.4.1 discusses the impacts of support materials on teachers' perceptions and practices, followed by discussion on other factors influencing teachers' perceptions of technology and technology are discussed in section 5.4.2. Section 5.4.3 presents the summary of the section.

Section 5.5 presents discussion on the role of the technology curriculum materials as a support for professional development and Section 5.6 presents the implications for Papua New Guinea primary school technology teachers and the further development of technology materials for teachers' technology in Papua New Guinea

5.2 Perceptions of technology and technology education

This section focuses on the research question:

What are the teachers' perceptions of technology and technology education of the primary teachers in this study?

The research findings reported in Chapter 4 revealed that the teachers in this study held a variety of views of technology and technology education. Their understanding of technology and technology education was influenced by the use of support materials and the teachers' views of technology and technology education were aligned with the views of technology and technology education that were promoted in technology curriculum materials in Papua New Guinea.

5.2.1 Perceptions of technology

Technology as artefacts

The findings related to the participant teachers' perceptions of technology revealed that technology as artefacts was the most dominant view held by them. Five out of the six teachers considered technology to be related to artefacts. This is a common perception held by teachers reported in several studies (Mitcham, 1994; Denvore, 1980; Wright, 1996) where teachers viewed technology as artefacts or hardware. The participant teachers who considered technology as artefacts, referred to new modern and foreign artefacts of foreign or western origin. For example, the teachers talked

about computers, fax machines, TVs and telephones. The MAL syllabus and the support materials include information about these modern artefacts and how to use them (*MAL Student Textbook 1*, 2005, pp. 94–96). This matches Symington’s (1987) findings about primary teachers’ ideas of technology where technology is linked with sophisticated artefacts such as machinery, computers, lasers, kidney transplants and so forth. As Papua New Guinea is a developing country, most of the modern technologies come from overseas. Therefore, it is perhaps not surprising that the participants also perceived such technologies to be foreign in origin. Modern technologies were generally seen by the participant teachers to be ‘more powerful’ than the local technologies and better at improving the lifestyle of Papua New Guinean people. However, a few of the participants identified a number of adverse impacts associated with modern technologies, particularly, the impact on the natural environment through modern industries. The participants saw that this affected their livelihoods. For example, they mentioned logging using machinery which causes massive destruction to natural forests and harmful waste disposal from mining industries into rivers and streams that poisoned all the fish. The teachers in this study believed that developing technological knowledge will help people to make informed decisions about the impacts of modern technologies on their lives and their environment.

Technology as knowledge

The teachers also perceived that technological knowledge was a means for coping with the technological changes that are taking place. Layton (1988) states that concern over the control of technology has been one of the strongest motivations for an increased effort to understand technology. The support materials also advocate community awareness to inform the people about these harmful impacts. Almost half of the Papua New Guinea’s population is illiterate and lacks technological knowledge about the modern technology and the potential to impact detrimentally on their lives. The primary teachers in this study were concerned about the impacts of modern technology on their lives and their natural environment. They believed that teaching students to be knowledgeable about the modern technologies would help them to make informed decisions. Likewise, Rasinen’s (2003) study advocates the need to prepare students to live in a rapidly changing technological world. Daker (2005) adds that a technologically literate person understands the relationship between technology

and society and will participate actively in controlling technological decision-making. The teachers in this study emphasised the need to be technologically literate to make informed decisions over the impact of technologies.

The technology support materials are very educative on the detrimental impacts of the modern technologies and promote an emphasis on sustainable practices. One such method for sustainable practice in utilising the natural environment is through the use of traditional technologies and methods of carrying out activities. While some participants in the study argued that traditional technologies were old and slow, the detrimental impacts of traditional technologies on the environment were seen to have a lesser impact compared to those of modern technologies. The teachers in this study also said that their previous views of technology as modern artefacts had changed to seeing technology involving both modern and traditional artefacts. The teachers regarded hands-on traditional skills-related activities such as gardening, fishing and carving as having a similar status to that of modern technical skills. Traditional technical skills are involved in daily practical activities carried out in both rural and urban communities in Papua New Guinea for survival. Their concepts of practical skills-related activities encompassed both modern and traditional processes for carrying out activities. These views of technology as artefacts, practical skills-related activities, everyday activities, processes and knowledge are promoted and fostered in the support materials. The teachers' use of the support material assisted them to build their views of technology as modern and traditional artefacts, of technology as having an impact on lives and the environment, and of technology as practical and everyday skills.

Technology as practical skills-related activities

Cluster (1995) explains that technological processes represent arenas of activity generally focused around technological activities. The idea of practical skills-related activities was born from the Papua New Guinean teachers' idea of vocational skills and technical aspects of technology. The technical trades, such as carpentry, mechanics and other hands-on practical activities, such as carving and painting were regarded as technological activities. The teachers related the practical skills-related activities that they had performed in their past school experiences in high school practical subjects such as Home Economics, Agriculture, Practical Skills. Practical

activities such as cooking, sewing, woodwork, metal work and handicraft making learnt in high school practical subjects were viewed as technological activities.

Technological activity involved both the modern and traditional practical activities using both modern and traditional tools. It is noteworthy that, traditional hands-on skill-related activities such as gardening, fishing, and carving were regarded as traditional technical skills had a similar status to that of modern technical skills, because such traditional technical skills were involved in daily practical activities that were carried out in the rural communities in Papua New Guinea for survival. The concept of practical skills-related activities encompassed in both modern and traditional processes of carrying out practical activities.

5.2.2 Perceptions of technology education

The various views of technology held by primary teachers in this study were reflected in their views of technology education. The teachers' views of technology education were technology education as knowledge of modern artefacts, technology education as the development of life-long skills and knowledge, technology education as learning about practical activities and technology education as development of technological knowledge. These views are discussed in order from the most dominant to the least perception held by teachers. These views are also fostered in the support materials.

Technology education as learning about modern artefacts

The findings show that the most dominant held view of teachers about technology education was that it should be about the learning about modern artefacts. This perception was consistent with their dominant view of technology as modern artefacts. The teachers talked about the need for students to learn about modern artefacts and how to use them. This is similar to Jones and Carr's (1992) finding that many New Zealand primary teachers saw technology education in terms of computers, the use of computers and other technologies to solve problems. Symington (1987) also found that teachers saw technology education as finding out how things work and about other modern and sophisticated hardware, like lasers, and other technological processes like kidney transplants. In this study, the teachers

regarded modern artefacts as foreign products made from overseas, having no origin in Papua New Guinea. Because of this they felt that it was important for students to be taught about these technological devices in technology education. The teachers talked about being knowledgeable about modern artefacts as a way of coping with the technologically changing world. They were concerned about the impact of modern technologies and devices on their lives. The teachers expressed the idea that if technology education focused on developing technological literacy in students, it would help them to make informed decisions in their lives. Similarly, Rasiński's (2003) study advocates the need to prepare students to live in a rapidly changing technological world. Papua New Guinea society consists of both traditional and modern technologies, and both are useful in rural and urban areas. The primary teachers in this study saw that technology education could help students learn about both local and modern technologies that exist in Papua New Guinea. The teachers talked about contextualising technology education to suit the Papua New Guinean context, they would teach about technologies and technological activities by using examples that were culturally appropriate, relevant and applicable to their settings. This is similar to Hennessy (1993) who stated that technological activities undertaken within cultural contexts and contextual approaches enhance appropriateness and relevance to a particular society. The emphasis of developing skills and knowledge that suit Papua New Guinean context is strongly advocated in the MAL syllabus and the support materials. The support materials recommended ways to foster the emphasis on contextualising technology to suit Papua New Guinean context, and this can be done through the involvement of local resource people, community based projects and the use of local skills and technologies. The support materials also recommend various teaching and learning strategies to enhance student learning, such as the use of real life experiences. Contextualised learning experiences in the support materials include students and teachers participating in community projects, field trips to local towns and markets, visiting local farms and industries, and networking with local communities and non-government organizations (*MAL Student Textbooks 1&2*, 2005).

Technology education as the development of life-long skills and knowledge

The teachers in this study viewed technology education as a learning area where students can develop life-long skills and knowledge. They believed that the development of life-long skills and knowledge is important in preparing students for their lives after school. In Papua New Guinea, primary universal education ends at Grade 8. Students who perform well academically further their education in high schools. However, large numbers of students either go to the few vocational schools, or go back to their local communities. Therefore, the aim for technology education in the primary school is to develop basic life-long skills and knowledge for students to use after school. One MAL syllabus goal is to foster the development of life-long skills and knowledge that students will use to make a living in their adulthood in their communities (DoE, 1996). This aim is promoted through the Better Living strand and is also reflected in other strands in MAL syllabus. The support materials promote the MAL syllabus goal of life-long skills and knowledge development. For example, they include step-by-step guides for undertaking technological activities, and they provide clear illustrations and demonstrations on how to use machines and tools.

The teachers believed that through the development of life-long skills and knowledge in technology they could help students to become more self-reliant. The idea of developing students to become self-reliant using the skills and knowledge learnt in technology education is also promoted in the support materials. The Papua New Guinean government and business cannot provide formal jobs for the increasing number of students completing schooling. Therefore, one of the ways the government is addressing the increasing unemployment problem was to reform the education system so that it is relevant to the Papua New Guinean context to help students to make their living and become more self-reliant. For example, self-reliance is described in the support materials as “becoming independent, supporting themselves and developing pride in doing things for themselves” (*MAL Students Textbook 2*, 2005, p. 181). The teachers also suggested that the development of life-long skills includes both traditional and modern skills and knowledge which will be useful for making a living in any community students chose to live in – either rural or urban. This view is demonstrated in the support materials through a wide range of suggested student activities utilising the local context resource available schools.

Technology education as learning about practical activities

The emphasis in the MAL syllabus and support materials on the development of life-long skills and knowledge has led the primary teachers in this study to view technology education as learning about practical activities, especially hands-on practical activities. They talked about technology education in terms of learning to do things by hand, practical and manual education, and learning about trade skills like making furniture, cooking and sewing. This view reflects their view that technology education is a learning area suitable for the development of technical skills. The teachers also expressed their view that technical skills were crucial for the development of Papua New Guinea. Papua New Guinea has vast natural resources that need to be developed. Therefore, the teachers talked about developing practical and technical skills so students could utilize them for the development their natural resources. The support materials also promoted the learning of practical activities through sustainable practice. For example, the Land and Water Management strand in the support materials strongly fosters the idea of sustainable practices. The teachers discussed the need for students to be involved with authentic activities such as gardening, fishing, raising livestock and other daily activities. This view promotes technology education as the learning of everyday activities based on technological practices and technological problem-solving. The support materials recommended problem-solving as a means to carry out technological processes and activities (Johnson, 1997; Moreland, 1998; Sharpe, 1996). A problem-solving approach in teaching technology helps students and teachers to develop critical and analytical thinking in decision-making (*MAL Teacher's Guide*, 2003). Problem-solving in technology teaching also fosters students' practical and theoretical knowledge.

Technology education as development of technological knowledge

The primary teachers in this study also viewed technology education as the development of technological knowledge. They raised concerns about the detrimental effects of modern technologies on their natural environment which many livelihoods depend on. This is similar to Layton's (1993) finding that concern over the control of technology has been one of the strongest motivations for an increased effort to understand technology. The primary teachers believed that developing technological knowledge in students will help them to make informed decisions about their lives

and their environment. This view is also reflected in Rasinen's (2003) suggestion that technologically literate people make rational and justified choices and become contributing members of society once they leave school. Papua New Guinea's technology education is focused on developing students as technologically literate. These teachers reflected this notion when they spoke of the importance of developing technological literacy (ITEA, 2000).

5.2.3 Summary

The primary teachers in this study held a wide range of views of technology and technology education. These views reflect technology as a broad multi-faceted concept (Petrina, 1998). The teachers viewed technology education as having the potential to develop technologically literate students capable of living satisfactory lives in either urban or rural communities and able to contribute to those communities. All views teachers held about technology and technology education are promoted and demonstrated in the MAL syllabus and the support materials. It is evident that the use of the support materials had a large influence on the study teachers' perceptions of technology and technology education.

5.3 Teachers views on Papua New Guinea's teachers' support materials.

This section focuses on the question:

How do the technology support materials influence the teachers' classroom practice in teaching technology education in Papua New Guinea?

Technology was introduced into Papua New Guinea primary schools in 1996 and implemented at the upper primary level. To help with the successful introduction of technology in classrooms, support materials were published and distributed to all primary schools. There were six publications; these were the MAL syllabus, a teacher guide, a teacher resource book, two student textbooks, and five student resource books. The descriptions of the publications are presented in section 1.6. These publications were sent to schools to be used as support materials for the teaching of the MAL syllabus.

The findings show that all the teachers in this study spoke highly of the support materials as being educative and supportive in their learning of technological concepts and in their pedagogical practices. In other words, these materials helped the teachers in their learning and teaching of technology. The participant teachers said that through the use of these materials, their understanding of technology was broadened (Ball & Cohen, 1996; Davis & Krajcik, 2005). The teachers' views are discussed under the following categories: support for outcome-based learning, support for lesson planning, encouraging subject integration, integrated teaching programmes, developing pedagogical content knowledge, promoting gender equity and encouraging student's independent learning.

Support for outcomes-based learning

The primary teachers in the study all said that the support materials supported the idea of outcomes-based learning. The Papua New Guinea national curriculum was changed from a subject-based curriculum to an outcomes-based curriculum under education reform (DoE, 1996). (See note on curriculum reform in section 1.2). The outcomes-based curriculum identified knowledge, skills, attitude and values that all students should achieve or demonstrate at a particular grade in a particular subject. (See section 1.3.3 on Outcome-Based Curriculum in Papua New Guinea). The primary teachers in this study said that outcomes-based learning was a new concept and they had difficulty in understanding the concept and how to plan and teach with an outcomes-based curriculum. They admitted that only when the support materials were distributed to their schools and when they started using the materials, did the concept of outcome-based learning become clearer to them. The teachers said that the technology support materials helped to clarify the concepts they did not understand. This view is in line with Putnam and Borko's (2000) view that educative curriculum materials serve as a cognitive tool for teachers' learning. The primary teachers in this study said that the support materials helped them to understand the idea of outcomes-based learning and they were useful for planning and teaching an outcomes-based teaching programme. The outcomes-based learning describes specifically what students need to know and will be able to do in each strand and grade. Flexibility in planning and teaching of technology is also promoted. This enabled teachers to write units of work and teaching programmes suitable for local conditions, available resources and individual student needs (DoE, 2003). Flexibility in planning enabled

teachers to alter learning outcomes to suit the context in which the technology was being taught. For example, teachers in School B altered the learning outcomes written in the MAL strand to formulate their own learning outcomes related to a coming national event in the country – the national general election. The learning outcomes were organised according to the strands and sub-strands for each grade level. This makes it easier for teachers to plan and revise future technology teaching programmes. Outcomes-based learning was a move away from the former subject-based learning. Outcomes-based learning promotes a wide range of broader achievement goals for students' achievement rather than specific learning objectives with a lesson. For example, the strands in the MAL syllabus consist of wide range of learning outcomes for students through a wide range of various activities.

Support for lesson planning

The primary teachers in this study talked about support materials helping them in their lesson planning. This is in line with Remillard's (2005) suggestion that curriculum materials such as the syllabus, teacher's guide and students' textbook provide instructional guides for teachers in their lesson preparation and teaching. The teachers described two kinds of lesson planning. First, a more text-bound lesson planning where they planned lessons in accordance with the learning outcomes, or objectives, and adopted activities to achieve learning outcomes suggested in the textbooks. This kind of planning was closely aligned to the text guidelines. For example, teachers strictly follow the learning outcomes and units of works set out in the textbook. There is no flexibility in teachers' planning, they stick by the textbook. For example, Betty's teaching plan (See lesson plan in Table 4.5) was a straight copy of the teaching programme suggested in the teacher guide (*MAL Teacher's Guide*, 2003, p.70).

The second kind of lesson planning used in the study was where the teachers used learning outcomes in the textbook, or syllabus, but altered, or contextualised, their learning activities to achieve the learning outcomes stated in the text (See Table 4.10). This kind of planning was more flexible and innovative. The first kind, in comparison, was where teachers copied from the textbooks and aimed at completing the units exactly as written in the textbooks. The two kinds of planning reflect teachers' knowledge about teaching technology. Teachers who were more knowledgeable about the subject were more flexible in their planning and teaching, when compared to the

teachers, who were either new to the subject, or lacking knowledge of the subject matter, who did not adapt the support materials in any way.

Encouraging subject integration

The primary teachers in this study believed that the support materials help them to see links to other subjects. They integrated learning outcomes from other subjects such as English, Mathematics, Science, Social Science and Arts with Technology through a thematic planning approach. The teachers identified themes such as those mentioned in the support materials or local events. They linked relevant learning outcomes to the themes, and then they developed these learning outcomes into teaching programmes. (See section 4.7.5 for an integrated plan and a sample integrated teaching programme in Tables 4.8 & 4.9). The teachers said that unifying ideas from other subject areas with technology helped them to broaden their understanding of technology from wider perspectives. As Petrina (1998) stated, technology is a multifaceted concept and a multi-dimensional approach to technology education may enhance broader understanding of technology. The teachers also said that an integrated approach helped them realize that technology is present in all subjects that their teaching linked well from one subject to the other, and that provided this link from previous lessons to present lessons.

Integrated teaching programme

The participant teachers indicated that they had developed their teaching plans using a thematic approach. (See section 4.7.5 on the thematic planning approach). The teachers believed that their thematic approach promoted integrated teaching. They said that integrated teaching broadened their understandings of technology from different perspectives. The teachers employed two ways of integrated planning. The first method was developing a teaching plan using themes and the second method was practical project based planning (Both methods of integrated planning have been described in section 4.7.5). In the themes approach, the teachers clustered all the learning outcomes from other subjects which were relevant to the learning outcome in technology and developed a teaching plan. This shows unifying of ideas from other learning areas with technology. (See sample of themes approach planning in Tables 4.7 & 4.8). A themes approach in planning fosters a coherent flow of ideas from one subject to another. The teachers in this study said that the themes approach helps them

to see technology being present in other subjects and then technological knowledge can be shared and integrated in other learning areas.

The other method in planning is the project based approach. (See a sample of a project based plan in Table 4.9). In this approach, the teachers design a practical project to be undertaken in a term and develop practical and theoretical lessons based on the projects. The teachers in this study said that the project based approach in planning helps them to combine both the practical and theoretical aspects of technology. In other words, both the technological skills and knowledge were encouraged in teaching technology. The support materials demonstrated these two integrated teaching approaches (*MAL Teacher's Guide*, 2003. pp. 45, 58). The teachers believed that they had broadened their knowledge of technology through their integrated teaching programmes. An integrated teaching programme reflects the notion that technology education needs to adopt a multi-dimensional approach in all areas such as planning, teaching and even talking about technology (Petrina, 1998; Jones, 1997).

Developing pedagogical content knowledge

The primary teachers in this study believed that the support materials helped them to better understand technology, as well as how to teach it to students. Schneider and Krajcik (2002) found that educative curriculum materials could be an additional support for teachers' pedagogical content knowledge. The teachers in this study talked about how the support materials showed them possible links with other subjects. (See an example of links in learning outcomes from other subjects with technology in Tables 4.8 & 4.9). They felt that integrating ideas from other subjects promoted flexibility and confidence in their teaching. They also talked about the support materials suggesting a wide range of teaching strategies that teachers may use in teaching technology. For example, on pages 59 to 66 of *MAL Teachers Guide*, it recommended a wide range of teaching and learning strategies that teachers could employ in their teaching in technology. The teaching strategies recommendations include brainstorming, problem-solving, demonstrations, setting group work, taking field trips, engaging in discussions, taking part in community-based projects, presenting seminars, promoting networking and involving local expertise in teaching technology. These teaching strategies were evident in the teachers' teaching plans. (See for examples of these strategies promoted in teachers plans in Tables 4.8 & 4.9).

The teachers believed that the uses of these strategies in their planning and teaching technology have broadened their understanding of technology and their pedagogical practices in classrooms.

Promoting gender equity

All the participants agreed that the support materials promoted gender equity. In the Papua New Guinea education system, this means that both boys and girls have equal rights to education and equal participation in activities (DoE, 1986). In technology this is promoted as a move away from the former system that restricted boys and girls to separate areas such as Home economics for girls and Practical Skills for boys. The support materials suggest activities that include both boys and girls. The teachers also mentioned that Papua New Guinea's former trend of men only jobs and women only jobs is changing and many Papua New Guinean women were trained to do jobs previously reserved for men only and also men were trained to do jobs reserved for women only. The teachers said that they supported gender equity through engaging all students in all lessons and activities in MAL. One way they encouraged gender equity was through setting group activities where boys and girls worked collaboratively, assisting each other.

Encouraging independent learning

Only one of the primary teachers identified how the support materials supported independent learning. Betty made a specific reference to student textbooks and resource books, where step-by-step guidelines are provided for how to make something. She mentioned that student textbooks contained very informative content notes and step-by-step practical activities that students can do without much teacher assistance. She made reference to the student textbooks' activity section that has the 'For You to Try' activities. These provide suggestions of useful practical activities students can do at home on their own. She believed that these activities helped students to be creative and innovative and helped them to explore their natural talents, creativity and make some things on their own.

In summary, the findings show that the teacher did not only use the support material as an instructional guide. These support materials played various roles. They felt that the support materials had broadened their knowledge about technology. They had

enhanced their pedagogical practices in their classrooms through the teaching and learning strategies recommended. The support materials were seen to be very educational and at the same time they guided teachers in their technology teaching. The teachers perceived the support materials promoted outcomes-based learning. The learning outcomes make explicit the broad objectives to be achieved at the completion of each strand. The support materials also promoted gender equity through suggestions of group activities that involve both male and female students. The involvements of both male and female students in same activities encourage students to work collaboratively. The support materials demonstrated methods for planning and teaching. Teaching strategies to be used by teachers for teaching technology successfully were shown in them. The support materials strongly recommended integrated planning and teaching in technology. Integrated approach in teaching enhanced unifying ideas from different learning areas. This broadened teachers' technological knowledge and practices.

5.4 Factors influencing Primary Teachers' Perceptions of Technology and Technology Education.

This section focuses on the research question:

What effect and influence did the technology support materials have on teachers' concepts of technology and technology education?

This thesis focused on the role of the support materials in teacher development. Therefore, the impacts of the technology support materials on technology will be discussed in this section. This also includes other factors influencing teachers' perceptions of technology and technology education. These impacts of technology support materials in the first section and other influencing factors will be discussed in the second section.

5.4.1 Impact of the technology support materials on teachers' perceptions of technology and technology education.

Data revealed that the technology MAL syllabus support materials impacted on teachers' perceptions of technology and technology education. The support materials were developed at least seven years ago after the MAL syllabus was introduced to

primary schools in Papua New Guinea in 1996. The support material teacher guide was published in 2003 and other support materials were published and distributed to schools in 2005, 2006 and 2007. Over time, the teachers' perceptions of technology and technology education changed as new publications were distributed. There were changes in their practices in their classrooms. They concluded that the support materials had changed their perceptions, broadened their technological understanding, changed their pedagogical practices in technology education, and enhanced their confidence to teach technology.

Change of perceptions

The findings showed primary teachers changed their views of technology and technology education when the support materials were distributed to them and when they started using these support materials. The primary teachers said that their view of technology as modern artefacts and technology education as a learning area for learning about modern artefacts had changed to seeing technology as artefacts including both the traditional and modern artefacts. Likewise, their perception of technology education as a learning area to develop skills and knowledge in using modern artefacts had changed to include the learning of both the traditional and modern artefacts to make something. Papua New Guinea society consists of both traditional and modern materials, and both are useful in rural and urban areas. The teachers in this study believed that technology education should include learning about both local and modern technologies that exist in society. The teachers included both kinds of technologies in technology education. The danger of teaching students only about modern artefacts would mean that technology education would be focusing on preparing students for a more urban society rather than a rural society where the majority of students would make their living when they finished school. The participant teachers also talked about their changes of perceptions from seeing technology education as the learning of practical skills only, to seeing technology education as learning practical activities and theoretical knowledge. The teachers former view of seeing technological knowledge of the 'know how to do it' (procedural knowledge) to use modern artefacts has changed to also including the 'Know why' knowledge (McCormick, 1997).

Broadened technological understanding

The findings show that these Papua New Guinean primary teachers' understanding of technology and technology technological concepts had broadened, as they came to use the support materials in their planning and teaching. For example, Bobby commented that his understanding of technology had broadened when he started reading through the new technology curriculum materials, and using the materials in his daily teaching planning and teaching. Bobby's learning experience through his daily practices reflects Putnam and Borko's (2000) suggestion that teachers' learning is situated in their daily practices. In other words, the teachers learnt more about technology while teaching technology.

One of the ways in which the teachers said that their knowledge base was broadened was through planning and teaching technology through an integrated approach. The support materials – *Teacher's Guide* and *Student Textbooks* - show links with other subjects. These links in the texts helped teachers to use integrated planning and teaching as a method to teach technology. The teachers said that the integrated approach (they referred to this as a thematic approach in planning) helped them to integrate technology with other learning areas and relate and understand technology from a wide range of perspectives.

The primary teachers new to technology and those untrained as technology teachers had difficulties in understanding technology and difficulties in teaching until the support materials were made available to them. Antonia is an example of an untrained technology and new to teaching technology. She graduated from pre-service training college long before the technology course was offered in pre-service college. She had difficulty teaching the technology subject until the support materials came to her aid. She strongly believed that the support materials were a major source of knowledge for her teaching in technology. Andrew said that the support materials helped broaden his understanding of technology. Those teachers trained to teach technology also acknowledge their changes. The research by Ball and Cohen (1996) into teachers' learning suggests that curriculum materials are a support in teachers' learning. All the participants in this study commented that the technology support materials had helped them to develop their knowledge base in technology.

Enhanced teachers' confidence to teach technology

All the participating primary teachers in this study agreed that the support materials have enhanced their confidence in teaching. The support materials enhanced teachers' confidence in teaching technology through their representations of content and pedagogical instructional guidelines (Remillard, 2005). The support materials define and explain technological concepts teachers need to know – content knowledge. The support materials explain the aims and focus of the strands, sub-strands, and the learning outcomes and show the links between technology and other subjects. The support materials suggest activities and recommend teaching methods. All these provided a direction and guidance for teachers to teach technology with confidence. The primary teachers in this study had some knowledge about technology, but were lacking knowledge and confidence in teaching it. When the support materials were made available to them, they began using the recommended teaching and learning strategies and methods. The suggested strategies in the support materials gave the teachers confidence to teach their lessons. They had materials they could draw on to help them implement technology in their classrooms.

Change in technological pedagogical practices

The teachers in this study talked about how the support materials had changed their ways or methods of teaching. They began to see themselves playing more of a facilitator's role in their students' learning, rather than being a teacher dominating the lessons. They talked about changing teaching techniques from being teacher-centred lessons to more student-centred approaches. They talked about setting more group activities than individual tasks. They said that group activities fostered collaborative interaction among students, with students sharing knowledge and assisting each other in learning. The teachers also talked about teaching technology in context and learning technology in real-life experiences. This helped them to provide purposeful and meaningful learning experiences for students. For example, the teachers talked of going out from the classroom and exposing students in real-life activities through field trips and excursions. They engaged their students in community-based activities and projects where they could have first-hand experiences. This kind of learning is referred to as experiential learning (DoE, 2003), where students learn new knowledge as they practise the skills in a real-life experience. The former teacher and chalkboard

focussed learning changed to being more student-centred and to a more collaborative approach.

The findings revealed that the support materials had impacted on the teachers' perceptions of technology and technology education and their technological pedagogical practices. It became evident that the teachers were beginning to develop a broader understanding of technology through their use of the support materials. The teachers were able to choose technological tasks from particular technological areas that were appropriate for their students. They were able to help students learn the positive and negative impacts of technology on their lives and their environment. They were able to teach technology with more confidence and were more effective in using the teaching and learning strategies and teaching methods recommended in the support materials. All these positive changes gradually took place as the teachers used these support materials over time. As the teachers continued to use the support materials they begin to discover other aspects of technology they had not known previously. For example, Betty said that studying the impact of harmful wastes from industries she had regarded as being Social Science knowledge, but she now realised that that it was also technology knowledge.

The teachers in this study talked about developing broader knowledge of technology and technological pedagogical practices. They did not talk about all technological aspects of technology that are promoted in the support materials. (See document analysis section in Chapter Four). Although, the support materials promoted technology as problem-solving and design, the teachers did not view these aspects as intrinsic to technology. Although the support materials promote these views of technology, teachers in this study may not realise all these aspects nor do they teach them to the students. The teachers' past experiences and other factors also impacted on their views of technology. These other factors are discussed in the next section.

5.4.2 Other factors influencing teachers' perceptions of technology and Technology Education

In the study, teachers' past experiences were investigated to explore whether these might have influenced their perceptions of technology and technology education. Jones and Carr (1992) found that teachers' past experiences influence perceptions of

technology education. The findings in this study are similar to these findings. The primary teachers commented that in and outside school experiences influenced their perceptions of technology and technology education.

The influence of past school experiences

Lindblad (1990) found that primary school teachers formulated technology classroom experiences based on their past experiences. Similarly, the primary teachers in this study reflected on subjects that they had experienced as learners of the subjects during their past schooling. They commented on their practical experiences in high school such as Agriculture, Practical Skills, Home Economics and Arts and Crafts. These practical subjects were offered in high schools in Papua New Guinea as enrichment subjects and they focused on providing technical skills involving the use of machines and tools. The teachers recalled these past high school practical experiences and considered these to be technological skills and knowledge and part of technology education.

Influence of previous hands-on experiences

In addition to the practical experiences primary teachers had in their school days, they also talked about other practical hands-on experiences they had from outside school that had influenced their perceptions of technology education. Most of these hands-on experiences were related to their own personal experiences in their own traditional societies. These were traditional practical skills learnt from their parents and local experts, such as gardening, fishing, carving and other traditional activities. Jones and Carr (1992) stated that teachers' perceptions of technology education were influenced by life experiences. The teachers in this study said that they felt more confident teaching students about their own prior hands-on experiences than teaching them about something new. These teachers also emphasised the importance of passing local skills and knowledge to the students. For example, local experts from the community at large were invited by the teachers to teach some the traditional technologies in Papua New Guinea.

Influence of subject sub-cultures.

The MAL syllabus integrated the Agriculture, Community Studies (Social Science) and Personal Development subjects. The teachers in this study believed that a form of technology education had been taught in primary school through the separate subjects of Agriculture, Community Studies and Personal Development. The participant teachers brought those experiences to their teaching of the new MAL syllabus. At times they said that they taught more from the previous subjects than the new MAL syllabus. At the time of this study, the teachers appeared to be still using ideas from the original three subjects within the MAL syllabus. It appears that more time and professional development is required to help teachers move entirely to the MAL syllabus. Teachers' subject backgrounds had a direct influence on the way they structured lessons and developed classroom strategies to teach technological concepts and processes. This is similar to Jones' (1996) finding that when teachers enter areas of uncertainty (new subject) they often reverted to their traditional teaching approaches and learning outcomes.

The influence of personally owned technology products

The data also shows that the teachers' perceptions were influenced by personally owned technology products. The excitement of owning new technology products had impacted on their perceptions. The teachers talked about their experiences with these technology products and how the technologies they owned improved their quality of life and made their lives easier. The study shows that teachers' easy access to modern technological products also contributed to the factors influencing their views of technology, especially the suburban school teachers. They considered technology education to be learning about modern technologies and how to use them.

5.4.3 Summary

While the support materials had influenced the teachers' perceptions of technology and technology, there were other influential factors. These were past school experiences, subject sub-cultures, hands-on experiences and personally owned technology products. Support materials aimed at changing teachers' views only do so against other existing backdrops. For example, those teachers who have a technical training background may shift their views to this background. Those teachers with no technology training have other experiences and skills that will influence how they

respond to the support materials. The participant teachers' past skills, experiences, their previous hands-on experiences and their personal ownership of hi-tech artefacts influenced how they responded to the support materials and the syllabus. For example, teachers who considered technology as practical activities referred to their past hands-on experiences and viewed technology as craft (Black, 1994). This influenced their emphasis on task descriptions and development of technical skills. This is in line with Lindblad's (1990) finding in Sweden that primary school teachers develop classroom experiences based on their past experiences. Those teachers who considered technology as modern artefacts and technology education as learning about modern artefacts may have been influenced by their personally owned hi-tech technologies. This indicates that teachers' existing concepts of technology and technology education have impacted on their technological practice, including concepts of technological knowledge and processes (Jones, 1996).

5.5 Support Materials and Teacher Professional Development

Teacher professional development is an on-going process and needs on-going support (Bell & Gilbert, 1994). In Papua New Guinea, there was no technology teacher professional development. Instead, technology support materials were developed as a substitute for professional development. According to Ball and Cohen (1996), curriculum materials can serve as a major support in on-going teacher professional development (See also Cohen, 2000). In this study, where the primary teachers lacked professional development and were challenged with difficulties in implementing technology, the support materials were a support to them for implementing technology in their schools. Data in this study demonstrates that the support materials were very beneficial to teachers during the implementation of technology education. The role of the support materials is discussed under two themes, as a source of knowledge and as a substitute for professional development.

A source of knowledge

Data show that the participant primary teachers agreed that the technology support materials were a source of knowledge for their understanding of technology and teaching technology. The primary teachers who were new to teaching technology and were not trained to teach technology strongly agreed that the support materials were a

major source of knowledge to them. Davis and Krajcik, (2005) also point out that those teachers new to a subject view curriculum materials as a source of knowledge and a tool for instruction. The primary teachers who were trained to teach technology agreed that the support materials were also a source of knowledge for them. They said that the technological knowledge they developed during pre-service training was inadequate to teach effectively. They were not confident in teaching technology; the support material helped them develop confidence and knowledge.

Substitute for professional development

Data in this study show that research primary teachers talked about the technology support materials as a substitute for professional development. According to Jones (2003), curriculum materials can serve as a substitute for professional development. The support materials had been a source for supporting the development of teachers' understanding of technological concepts as well as how to teach technology. However, it has been argued that broader understanding of technology and technological practices can be achieved with the aid professional development: this can include teachers talking to each other, school-based support, informed facilitation including workshops with classroom practices and administrative support (Bell, 1993; Bell, 2005; Bell & Gilbert, 1996). Davis and Krajcik (2005) argue that an educative curriculum can be more effective if used in conjunction with other forms of support. Researchers in New Zealand found that long-term, ongoing professional development in technology education has enabled technology education teachers to have a much broader view of technology and technology education consistent with the technology curriculum (Jones, 2003; Moreland, 2000).

5. 6 Conclusion and Implications

In conclusion, the findings show that support materials had an impact on teachers' understanding of technology and technological pedagogical practices in classrooms. Because there had been little professional development since technology was first introduced in Papua New Guinea, technology support materials were developed and used as substitute for professional development. These materials have proven to have promoted and fostered a multifaceted view of technology (Gardner 1994; Layton, 1988; Mitcham, 1994; Pacey, 1993) and technology education (Black, 1994). The

support materials were educational in that they enhanced teachers' knowledge of technology and technological practices. The study also shows that there were changes to teachers' perceptions of technology and technological practices in classroom through their use of the support materials. This included teachers' views of technology as being mostly of modern artefacts changing to the inclusion of traditional artefacts. The teachers' views of technology as a practical subject changed to viewing technology as including both skills and knowledge. Importantly, the teachers were beginning to realise the social aspects of technology through their use of the support materials. They realised the impact of modern technology and its detrimental effects. The support materials suggested ways the teachers and students could undertake ways to minimize detrimental effects on their lives and environment through sustainable practices. To do this required technological knowledge, thus teachers in this study strongly recommended students to become technologically literate so as to make informed decisions and cope with the fast-changing technological world (Daker, 2005; Resinen, 2003).

The findings also revealed that there were short falls in teachers' knowledge and practice of some aspects of technology that were been promoted in the MAL syllabus and the support materials. For example, technology as problem-'solving and design are promoted in the support materials. However, the teachers in the study had yet to talk about and incorporate problem and design aspects in their teaching of technology. Therefore, there is a need for professional development. Unless there is professional development, the teachers may continue to overlook these major technological aspects. This could lead to viewing technology and technology education from a rather a restricted and narrow view.

Implications

There are three main implications which arise from the findings in this research. Firstly, because there is no training (professional development) available in the use of the support materials, teachers' existing attitudes and concepts will act as a filter for their use. Secondly, the support materials will be used in conjunction with other forms of support for effective use of support materials. Despite the usefulness of the specifically developed support materials, a lack of training has made the implementation of the new syllabus difficult for the teachers. Thirdly, for an effective

implementation of the technology education curriculum teacher professional development is needed.

Any support materials are used alongside already existing materials and practices. Therefore, it is important to examine teachers' existing ideas and build on these to help them teach technology more effectively.

The independent use of the technology support material by the teachers might develop misconceptions of narrower views of technology and technology education than those promoted in the support materials. Therefore, there is a need for teacher professional development, workshops and in-service programmes conducted at a national level. These would help expand teachers' knowledge, practices and confidence to teach technology and would help to develop a coherent and consistent approach across all of Papua New Guinea.

The research revealed that the technology support materials were seen to be supportive in helping teachers understand technology and technological practices. However, to extend their teaching of technology, curriculum materials such as the Papua New Guinea support materials could be far more effective if used in conjunction with other forms of support such as professional development.

5.7 Suggestion for future research

This study focused specifically on six Papua New Guinean primary teachers' perceptions of technology and technology education, the role of the technology support materials and how these support materials impacted on the teachers' perceptions and their pedagogical practices in technology. This is the first of any research related to primary technology teachers in Papua New Guinea. However, little is known about primary students and their views of technology and technology education. As such, it can serve as a foundation for future research especially that related to technology teachers' perceptions and practices.

It would be of great interest to probe the views of Papua New Guinean primary students' views about technology and technology education. The students' perceptions of technology and technology education would help teachers to plan and

develop strategies that would foster effective teaching and enhance student learning in the classroom. If teachers are made aware of the views held by students on technology, they may become more aware of common misconceptions that could inhibit students learning of technology.

Exploring students' technological capability is another possible area for research. It is important for teachers to develop an understanding of the level of students' capability when undertaking technological tasks. Understanding primary students' technological capability would help teachers to be aware of students' weak areas in technology and to have much more realistic expectations of students' strengths and weaknesses in technology. They would then have a much more realistic expectation of students' learning.

Professional development is an important area in curriculum implementation. It would be of interest to conduct research on professional development programmes in Papua New Guinea. This would provide useful information for planning on-going professional development programmes for technology education for Papua New Guinea primary teachers.

Appendix A
**Letter of Transmittal for the National Department of Education in Papua New
Guinea: National Research Unit**

Eron Hagunama
4/4 Inverness Avenue
Hillcrest
HAMILTON
New Zealand

25th March, 2007

The Director

National Department of Education
Research, Policy and Communication Division
Research and Evaluation Section
P.O. Box 446
WAIGANI
National Capital District
Papua New Guinea

Dear Sir/Madam,

**SUBJECT: SEEKING CONSENT TO CONDUCT RESEARCH IN TWO
SCHOOLS IN EASTERN HIGHLANDS PROVINCE.**

My name is Eron Hagunama and I am a Master of Education student at the University of Waikato in Hamilton, New Zealand. As part of my study, I am required to undertake a research project, which is being planned to be conducted in Eastern Highlands Province in Papua New Guinea. Two schools were chosen to take part in the study. This letter therefore, serves to formally seek your consent for the execution of the study which is being planned to be conducted around May and June, 2007. The actual date of the research will be communicated to you in due course once the research is approved by the University Of Waikato School Of Education Research Ethics Committee. I will report to your office once I am in Port Moresby.

The research topic is: *“Technology Curriculum in Primary Schools in Papua New Guinea: Teachers’ Perceptions and Practices”*

This study is aimed at investigating teachers’ perceptions of technology and technology education and the impacts of the support materials and their influence on their perceptions and practices in the classrooms. The focus of the study will be on technology subject, ‘Making a Living’ offered in the upper primary level. This will be done by way of investigating the classroom teachers’ perspectives and experiences when ordered under the curriculum reform to implement this as a school curriculum in primary schools. Understanding teachers’ perceptions of a subject is seen to be important in curriculum development and implementation. The need for this study has arisen out of my personal experiences with the pre-service training teachers and primary teachers about the challenges and difficulties encountered in understanding

and implementing the concept of technology and technology education in primary schools in Papua New Guinea and as a writer for these support materials.

During the study, two methods will be used in data collection. First, participant teachers will be interviewed on an individual basis using a semi-structured interview schedule. Interviews will take about 30 to 40 minutes. These interviews will be taped and transcribed. The second method is document analysis, some documents pertaining to technology education that may be in your schools such as national policies or school policies, technology support materials will be collected and analyzed. Full consent will be sought from administrators and teachers in charge of these documents.

Be informed that during the entire research process, the selected schools and the research participants will be respected as much as possible. That means the individual names of schools and the participants will not be mentioned in the write-up but a code name or group representations will be used. After the data collection, the participants will have an opportunity to look through the data, both tape-recorded and hand-written transcripts, for verification purposes

The following people are my research supervisors and they can be contacted via the following contact details for further information or questions regarding this study:

Dr. Judy Moreland
Principal Supervisor
University of Waikato
Centre for Science and Technology
Education Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: j.moreland@waikato.ac.nz

Dr. Mike Forret
Co-supervisor
University of Waikato
Centre for Science and Technology
Education Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: m.forret@waikato.ac.nz

Enclosed is the University of Waikato Ethics Committee approval letter for the research, a sample interview schedule, and other information related to the study.

Yours faithfully,

.....

Eron Hagunama
Master of Education student
Phone: (647) 0211407995
Facsimile: (647) 8384218
E-mail: eh23@waikato.ac.nz

Please state your full name and sign here to show that you have read and understood this letter.

Name:

Position:

Signature...

Appendix B
**Letter of Transmittal for the Eastern Highlands Provincial Education Division in
Papua New Guinea**

Eron Hagunama
4/4 Inverness Avenue
Hillcrest
HAMILTON
New Zealand

25th March, 2007

The Provincial Education Advisor
Eastern Highlands Provincial Education Division
P.O. Box 240
GOROKA
Eastern Highlands Province
Papua New Guinea

Dear Sir/Madam,

**SUBJECT: SEEKING CONSENT TO CONDUCT RESEARCH IN PRIMARY
SCHOOLS IN EASTERN HIGHLANDS PROVINCE.**

My name is Eron Hagunama, I am a Master of Education student at the University of Waikato in Hamilton, New Zealand. As part of my study, I am required to undertake a research project, which is being planned to be conducted in your province in Papua New Guinea. Two schools in Eastern Highlands Province were chosen to take part in the study. They are Kuru – Henagaru primary school and North Goroka primary school. This letter therefore, serves to formally seek your consent for the execution of the study which is being planned to be conducted around mid-May and the two first week of June, 2007. The actual date of the research will be communicated to you in due course once the approval is granted by the University of Waikato through the Research Ethics Committee. I will report to your office once I am in Goroka.

The research topic is: *Technology Curriculum in Primary Schools in Papua New Guinea: Teachers' Perceptions and Practices.*

This study is aimed at investigating teachers' perceptions of technology and technology education and the impacts of the support materials on their perceptions and practices in the classrooms. The focus of the study will be on technology subject, 'Making a Living' offered in the upper primary level. This will be done by way of investigating the classroom teachers' perspectives and experiences when ordered under the curriculum reform to implement this as a school curriculum in primary schools. Understanding teachers' perceptions of a subject is seen to be important in curriculum development and implementation. The need for this study has arisen out of my personal experiences with the pre-service training teachers and primary teachers about the challenges and difficulties encountered in understanding and implementing the concept of technology and technology education in primary schools in Papua New Guinea and as a writer of these support materials.

During the study, two methods will be used in data collection. First, participant teachers will be interviewed on an individual basis using a semi-structured interview schedule. Then, where possible, group interviews will be conducted to gauge collective views. Individual interviews will take about 40 minutes whilst the group interviews will take less than 40 minutes. These interviews will be taped and transcribed. The second method is document analysis, some documents pertaining to technology education that may be in your school - such as national policies or school policies, technology curriculum materials, yearly and term school programmes and lesson plans and teaching aids - will be collected and analyzed. Full consent will be sought from administrators and teachers in charge of these documents.

Be informed that during the entire research process, the selected schools and the research participants will be respected as much as possible. That means the individual name(s) of schools or the participants will not be mentioned in the write-up but a code name or group representations will be used. After the data collection, the participants will have an opportunity to look through the data; both tape-recorded and hand-written transcripts for verification purposes

The following people are my research supervisors and they can be contacted on the following contact details for further information or questions regarding this study:

Dr. Judy Moreland
Principal Supervisor
University of Waikato
Centre for Science and Technology
Education Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: J.moreland@waikato.ac.nz

Dr. Mike Forret
Co-supervisor
University of Waikato
Centre for Science and Technology
Education Research
Private Bag 3105
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Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: m.forret@waikato.ac.nz

Enclosed is the University of Waikato Ethics Committee approval letter for the research, a sample interview schedule, and other information related to the study.

Yours faithfully,

.....

Eron Hagunama
Master of Education student
Phone: (647) 0211407995
Facsimile: (647) 8384218
E-mail: eh23@waikato.ac.nz

Please state your full name and sign here to show that you have read and understood this letter.

Name:

Position:

Signature:

Appendix C

Letter of Transmittal for Schools

Eron Hagunama
4/4 Inverness Avenue
Hillcrest
HAMILTON
New Zealand

25th March, 2007

The Head Teachers

Kuru-Henagaru Primary School &
North Goroka Primary School.
P.O. Box 240

GOROKA

Eastern Highlands Province
Papua New Guinea

Dear Sir/Madam,

SUBJECT: SEEKING CONSENT TO CONDUCT RESEARCH IN YOUR SCHOOL.

My name is Eron Hagunama, I am a Master of Education student at the University of Waikato in Hamilton, New Zealand. As part of my study, I am required to undertake a research project, which is being planned to be conducted in Eastern Highlands Province in Papua New Guinea. Your school was chosen as one of the participating schools for the study. This letter therefore, serves to formally seek your consent for the execution of the study which is being planned to be conducted around mid-May and first two weeks of June, 2007. The actual date of the research will be communicated to you in due course.

The research topic is: *Technology Curriculum in Primary Schools in Papua New Guinea: Teachers' Perceptions and Practices.*

This study is aimed at investigating teachers' perceptions of technology and technology education and the impacts of the support materials and their influence on their perceptions and practices in the classrooms. The focus of the study will be on technology subject, 'Making a Living' offered in the upper primary level. This will be done by way of investigating the classroom teachers' perspectives and experiences when ordered under the curriculum reform to implement this as a school curriculum in primary schools. Understanding teachers' perceptions of a subject is seen to be important in curriculum development and implementation. The need for this study has arisen out of my personal experiences with the pre-service training teachers and primary teachers about the challenges and difficulties encountered in understanding and implementing the concept of technology and technology education in primary schools in Papua New Guinea.

During the study, two methods will be used in data collection. First, technology teachers will be interviewed on an individual basis using a semi-structured interview schedule. Where possible, group interviews will be conducted to gauge collective views on technology. Individual interviews will take about 40 minutes whilst the group interviews will take less than 40 minutes. These interviews will be taped and transcribed. The second method is document analysis. Some documents pertaining to technology education that may be in your school - such as national policies or school policies, technology curriculum materials, yearly and term school programmes and lesson plans and teaching aids - will be collected and analyzed. Permission will be sought from individual participants for the use of documents.

Be informed that during the entire research process, your school and the research participants will be respected as much as possible. That means the individual names of your school and the participants will not be mentioned in the write-up, but a code name or group representations will be used. After the data collection, the participants will have an opportunity to look through the data, both tape-recorded and hand-written transcripts, for verification purposes.

The following people are my research supervisors and they can be contacted via the following contact details for further information or questions regarding this study:

Dr. Judy Moreland
Principal Supervisor
University of Waikato
Centre for Science and Technology Education
Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: j.moreland@waikato.ac.nz

Dr. Mike Forret
Co-supervisor
University of Waikato
Centre for Science and Technology
Education Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
E-mail: m.forret@waikato.ac.nz

Enclosed is the University of Waikato Ethics Committee approval letter for the research, a sample interview schedule, and other information related to the study.

Yours faithfully,
.....

Eron Hagunama
Master of Education student
Phone: (647) 0211405995
Facsimile: (647) 8384218
E-mail: eh23@waikato.ac.nz

Please state your full name and sign here to show that you have read and understood this letter.

Name:

Position:

Signature:

Appendix D

Sample: Semi-Structured Interview Schedule

Please feel free to answer all or only some of the questions that I am about to ask you.

1. What is your name?
2. Tell me about your teaching background.
3. I understand that you are teaching 'Making a Living' subject. How did you become involved with 'Making a Living' subjects?
4. Have you gone through some training on how to teach 'Making a Living'?
5. When you think of technology, what comes into your mind?
6. What do you think technology education is?
7. What helps you teach technology?
8. What technology support materials do you have in your school?
9. How do you find these curriculum materials?
10. How do the support materials help you in your understanding about technology and technology education?
11. How do the support materials help you in your planning and teaching 'Making a Living'?
12. In your planning and teaching, do you strictly follow the instructions in the text book or teacher's guide?
13. What teaching and learning strategies do you apply in teaching 'Making a Living' subject?
14. What teaching methods do you find effective in teaching technology lessons? (Why?)
15. When teaching 'Making a Living', do you include both boys and girls in technology activities or engage boys in different activities and girls in other activities?
16. 'Making a Living' subject is programmed in strands and sub-strands. What strands and sub-strands do you like teaching best? (Why?)
17. What the kinds of support are available at your school for teaching technology?
18. Explain some of the ways through which the school administrators support the Technology education in your school?
19. Do you involve outside of school expertise in your technology teaching?
20. What kind of assessment procedures do you apply when assessing 'Making a Living' lessons in your classroom?

NB: *With your full permission this interview session will be tape-recorded and it will be later transcribed. The transcripts will be returned to you for comments and necessary changes.*

End of interview session and thank you very much for your time.

Appendix E
Participant Information and Consent Form
(For the Teachers and School Administrators)

Before you sign the consent form below, please read the relevant information about the study. If you feel comfortable to take part in the study, sign the consent form as a proof that you have read and understood the research title, the objective, the rationale and benefits, the areas that you will be involved in during the study, and the associated ethical principles.

Title of Project

Technology Curriculum in Primary Schools in Papua New Guinea: Teachers' Perceptions and Practices

Research Objective

To investigate teachers' perceptions of technology and technology education and the role of the support materials and its impacts on teachers' perceptions and practices.

Information about the Study

As you are aware, the technology subject, 'Making a Living' is a new inclusion into the primary school (upper primary) curriculum under the recent curriculum reform. It may be a new subject to most of you as teachers and school administrators. This new subject is composite of the subjects Agriculture, Home Economics, Practical Skills, Commerce. The significance of this subject is that it underpins the recent call for 'Relevant Education' which emphasizes the provision of relevant and appropriate skills for children in preparation for life after school. It has to be brought to your attention that technology education (Basic Technology as is called in Primary Teachers Colleges) courses have been incorporated into the existing curriculum in Primary Teachers Colleges in Papua New Guinea but most teachers who graduated prior to the introduction of this course were not aware of what technology education is all about and are struggling to effectively implement the subject in their classrooms. Some of you may be in this situation. From my (researcher) personal experiences as a teacher in secondary schools and primary teachers' college in Papua New Guinea, it is clear that even teachers who took some technology education courses are not sure of how to go about implementing technology education. Technology support materials were developed and made available in schools to be used as a support for teaching the MAL as a substitute for professional development. Therefore, this study will attempt

to investigate your perceptions of technology and technology education and the impact of these support materials influences on your perceptions and practices in the classroom. Studies have revealed various issues related to the implementation of technology by primary teachers (Anning, 1994; Johnsey, 1995) These revealed that the difficulties teachers experience are often related to the newness of the learning, their lack of familiarity and explicit knowledge of technology and technology education, and their limited and narrow views of technology (Jones & Carr, 1992; Jarvis & Rennie, 1996). So, the study attempts to investigate the understanding and use of technology curriculum materials in teaching and students' learning. A recent study shows that understanding teachers' perceptions of a subject is seen to be important in curriculum development and implementation. Teachers' perception of technology has significantly affected what and how they teach (Jones & Carr, 1992). Thus the development of appropriate concepts in teachers is crucial for a successful implementation of curriculum proposals. It is hoped that through the findings of the current study, relevant legislation and policies and curriculum materials can be developed, at the national, provincial and school levels for the education of children. The study will also provide an opportunity for you to voice your views on the successes and failures of technology curriculum as teachers are the front line in the implementation of the curriculum reform. If you want to know more about the study I am willing to provide that verbally during the interviews.

Areas that you will be involved in during the study

Be informed that as part of the data collection process, you will be involved in an interview and provide some documents that represent your planning and teaching to enhance students' learning. First, you will be interviewed on individual basis using a semi-structured interview schedule. There will be two interview sessions, the initial interview and a second interview a week later. Then, where possible, group semi-structured interviews will be conducted to gauge collective views on the understanding and implementation of technology and technology in your classroom or school. Individual interviews will take about 40 minutes, whilst the group interviews will take less than 40 minutes. In the semi-structured interviews, you will be asked some questions related to your understanding of technology and practices and use of

technology curriculum materials. During interviews I will tape-record as well as write down your exact words and these will be transcribed later. In the second interview session, the first audio-taped interview will be played to you for your verification. You will have the flexibility to change or add information. After the interview, you will be requested to provide/show relevant documents you may have and used for the implementation of the technology subject, in particular, 'Making a Living'. This letter, therefore, serves to seek your full permission to interview you and seeks to have access to the documents that may be available.

Be informed that during the entire research process, you as the research participants and your school will be respected as much as possible. That means individual names of your school or you as the research participant will not be mentioned in the write-up but a code name or group representations will be used. The study will take three weeks and you may withdraw from the study any time. After the data collection, you will have an opportunity to look through the data collected, both tape-recorded and hand-written transcripts, for verification purposes. When the study is completed, one copy of a hard bound thesis will be sent to your school as part of the ethical research process.

NB: Please tick the appropriate boxes and write your full name and sign on page 34 of this document if you feel comfortable to take part in this study.

My consent to take part in the study (put a ✓ to the boxes below)

- I have read and fully understood the information about this study provided by the researcher.
- I understand that even if I have initially agreed to take part in the study, I can withdraw consent but only up to the first week into the research project.
- I understand that taking part in this study is voluntary.

I (*please print your name*) _____, of (*name of school*) _____, in Eastern Highlands Province, Papua New Guinea have read the above information and do agree to participate in this research and to have my interview tape-recorded and allow the use of my documents.

Signature:

Position:

Date:

End of consent form

Appendix F
Letter of Approval from the Eastern Highlands Province Administration



Eastern Highlands Provincial Administration
Division Of Education



P.O. Box 240
GOROKA, 441
Eastern Highlands Province
PAPUA NEW GUINEA

Telephone (675) 732 2242
(675) 732 2242
Facsimile (675) 732 2242

17th May 2007

Eron Hagunama
4/4 Inverness Avenue
Hillcrest
HAMILTON
New Zealand

Dear Mr. Hagunama

RE: LETTER SEEKING PERMISSION

Your letter seeking permission to implement research activities in two schools dated 25th March 2006 is acknowledged.

You are granted permission to pursue your endeavor, however seek consent from the respective schools to avoid clash with their normal programs.

Also you are required to provide a copy of the thesis upon completion of your research studies for our information. The research findings may help us in many ways to help our teachers teaching technology subjects.

Wish you all the best in your studies.

For your action

Thank you

A handwritten signature in black ink, appearing to read "Robert Kokao".

ROBERT KOKAO
SPA- PRIMARY SCHOOLS

Cc: Provincial Education Advisor

Appendix G
Letter of Approval from the National Research Committee in Papua New Guinea

PAPUA NEW GUINEA



Department of Education

Office of the Deputy Secretary Administration and Policy

TELEPHONE: (675) 301 3529/3526
TELEGRAMS: TLX NE22193
TELEX: NE22193
FAX: 301 3544
Email: luke_taita@educationpng.gov.pg

FINCORP HAUS
P.O. Box 446
WAIGANI 131
PAPUA NEW GUINEA

File: PRI-1-2
Date 7th May 2007

Dear Eron Hagunama

Your research proposal titled: *“Technology curriculum in primary schools in Papua New Guinea: Teachers perceptions and practices”* has been approved in principle prior to Research and Evaluation Steering Committee (RESC) next meeting. The approval in principle is given due to the urgency of your data collection and presentation of final report for the award of your nominated degree program. Use this letter as an approval for your data collection in your appointed institutions and provinces.

While your research is approved in principle to collect data in educational institution/s it is also subject to approval by the Provincial Research Committee (where applicable) and/or the Provincial Education Advisor or the principals or head teachers of your nominated institutions. It is your responsibility to ensure such is obtained prior to the field work.

In serious case of breach of ethical issues and DOE research guidelines the Department of Education reserves the right to inform the researchers home institution or sponsors directly and take necessary actions as deem necessary.

Failure to observe the above conditions may lead to the withdrawal of research approval.

I thank you and wish you good luck in your study

Luke Taita

Deputy Secretary Policy and Administration
and Chairman of Research and Evaluation Steering Committee

Appendix H

Application for Ethical Approval

The University of Waikato

Application for Ethics Approval

Chapter 1 Human Research Ethics Committee

1 Title of Project

The technology curriculum in primary schools in Papua New Guinea: Teachers' perceptions and practices

2 Researcher(s) and Contact Details

a Name of applicant

Eron Hagunama

b Program of study (if applicable)

Masters in Education

c Course number (if applicable)

STER 594-07C

d Department/Centre/Unit

Science and Technology Education Research Centre

e Contact Address

4/4 Inverness Avenue. Hamilton. NZ

f Phone number

Landline (07)8562509, Mobile Ph. 0211407995

g Qualifications

Masters in Education

h Other personnel

Dr. Judy Moreland & Dr Michael Forret

3 Research Procedures

Methodology is best understood as a process, which considers the whole research inquiry rather than just the inquiry outcome (Cohen and Manion, 1994). Therefore, methodology is seen as the overall strategy used to guide a research inquiry (Guba & Lincoln 1989). Hence, when choosing a methodology for a research project, it is vital to consider research methodologies that take into account the research questions or objectives (Patton, 1990), as well as the technical details that guide the research inquiry (Bell, 1999). For this research inquiry, a qualitative approach, which is based on the interpretivist paradigm (Guba & Lincoln, 1989), is an appropriate methodology for data collection and analysis.

A qualitative approach is considered most appropriate for this inquiry as it seeks to gather rich descriptions and detailed explanations with deeper understanding of the key factors influencing the teachers' perceptions and their classroom practices being investigated. The use of this approach will also enable the researcher to explore and identify the key issues, influencing the success or failure of technology curriculum development and implementation of technology curriculum materials.

a Procedure for recruitment of participants and obtaining informed consent

The researcher has formulated letters which will be sent out to the National Department of Education, (see appendix A) the Eastern Highlands Provincial Education Division (see appendix B) and the school administrators of schools (see appendix C) for their approval of the study to be conducted. The research will be conducted in two Top-up primary schools in Eastern Highlands Province, one urban primary school and the other rural primary school. Three technology teachers from each school, a total of six, will be selected to participate in the research. Participants will be informed directly through the principals of their schools. (see appendix D)

When full consent is given in writing from the National Department of Education, the provincial education division and the principals of the intended schools, the researcher will set off to the individual schools to conduct the study. Whilst in the field, the researcher will get full consent of each teacher before they are asked to take part in the study (see appendix E). The importance of the study will be explained lucidly to them so that they can make informed decisions on whether to take part in the study or not.

b Procedures in which research participants will be involved

For the purpose of the current study, research participants will be involved with two methods of data collection. They are interview and document analysis.

1. Interviews (Semi-structured interviews)

The interview type to be used is semi-structured interview using prepared questions. During the interviews, pre-arranged questions will be used and guided around the focused topic, *Technology Curriculum in primary schools in Papua New Guinea: Teachers Perceptions and Practices*. The researcher will retain flexibility to probe issues and responses as they arise during the interviews. Two interviews will be conducted with each participant. The interviews may take up 40 minutes. One interview will take place at the beginning of the research at a selected place at the schools. Audio taping of the interviews will occur. Research participants will be able to verify their transcripts.

2. Document analysis

Permission will only be sought from the participating teachers responsible for the documents. Documents collected will be returned to the teachers and school after analyzing the data. Permission will be sought to photocopy or use teachers' planning and teaching materials. This will be done only upon individual teacher's consent. The researcher will acknowledge teachers in a way of referencing the source.

The kind of documents intended to be used in this study will range from national curriculum policies curriculum materials such as syllabus, textbooks, teachers' guides, students activity guides, and teacher's daily lesson plans.

c Procedures for handling information and materials produced in the course of the research

The audiotape will be transcribed for analysis. The tape and scripts will be kept at home in a locked cupboard. Documents collected will also be kept safe locked in locked cupboards.

4 Ethical Concerns

This research will be undertaken within the guidelines and procedures outlined in the Handbook on Ethical Conduct in Research (2001). Permission to undertake this research in Papua New Guinea will be obtained from the National Research Committee responsible for overseeing research associated with institutions outside the country.

a Access to participants

First, initial access to get permission to conduct this research will be obtained through the Director of National Research Committee responsible for overseeing research associated with institutions outside the country based in Port Moresby. (see appendix A) The Eastern Highlands provincial education division will also be informed of the study to be conducted in two schools within the province. (see appendix B) Letters of consent will also be sent to the school principals concerned seeking their full consent to conduct the research in their respective schools. The research participants, six technology teachers, three from each school, will be contacted directly through the principals of the two schools. (see appendix C) The individual research participants will be asked to voluntarily take part in the study whilst in the respective schools. The researcher will not in anyway influence the research participants but rather inform them of the importance and benefits of the study.(see appendix E)

b Informed consent

The participants will be informed of their accessibility to the data they have provided and will be kept informed about what is happening to the data they supply and what the analysis is showing where appropriate. Participants will also be informed of their right to complain and withdraw their involvement from this research at any time, or withheld the information they supply. Throughout the research the willingness of the participants will be monitored.

c Confidentiality

The researcher will accord respect for the participants and the research context by establishing confidentiality In order to uphold this ethical principle, the researcher will ensure that information provided is kept confidential by way of keeping it in a safe storage and not disclosing it to any third party. Participants' names and schools will not be published in any way, but codes will be used so that risks of identifying individuals is minimised. Participants (schools and teachers) will not be identified by name, or by detailed descriptions that could reveal their identity. Participants and/or schools will be identified using a single letter or a code name. Off the record or private communication will be kept confidential.

d Potential harm to participants

As the research is with people, the researcher will endeavour to protect the participants. There is no significant harm that can be foreseen for the participants, as the researcher also has the same ethnic and cultural background. However, should there be social discomfort the participants will be free to withdraw at any time. The researcher will monitor every situation in an effort to minimise any potential harm.

e Participants right to decline

Teachers have the right to decline participation and once the project has begun they retain the right to withdraw from the project at any time, including the withdrawal of the data they have provided.

f Arrangements for participants to receive information

All participants will receive written information about the project's objectives, study design, data collection methods and research ethics. The researcher will ensure that information that is collected through the interviews and document analysis will be accessible to the research participants. For instance, after each interview the research participants will be asked to go through the tape recorded transcripts of anything so that they can alter the transcript if necessary. Finally, a hard copy of the complete thesis will be sent to each school involved in the study.

g Use of information

Participants will be made aware that the information that is collected will only be used for the purposes of the research towards the Master of Education at the University of Waikato. It is also likely that the data and subsequent analysis will be used as a basis for published papers, seminars, conferences, and resource materials for the Department of Education in Papua New Guinea.

h Conflicts of interest

None anticipated.

i Other ethical concerns relevant to the research

N/A

j Procedure for resolution of disputes

All research participants will be informed about the procedures for resolving dispute should any form of it arise within the research timeframe. The procedures are to firstly talk with the researcher to discuss and resolve the disagreements or disputes of concern. Your details must be included here. If no resolution is reached at this stage, then the second step is to contact my supervisors at the University of Waikato. They are:

Dr. Judy Moreland
Principal Supervisor
University of Waikato
Centre for Science and Technology Education Research
Private Bag 3105
HAMILTON 2001
New Zealand
Phone: (647) 8384100
Facsimile: (647) 8384218
[E-mail: j.moreland@waikato.ac.nz](mailto:j.moreland@waikato.ac.nz)

Dr. Mike Forret
Co-supervisor
University of Waikato
Centre for Science and Technology Education Research
Private Bag 3105
HAMILTON 2001
New Zealand

Phone: (647) 8384100
Facsimile: (647) 8384218
[E-mail: m.forret@waikato.ac.nz](mailto:m.forret@waikato.ac.nz)

5 Ethical Statement

The project will follow the University of Waikato Human Research Ethics Regulations 2000 and the ethical guidelines of the NZARE and include the following. Informed consent of participants will be obtained, without coercion. Exploitation (or perception of exploitation) of researcher-participant relationship will be prevented. Privacy and confidentiality will be respected. The participant will own the raw material collected, and their requests regarding the material will be honoured. Participation in the research will not impact academically on the participants.

6 Legal Issues

a Copyright

As per University copyright regulation

b Ownership of materials produced

Participants will own their data.

c Any other legal issues relevant to the research

None

7 Place in which the research will be conducted

The research will be conducted in two primary schools in Eastern Highlands Province in Papua New Guinea. One school in a rural setting and the other in an urban primary school.

8 Has this application in whole or part previously been declined approval by another ethics committee?

No

9 For research to be undertaken at other facilities under the control of another ethics committee, has an application also been made to that committee?

A copy of this application will be sent to the National Research committee in Papua New Guinea, who grant approval for research undertaken in the country by other outside institutions.

10 Is any of this work being used in a thesis to be submitted for a degree at the University of Waikato? Please specify.

Master of Education

11 Further conditions

In the event of this application being approved, the undersigned agrees to inform the Human Research Ethics Committee of any change subsequently proposed.

5 Applicant Request for Approval of Ethics Application

Signed by the Applicant

Date

Signed by the Supervisor

Date

Signed by the Chairperson/Director

Date

The ethics application is approved/requires further work

Signed on behalf of the Committee

(Chairperson of the Committee

Date

References

- Anning, A. (1994) Dilemmas and opportunities of a new curriculum: Design and technology with young children. *International Journal of Technology and Design Education* 4(2), 155-178
- Adams, J. (1993). *Flying buttresses, entropy and o-rings: The world of engineers*. Cambridge, MA: Harvard University Press.
- Ball, D.I., & Cohen, D.K. (1996). Reform by the book: What is-or might be-the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), 6-8, 14.
- Bell, B. (1993). *I know about LISP but how do I put it into practice?* Final report of Learning in Science Project (Teacher Development). Hamilton, New Zealand: Centre for Science and Mathematics Education Research. University of Waikato.
- Bell, B. (2005). *Learning in science: The Waikato research*. London: Taylor & Francis Group, Routledge Falmer
- Bell, B. & Gilbert, J. (1994). Teacher development as personal, professional and social. *Teacher and Teacher Education*. 10, 483-497
- Bereiter, C. (1992). Referent-centred and problem-centred knowledge: Elements of an educational epistemology. *Interchange*, 23(4), 337-361.
- Black, P.J. (1994). *Technology in the school curriculum*. Papers from science, mathematics and technology (SMT) education in OECD countries.
- Blythe, J. (1998). *The teaching for understanding guide*. San Francisco: Jossey-Bass.

- Bouma, G.D. (1996). *The research process* (3rd ed.). Melbourne: Oxford University Press.
- Brown, M., & Edelson, D. (2003). *Teaching as design: Can we better understand the ways in which teachers use materials so we can better design materials to support their changes in practice?* Evanston, IL: Centre for Learning & Technology in Urban Schools, Northwestern University.
- Bruner, J. (1996). *The process of education*. Cambridge: Harvard University Press.
- Burns, J. (1992). Student perceptions and implications for an empowering curriculum. *Research in Science Education*, 22, 72-80.
- Burns, J. (1997). Technology – intervening in the world. In J. Burns (Ed.), *Technology in the New Zealand curriculum: Perspective and practice* (pp. 15-30). Palmerston North, New Zealand: Dunmore.
- Claxton, G., & Carr, M.D., (1991). Understanding change: The personal perspective. In B. Bell (Ed.), *SAME papers* (pp. 1-14). Hamilton, New Zealand: Longman Paul.
- Cohen, L., & Marion, L. (1994). *Research methods in education* (4th ed.). London: Croom Helm.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London: Routledge Falmer Press.
- Collopy, R. (2003). Curriculum materials as a professional development tool: How a mathematics textbook affected two teachers' learning. *The Elementary School Journal*, 103(3), 227-311
- Compton, V., & Harwood, C. D., (2003). Enhancing technological practice: An assessment framework for technology education in New Zealand. *International Journal of Technology and Design Education* 13(1), 1-26

- Compton, V., & Jones, A. (1998). Reflecting on teacher development in technology education: Implications for future programmes. *International Journal of Technology and Design Education* 8, 151-166.
- Compton, V., & Frances, B. (2006). *Discussion document: Background information on the new strands*: Auckland, New Zealand: Faculty of Education, The University of Auckland.
- Compton, V., & Jones, A. (2004). *The nature of technology: briefing paper prepared for the New Zealand Ministry of Education curriculum project*. Wellington, New Zealand: Ministry of Education.
- Creswell, J.W. (1994). *Research design: Qualitative and quantitative research approaches*. California: Sage Publications, Inc.
- Creswell, J.W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Upper Saddle River, New Jersey: Pearson Education Inc.
- Cutcliffe, S.H. (1981). Technological literacy for non-technologist: In editors (Ed.). *Proceedings of the technology education symposium II*. Menomonie, WI: University of Wisconsin-Stout.
- Custer, R.L. (1995). Examining the dimensions of technology. *Internal Journal of Technology and Design Education*, 5(3), 219-244.
- Daker, J. (2005). Technology education as solo activity or socially constructed learning. *International Journal of Technology and Design Education* 15, 78-89.
- Davis, E., & Krajcik, J. (2005). Designing educative curriculum materials to support teacher learning. *Educational Researcher*, 34(3), 3-14

Department of Education (1986). A philosophy of education for Papua New Guinea: *Ministerial Committee Report*, Papua New Guinea: Department of Education Publishing.

Department of Education (1994). *Education Reforms in Papua New Guinea*. Papua New Guinea: Department of Education Publishing.

Department of Education (1995). 'Technology Curriculum Statement for Grades 11-12,' *Draft for discussion*, Curriculum Unit, Waigani, June, 1995, (p. 1). Papua New Guinea: Author

Department of Education (1996). *Making a Living Syllabus*. Papua New Guinea: Department of Education Publishing.

Department of Education (2003). *Making a Living Teacher's Guide*. Papua New Guinea: Department of Education Publishing.

Devore, P.W. (1980) *Technology: An introduction*. Worcester, MA: Devis.

Fox-Turnbull, W. (2006). The influence of teacher knowledge and authentic formative assessment on student learning in technology education. *International Journal of Technology and Design Education*, 16 (Spring), 53-77.

Gardner, P. (1994). The relationship between technology and science: Some historical and philosophical relations. Part 1. *International Journal of Technology and Design Education*, 4(2) 123-153.

Gardner, P. (1997). The roots of technology and science: A philosophical and historical view. *International Journal of Technology and Design Education*, 7(1-2) 13-20.

Gess-Newsome, J. (1999). Secondary teachers' knowledge and beliefs about subject matter and their impact on instruction, in J. Gess-Newsome & N. Lederman, *Examining Pedagogical Content Knowledge*. (pp.34 - 38) Dordrecht: Kluwer Academic Publishers.

- Glaser, R., (1993). Referent-centred and problem-centred knowledge: Elements of an educational epistemology. *Interchange*, 23(4), 337-361.
- Gillham, B. (2000). *Case study research methods*. London: Continuum.
- Grossman, P. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.
- Guba, E.G., & Lincoln, Y.S. (1989). *Fourth generation evaluation*. Newbury Park: Sage Publication.
- Hansen, R., & Froelich, M. (1994). Defining technology and technology education: A crisis, or cause for celebration? *International Journal of Technology and Design Education*, 4(2), 179-206.
- Harker, R. (1999). *Research methods, unit four: Research design and methodologies*. Palmerston North, New Zealand: Massey University College of Education.
- Hennessy, S. (1993). Situated cognition and cognition apprenticeship: Implications for classroom learning. *Studies in Science Education*, 22, 1-41.
- International Technology Education Association and Technology for All Americans. (2000). *Standards for technological literacy*. Virginia: International Technology Association.
- Jarvis, T., & Rennie, L. (1996). Perceptions about technology held by primary teachers in England. *Research in Science and Technology Education*, 14(1), 43-54.
- Johnson, S.D. (1992). A framework for technology education curricular which emphasises intellectual processes. *Journal of Technology Education*, 3(2), 124-132

- Johnson, S. D. (1997) Learning technological concepts and developing intellectual skills. *International Journal of Technology and Design Education*, 7 (1-2), 161-180.
- Jones, A. (1996). *Recent research in student learning of technological concepts and processes*. Paper Presented at the JISTEC '96, Jerusalem.
- Jones, A. (1997). Technology education in the New Zealand curriculum. In J. Burns (Ed.), *Technology in the New Zealand curriculum: Perspective and practice* (pp. 46-59). Palmerston North, New Zealand: Dunmore.
- Jones, A. (1999). Teacher subject cultures and curriculum innovation: the example of technology education. In X Loughran (Ed.), *Researching teaching: Methodologies and practices for understanding pedagogy*, London: Falmer Press.
- Jones, A. (2003). Developing a national curriculum in technology for New Zealand. *International Journal of Technology and Design Education* 13(1), 83-99
- Jones, A., & Carr, M. (1992). Teachers' perception of technology education: Implications for curriculum innovation. *Research in Science Education*, 22, 230-239.
- Jones, A., & Carr, M. (1993). Analysis of student technological capability. *Working papers 502. Learning Technology Project*. Hamilton, New Zealand: Centre for Science and Mathematics Education Research, University of Waikato.
- Jones, A. & Compton, V. (1998). Towards a model for teacher development in technology education: From research to practice. *International Journal of Technology and Design Education* 8, 51 - 65.
- Jones, A. T., Marther V., & Carr, M. D. (1995) *Issues in the practice of technology education*. Hamilton, New Zealand: Centre for Science and Mathematics Education Research, University of Waikato.

Jones, A., & Moreland, J. (2004). Enhancing practicing primary teachers' pedagogical content knowledge in technology. *International Journal of Technology and Design Education* 14, 121 - 140.

Kvale, S. (1996). *Methods of Analysis. Interviews: an introduction to qualitative research interviewing*. Thousand Oaks: Sage Publications.

Kimbell, R. (1991) Tasks in technology. An Analysis of their purpose and effects. *International Journal Technology and Design Education*, 4(3), 241-256.

Kimbell, R. (1994). Tasks in technology. *International Journal of Education and Design Education*, 4(3), 241-256.

Kimbell, R. (1997). *Assessing technology: International trends in curriculum and assessment: UK, Germany, USA, Taiwan, Australia*. Buckingham, UK: Open University Press.

Krajcik, J., & Schneider, R. (2002). The role of educative curriculum materials. *Journal of Teacher Education* 13: 221-245.

Gunckel, K. L. and Vandenbelt, D., (2006). Curriculum in the classroom: *The Functions of curriculum materials in Planning and Teaching in High School Science*. Paper presented at the National Association of Research in Science. San Francisco, CA

Layton, D. (1993). Developing science and technology education. In x. editor (Ed.), *Technology's challenge to science education*. Buckingham, Philadelphia: Open University Press.

Lewis, T. (1999). Research in technology education: Some areas of need. *Journal of Education*, 10(2), 44-56

- Linblad, S. (1990). From technology to craft: One teachers' experimental adoption of technology as a new subject *Swedish Primary School. Journal of Curriculum Studies*. 22(2), 165-175
- Lincoln, Y. S. & Guba, E.G., (1989). *Naturalistic inquiry*. Beverly Hills. CA: Sage
- Linn, M. C., Eylon, B., & Davis, E. A. (2004). The knowledge integration perspective on learning. In M. C., Linn, E. A. Davis & P. Bell (Eds.), *Internet environment for science education* (pp. 29-46). Mahwah, NJ: Lawrence Erlbaum.
- Lux, D.G. (1983, April). *Science and technology: A new alliance*. Paper presented at the America Industrial Arts Association Annual Conference. Milwaukee, WI.
- Magnusson, S. J., Borko, H., & Krajcik, J. S. (1994, March). *Teaching complex subject matter in science: Insights from an analysis of pedagogical content knowledge*, Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Anaheim, CA.
- Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J.Gess-Newsome & N. Lederman (Eds.). *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95-132). Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Mather, V. (1995) *Students' concepts of technology and technology education: Implications for practice*. Unpublished MEd Thesis, University of Waikato.
- Maykut, P., & Morehouse, R. (1994). *Beginning qualitative research*. London: Falmer.
- McCormick, R. (1992). The evolution of current practice in technology education. In R. McCormick, P. Murphy and M. Harrison (Eds.) *Teaching and Learning Technology*. Wokingham: Addison-Wesley, Open University.

- McCormick, R. (1997) Conceptual and procedural knowledge. *International Journal of Technology and Design Education* 4(1), 141-157
- McCormick, R. (2000). *Theoretical and empirical issues of technology education research*. Address given to AAAS Technology Education Research Conference 2000.
- McCormick, R., Murphy, P., & Hennessey, S. (1994). Problem solving processes in technology education: A pilot study. *International Journal of Technology and Design Education*, 4(1), 5-34.
- McRobbie, C, J., & Tobin, K. (1995). Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching*, 32(4), 373-385.
- Merriam, S.B. (1988). Dealing with validity, reliability, and ethics in case study research. *Case study research in education: A quotation approach*. San Francisco: Jossey-Bass.
- Mitcham, C. (1994). *Thinking through technology*. Chicago, IL: University of Illinois Press
- Moreland, J. P. (1998). Technology education teacher development: The importance of experiences in technological practice. Unpublished MEd Thesis, University of Waikato, Hamilton. New Zealand.
- Moreland, J., & Jones, A. (2000). Emerging assessment practice in emergent curriculum: Implications for technology. *International Journal of Technology and Design Education* 4(1), 5-34
- Moreland, J., Jones, A., & Chambers, C. (2001). *Enhancing teacher formative interactions*. Set 3, 16-19

- Moreland, J., Jones, A., & Northover, A. (2001). Enhancing Teachers' Technological Knowledge and Assessment Practices to Enhance Student Learning in Technology: A two Year Classroom Study. *Research in Science Education* 31(1), 155-176
- Moreland, J. P., (2003). Becoming effective technology teachers: Enhancing assessment practices in primary classrooms. Unpublished PhD thesis, Hamilton, University of Waikato.
- Murdoch, K. (2004). *Classroom connections-strategies for integrated learning*. South Yarra, Australia: Eleanor Curtain Publishing.
- Naughton, J. (1992). What is technology'? In McCormick, Newey, & Sparkes, (Eds.), *Technology for technology education* (pp. 3-10). London: Open University.
- Norman, P., Potek, S., Hagunama, E., & Deruage, J. (2005). *Making a living: Teacher resource book*. Melbourne: Oxford University Press.
- Norman, P., Potek, S., Hagunama, E., & Deruage, J. (2005). *Making a living: Student textbook 1*. Melbourne: Oxford University Press.
- Norman, P., Potek, S., Hagunama, E., & Deruage, J. (2005). *Making a living: Student textbook 2*. Melbourne: Oxford University Press.
- Pacey, A. (1993). *The culture of technology*. Oxford, UK: Blackwell.
- Paechter, C. F. (1992). *Subcultural retreat: Negotiating the design and technology curriculum*. Paper presented at the British Educational Research Association Annual conference.
- Petrina, S. (1998). Multi-disciplinary technology education. *International Journal of Technology and Design Education*, 8(2), 103-138.

- Powney, J. & Watts, M. (1987). *Interviewing in educational research*. London: Routledge & Kegan Paul Ltd.
- Putman, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about on teacher learning? *Educational Researcher*, 29(1), 4-15.
- Rasinen, A., (2003). An Analysis of the technology education curriculum of six countries. *International Journal of Technology and Design Education*, 15, 31-47.
- Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry*, 19(3), 315-342.
- Remillard, J. T. (2000). Can curriculum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *Elementary School Journal*, 100(4), 331-350.
- Remillard, J. T. (2005). Examining key concepts in research on teacher use of Mathematics curricula. *Review of Educational Research*, 75 (2).
- Rennie, L. (1987). Teachers' and pupils' perceptions of technology and the implications for curriculum. *Research in Science and Technology Education*, 5(2), 121-133.
- Rennie, L.J., & Jarvis, T. (1995). Three approaches to measuring children's perceptions about technology. *International Journal of Science Education*, 17(6), 755-774.
- Resnick, L. B. (1991) Shared cognition: Thinking as social practice. Chapter 1 in L. B. Resnick., J.M. Levine, and S.D. Teasley (Eds.) *Perspectives on socially shared cognition*. Washington: America Psychological Association.

- Sade, D., & Coll, R.K., (2003). Technology and technology education: Views of some Solomon Island primary school teachers and curriculum development officers. *International Journal of Science and Mathematics Education*, 1, 87-114
- Schneider, R., & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. *Journal of Science Teacher Education*, 13(3), 221-245.
- Sharpe, D. B. (1996) Out with the old, in with the new. *Journal of Design and Technology Education* 1(1), 24-36.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57 (1), 1-22
- Smith, T., & Ingersoll, R. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal*, 41(3), 681-714.
- Staudenmaier, D. (1989). *Technology's storytellers*. Cambridge, MA: MIT Press.
- Symington, D.J. (1987). Technology in the primary school curriculum: Teachers' ideas. *Research in science and technology education*, 5(2), 167-172.
- Tuckman, B.W, (1972) Conducting educational research In L. Cohen, and L. Manion, (1997) *Research methods in education*. NY.: Harcourt Brace Jovanovich.
- Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. In M. Cole, V. John-Steiner & E. Souberman (Eds.) London: Harvard University Press.
- William, P. J., (1992). Technology as a discipline. In *ACER 10th Biennial National Conference proceedings* (pp. 83-88). Gold Coast, Queensland, Australia

Wright, T. (1996, January). *Technology education: A hands on / minds on experience*.

Paper presented at the ACET conference. Tasmania, Australia.

Wright, R. T., & Lauda, D. P., (1993). Technology education – a position paper. *The*

Technology Teacher, 52, 3-5.

Yin, R.K. (1994). Case study research: Design and methods. In x Editors *Applied*

social research methods series: Volume 5. (2nd ed.). California: Sage

Publications, Inc.