TEACHING AND ASSSSING ASPECTS OF THE TECHNOLOGY LEARNING AREA

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by

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DECLARATION

I, the undersigned, declare that:

TEACHING AND ASSESSING ASPECTS OF THE TECHNOLOGY LEARNING AREA

is my own original work and that it has not been presented to any other university to obtain a degree.

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Signed

15 January 2005

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Date

ABSTRACT

With the introduction of Outcomes Based Education (OBE), Technology became a new learning area which is compulsory in the General Education and Training band. Technology Education was not offered as a teaching subject in teacher education institutions and as a consequence most teachers received little or no training in technology education. The approach to the teaching of Technology, with its demands, could pose challenges or problems to teachers who did not receive adequate training in Technology Education.

The purpose of this research is to investigate the manner in which technology teachers plan, teach and assess the technological process and the way the learners experience the teaching and assessment of the technological process. Attention is focused on how grade seven teachers and learners work towards the achievement of the first learning outcome (i.e. the application of technological processes and skills). The main objective of the study is to enhance classroom practice by highlighting the challenges that face teachers and learners and by offering guidelines for teaching and assessing the technological process.

The literature survey describes the importance of technology in the South African education system and its contribution to our economic development. The study also draws on literature that describes the different phases of the technological process, the various skills that the learners need to acquire, the methodologies

and pedagogical skills teachers need to have for teaching and assessing the technological process.

The researcher used both qualitative and quantitative data collection methods in this investigation. The following four research instruments were used in this investigation: Interviews with technology teachers, the questionnaire for the learners, classroom observations and a study of learner portfolios.

The most important findings from this investigation are:

- Teachers with experience in practical subjects such as woodwork and needlework, which were taught under the old education system, teach and facilitate the design process by following all the steps prescribed for the teaching of the technological process.
- Teachers who do not have experience in teaching practical subjects tend to exclude certain essential skills and steps such as problem identification, designing, testing and evaluating the product.
- Essentials skills within the technological process such as graphical communication, conducting a research and testing the product or solution are seldom developed to enhance the learners' technological capability.
- There is little use of resource tasks (exercises to develop practical skills in the use of tools or equipment) that can develop the learners' motor (practical) skills.

- Activities are not always planned within the immediate environment of the learner to investigate and solve problems within his or her own community.
- Learners are exposed to limited methods of research and data collection.
- Due to the fact that the learners' skills in graphic communication and written descriptions are not developed to the full potential, their ideas are not very clear and illustrative.
- Learners' designed products are not evaluated according to functionality and displayed or presented at exhibitions for the rest of the school or the community.
- *Teachers are uncertain about the process of assessment.*

The implications of these findings are described and recommendations are made to enhance classroom practice in the teaching, facilitation and assessment of the technological process.

THIS THESIS IS DEDICATED

TO

MY LATE GRANDPARENTS

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  Glory to God.

DEFINITION OF TERMS

The following terms are used throughout this study in the ways defined by the National Education Department.

Technology:

The learning area that promotes the use of knowledge, skills, resources and appropriate values to develop practical solutions to problems and meet human needs and wants.

Technology education:

A planned teaching process designed to develop the learner's competencies and confidence in understanding and using technologies and in creating solutions to technological problems.

Learning outcomes:

Demonstrated technological knowledge, skills, values and attitudes that result from the learning processes and reflect critical cross-field outcomes.

Technological process:

A creative human activity that involves problem identification or needs analysis, setting of specifications, doing research and graphic communication to find possible solutions, designing the best solution, planning, making and evaluating the best technological product.

Resource task:

A practical task that gives learners the opportunity to practice and develop skills needed within the technological process.

CONTENTS

Chapter One

Introduction

Chapter Two

Literature Survey

Chapter Three
Research Methodology

Chapter Four
The Research Findings.

Chapter Five

Summary of findings, conclusions and recommendations

List of tables

List of figures

CHAPTER 1

INTRODUCTION

1.1 RESEARCH CONTEXT

One feature of the current reform initiatives in the South African education system is the introduction of the Revised National Curriculum Statement that outlines learning outcomes for different learning areas in schools. In the Revised National Curriculum Statement for the Technology learning area for grades R-9, the learners are expected to achieve the following three learning outcomes:

The learner should be able to:

1. Apply technological processes and skills ethically and responsibly using appropriate information and communication technologies.
2. Understand and apply relevant technological knowledge ethically and responsibly.
3. Demonstrate an understanding of the interrelationships between science, technology, society and the environment.

(Department of Education 2002: 11)

The current research focuses on the first learning outcome, which is regarded as the backbone of technology education (Department of Education 2002). This outcome requires the learners to apply technological processes and skills ethically and responsibly using appropriate information and communication technologies. Technology teachers are expected to facilitate learning towards the achievement of this outcome by assisting the learners to identify problems, investigate the situation, compile specifications, design, make, and evaluate a product that will solve a particular problem, or satisfy a specific human need. When assessing the learners the teachers are expected to ensure that the learners develop the necessary skills to understand and apply this process ethically and responsibly.

The technological process is central to technology, which is the interaction of hand and brain, that is, thinking and doing. It means that technology is not the end product, the thing that is made, but is actually a process that starts when you identify a need, investigate it, and then decide to design something to address the need or solve the problem (McCormick 1996).

This first learning outcome presents a drastic change in the way teaching, learning and assessment have been conducted in the old education system of South Africa. It is an attempt to enhance the learner's ability to think critically and to be engaged in a problem solving process by designing, developing, making, and evaluating technological products that could satisfy human needs.

Teaching the learners to use the technological process might not be easy, as most learners are used to letting their teachers do the thinking for them (Edwards 2001). The best way of teaching the learners to use the technological process is by finding a need in the learner's everyday life and then work through the process to find a solution to the problem (Edwards 2001).

Another challenge that is presented by this outcome is that the technological process has to be linked to the content areas of the technology learning area. These content areas include structures, processing, and systems. The content of the technology learning area requires teachers and learners to display the ability to interpret the workings and essentials of mechanical systems, electrical systems, structures, processing, and materials. Observations at various schools have shown that even if some of the teachers could understand the technological process, and the way of teaching it, they might not be familiar with the content, which requires background knowledge of science subjects (Waks 1992).

In addition, the technological process involves making of technological products, which requires both the teacher and the learner to display the ability to use tools and equipment. Most teachers in South Africa have never been exposed to practical skills in their primary, secondary and teacher education and the sudden expectation that they should assist the learners to use tools and equipment could be a great challenge (Dyrenfurth 1995).

Graphical communication is an important component of the technological process. This requires the learners to draw appropriate two-dimensional and three-dimensional sketches or drawings of their ideas, enhanced drawings of final solutions and drawings showing measurements, to communicate different kinds of information appropriately and effectively. Graphic communication might again not be easy to teach if the teachers themselves did not undergo the same process prior to becoming teachers.

An expectation for the learners to understand and apply the technological process ethically and responsibly could also present some challenges that relate to the teaching of values. Values education is an area that was not given enough attention in the old South African education system. This could also not be an easy task for the teachers to teach values. Reddy (2001)

Finally in the new education system assessment is outcomes-based and is planned together with teaching and learning activities. Since the teachers are used to content-based assessment which places emphasis on acquiring knowledge, it might not be easy for them to assess skills, values and attitudes and provide learner feedback on a continuous basis and according to the requirements of the assessment standards.

Some of the claims mentioned above are based on my experience as a technology teacher.

1.2 PROBLEM STATEMENT AND JUSTIFICATION

Technology Education was not offered as a teaching subject in teacher education institutions and as a consequence most teachers received little or no training in technology education. Contact with various school principals indicated that the teachers who, in the old education system, taught practical subjects such as woodwork, needlework, art and metalwork are regarded as ideal educators to teach this new learning area although some of them have no formal and specialised training in technology. The approach to the teaching of Technology, with its demands, could pose challenges or problems to teachers who did not receive adequate training in Technology Education.

The purpose of this research is to investigate the manner in which technology teachers plan, teach and assess the technological process and the way the learners experience the teaching and assessment of the technological process.

1.3. THE RESEARCH OBJECTIVE

The main objective of this research is to enhance classroom practice by highlighting the challenges that teachers and learners face when they work towards the achievement of the first learning outcome (i.e. the application of technological processes and skills) in the technology learning area. It is hoped that the highlighted challenges would call for interventions that could offer guidelines for teaching and assessing the technological process.

In achieving the above objective this study could be valuable to the Education Department in the sense that it could lead to the development of a training programme for Technology teachers, and to the effective implementation of the technological process in schools.

A successful implementation of Technology could benefit the learners, as they would be able to identify and solve problems, thereby meeting one of the critical outcomes of OBE. By mastering all the activities of the technological process the learners could develop a variety of skills such as observation, investigation, critical thinking and research.

The teachers could also benefit from the findings of this research as they could gain a deeper understanding of teaching methodologies related to the technological process. A thorough understanding of the technological process could develop a confident teacher to whom it would be a challenge to facilitate the technological process, and understand the broader aim of Technology Education.

The community could also benefit from this investigation, as the learners would be able to identify community needs, and design and make technology products that could be responsive and useful to community development.

Since technology is a new learning area there are few studies that focus on teaching and learning experiences of teachers and learners in classrooms. Such studies are necessary as they could reveal challenges or difficulties that are encountered by teachers and make increasing calls for appropriate interventions.

In order to achieve the objective stated above the following research questions were used:

1. How do technology teachers design their learning activities?
2. How do technology teachers facilitate learning?
3. How do technology teachers assess the technological process?
4. What are the learners' experiences with regard to the teaching and assessment of the technological process?

1.4 DELIMITATION OF THE STUDY

This investigation was conducted at five primary schools in the Paarl-Valley and focused on grade seven teachers and learners.

1.5 THE STRUCTURE OF THE STUDY

The research study comprises five chapters. Chapter one is the introduction, which introduces the reform initiatives in the South African education system as set out in the Revised National Curriculum Statement for Technology learning area- Grades R-9. Three learning outcomes for the technology learning area are listed and emphasis is placed on the first learning outcome, which is the technological process. Challenges that could be presented by this learning outcome are also discussed in this chapter.

Chapter two entails the overview of the literature on the need for technology in the South African education system. The literature on the new National Curriculum and introduction of technology is also cited. This chapter also focuses attention on the goal of technology education, the Revised National

Curriculum Statements and learning outcomes for technology. Finally the chapter examines the steps that need to be followed in learning, teaching and assessing the technological process. The unique approach for teaching technology is documented and the important role that could be played by teachers in teaching the technological process is portrayed.

The third chapter describes the methodology and procedures the researcher used to conduct this investigation. The debates on quantitative and qualitative methodological paradigms are examined and emphasis is placed on the importance of combining methods of the two paradigms for the purpose of triangulation. The researcher's position is discussed and the reasons for using both quantitative and qualitative approaches are explained. This chapter also analyses and reflects on the research design, research instruments, approaches and techniques that were used to collect and produce data. The role of the research participants, analysis and interpretation of data, data verification and the limitations of the study also form the subject of this chapter.

Chapter 4 presents the findings that were obtained after the collected data was captured, analysed and interpreted. This chapter is divided into four sections. The first section presents the findings that were derived from the interviews conducted with technology teachers. Section two documents the responses of the learners to the questionnaire. The third section focuses on observations of classroom practices and the last section deals with the document study of the learner portfolios.

Following Chapter four is the final chapter which presents a summary of the research findings that were derived by comparing the responses of all the participants and data gathered by means of observation schedules in order to find similarities and differences. Chapter five also puts forward some recommendations that could enhance learning, teaching and assessment of the technological process. The conclusion of the study is also set out in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The South African education and training system of the National Party Government in the apartheid era was characterised by a curriculum which was content driven and succeeded in producing passive learners, who were more capable of following a set of instructions and less able to engage in critical thinking and problem solving activities (Edwards 2001). The learners in DET schools were prepared for manual labour, with little consideration given to a thinking learner who can make a meaningful contribution to the development of the country (Reddy 2001).

According to the African National Congress discussion document (ANC 1994), this fragmented, unequal and undemocratic nature of education and training had profound effects on the development of the economy and society. It led to the destruction, distortion or neglect of the human potential of our country, with devastating consequences for social and economic development. This is evident in South Africa's lack of skilled and trained labour which has had adverse effects on productivity and international competitiveness of the economy. In the policy framework for education and training (ANC 1994), the ANC points out that there is a challenge of creating an education and training system which would ensure that "human resources and potential in society are developed to the full" (Freedom Charter: June 1955: 5).

2.2 THE NEED FOR TECHNOLOGY IN THE SOUTH AFRICAN EDUCATION SYSTEM

There is a realisation that South Africans should become technologically literate in order to be part of the global economy (Rautenbach, 1991). According to Bowyer (1990) more than one third of the world's adults and children have no access to the knowledge, skills and technologies that can improve the quality of their lives and help them shape and adapt better to social and cultural change. He describes this situation as intolerable and maintains that it can only change if scientific, mathematical and technological literacy are a basic part of everyone's education. Sharing the same view Dyrenfurth (1995: 42) states:

> Technology is acknowledged as the single most powerful force in the world today. It permeates every aspect of public and private life, of work and play. Furthermore, technology is one of the essential cornerstones of productivity and economic competitiveness. Given this, it necessarily follows that systematic education technology must be present in the schools of any nation that wishes to be a serious economic competitor and a world citizen, that seeks to enhance its citizenry's quality of life.

Rautenbach (1991) emphasises the importance of technological and scientific changes to take place in order for South Africa to be part of the global economy. He addresses the situation that might be envisaged in post apartheid South

Africa where economic sanctions will be something of the past and where technological and scientific exchange with the rest of the world would be normalised. His argument is based on the fact that South Africa would become part of the global economy. According to Rautenbach (1991), the global economy can be divided between two main groups of countries the so-called developed or industrialised countries on the one hand and the developing countries, which are in the process of industrialising, on the other. Pytlik (1983) goes a step further and identifies five levels of technological development of a country:

- **Indigenous**: it is a basic level that is needed to keep its citizens at a particular level. Technology is indigenous to specific areas- most economic benefits come from sale of natural resources, and the work of crafts and artisans.
- **Emerging**: this is characterized by the transfer of Technology from other countries, usually from developing or industrialized countries.
- **Developing**: as a country grows in the use of Technological transfer, it focuses on the appropriateness of that which has been adopted and makes decisions on its way forward based on what is necessary for the country.
- **Industrialized**: these countries can usually provide products and services for itself and for export.
- **Cybernetic**: these have an existing economic base, not only in goods but also in services, and have industries that provide machines, systems that process, transmit and provide information.

Sadeck (2001) states that South Africa is in an emerging stage of development and that it relies heavily and blindly on technological transfer. He further suggests that we should be looking at progressing to the developing stage.

The implementation of the Reconstruction and Development Program (RDP) in South Africa requires economic growth and equity, healthy industrial relations and increased investment in the economy. This involves developing the nation's economy to a point where it can support the programmes needed to redress past inequalities, and to increase the wealth to person ratio levels that in themselves stimulate further economic growth. The economy thus depends on technological capability of people.

The need for technology has also been recognised by authors in other parts of the world. Ginner and Klasander (2001) document the importance of technology education in Sweden and list the following three most important motives for compulsory technology education in Sweden:

- As a citizen in a democracy everyone needs a basic understanding of technology.
- We (they) all need to be able to understand and handle everyday technology.
- There is a need for more engineers and scientists

The relationship between technology and economic growth of a nation was also highlighted by President Bill Clinton in 1993 when he introduced his technology policy and stated that: "Technology is the engine of economic growth" (Clinton 1993: 42). According to Dyrenfurth (1995), technological advance in the United States of America has been responsible for two-thirds of productivity growth since the depression. Technological development is seen as not an end in itself, but rather a means of enhancing the standard of living of people and the competitiveness of economies.

Technology education is the learning area that has the potential to address the needs of the society and to make people technologically literate. Referring to economic growth as one of the needs that could be addressed by technology education, Khan (1995:1) states:

> Future economic growth in South Africa will depend on the ability of local people to master a technologically driven manufacturing industry with internationally competitive expert capability. Wealth distribution can now only be achieved through skills distribution.

Kwende (1996: 1) stresses the importance of science and technology from an African point of view by stating that: "The issue of science and technology is crucial for the future of the African continent, since all previsions indicate that science and technology will play a major role in the 21st century." Explaining the importance and the impact of technology on society Kwende (1996) further states that the quality of life in a culture or society is directly related to its members' ability to solve problems through the design, production, appreciation and appropriate use of technology, and that the quality of life is directly related to an ability to creatively develop new technologies while simultaneously appreciating scientific, economic and ecological considerations.

The Draft National Framework for curriculum development (1996) also emphasises the importance of technology education in our changing world and states that we must compete as communities and as a nation to secure and sustain the viability of our economies, the critical skills of resourcefulness, problem-solving, the ability to learn both individually and in groups and the ability to conceptualise and design novel solutions.

Also placing emphasis on the need for technology education in South Africa, Dyrenfurth (1995: 42) states:

> No individual, societal group or overall society can afford to be technologically illiterate in today's world. The leadership role South Africa plays in the African continent have created a mood for optimism on this continent; therefore we have to take responsibility for leadership in technology education.

The importance of technology has also been noted in the Swedish curriculum. According to Ginner and Klasander (2001) the Swedish curriculum regards technology as a special human activity, a knowledge area in its own right. The school subject technology is described as a multi-disciplinary subject forming a seamless web of intellectual and manual skills and knowledge where social sciences, humanities and sciences are all important elements as well as hands-on experiences.

The challenge for technology education in South Africa has been to develop a curriculum that ensures opportunities for learners to develop shared understandings; specific personal qualities and perceptions; and a range of useful, individual skills which will help to make school-leavers independent citizens, prepared for life long education and training and better equipped to enhance the capacity of the South African economy. Attempts to develop such a curriculum for technology education in South Africa are highlighted in the following section.

2.3 THE NEW NATIONAL CURRICULUM AND INTRODUCTION OF TECHNOLOGY

The constitution of the Republic of South Africa (Act 108 of 1996) provides the basis for curriculum transformation and development in South Africa. This transformation was based on the White Paper on Education and Training (1995), the South African Qualifications Act (no 58 of 1995) and the National Education Policy Act (no 27 of 1996). These official documents have highlighted the benefits that could be brought by current education reforms in South Africa. Such benefits include the integration of education and training and the development of a variety of skills that could enable the learners to be thinking competent future citizens after they complete their education and training. The purpose of this transformation was to lay the foundation for a single national core curriculum. Curriculum 2005 was introduced into schools in 1998 and the emphasis moved from an aims and objective approach to outcomes-based education (Department of Education 1997). The values of the constitution are expressed in the twelve critical and developmental outcomes, which describe the kind of citizen the education and training system should aim to produce. The intention of the critical outcomes is to enable learners to:

- Communicate effectively
- Identify and solve problems
- Organize and manage activities
- Work effectively with others
- Collect, analyse, organize and evaluate information
- Use science and technology effectively
- Understand the world as a set of related systems.

The developmental outcomes intend learners who can:

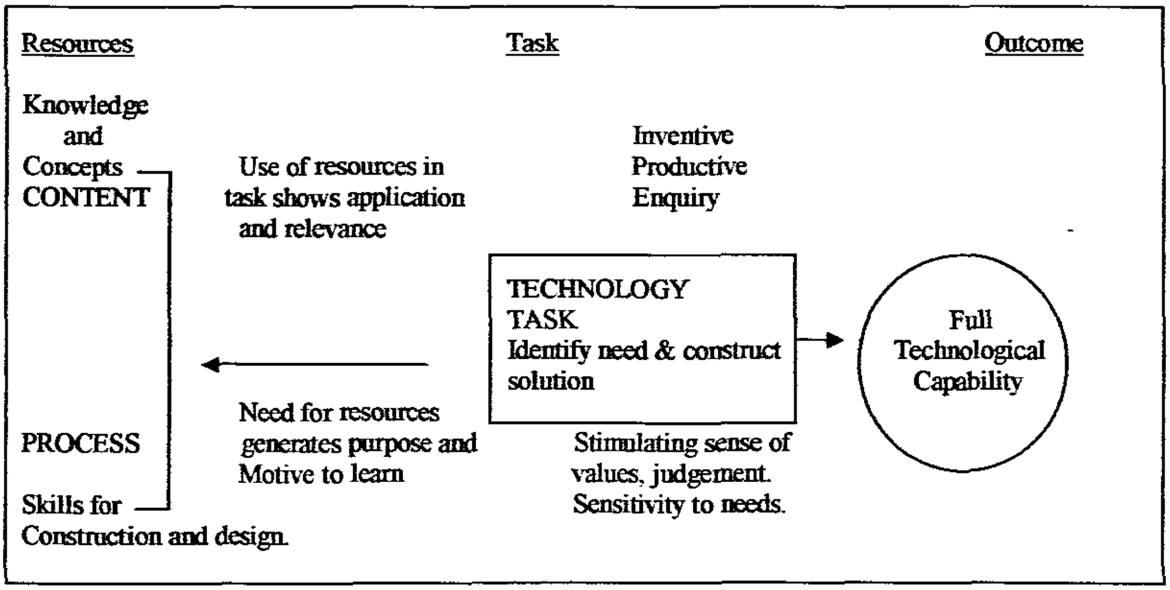
- Reflect and explore a variety of strategies to learn effectively
- Participate as responsible citizens in communities
- Be sensitive to a range of social contexts
- Explore education and career opportunities
- Develop entrepreneurial capacities.

With the introduction of Outcomes Based Education (OBE) in South Africa in 1998, about eight learning areas were introduced in the curriculum and technology became a new learning area, which is compulsory in the General Education and Training (GET) band (Department of Education 1997; Edwards 2001).

2.4 THE GOAL OF TECHNOLOGY EDUCATION

Mallet (1997) lists three valuable aims of technology on the development of the learner: technology contributes to the psychomotor development of the individual and their cognitive and effective development through a number of mechanisms. Technology education emphasises the process (learning how to learn) rather than the end product. Secondly, technology links affective, cognitive and psychomotor skills in a harmonious way through technological activities, which enhance problem solving skills. Finally, technology education offers an appropriate forum for discussion on issues such as ecology and sustainability, the appropriateness of technology, or knowledge dissemination in countries with limited resources.

According to Siraj-Blatchford (1993) and Banks (1994) the goal of technology education is to develop citizens who can display the competencies and values encapsulated in the critical and developmental outcomes. Banks (1994) explains technology education within the following model:



(Figure 2.1)

(Source: Banks 1994)

From this model it is clear that technology education expects the learner to use resources, knowledge and concepts, develop skills such as designing and construction, and participate in a process that leads to an attainment of the outcome, which is the full technological capability.

2.5 THE REVISED NATIONAL CURRICULUM STATEMENTS

Some authors have highlighted the teething problems of the new education system. Edwards (2001) points out that the development and implementation of OBE has been a challenging and bumpy road for the Education Department, resulting in the appointment of the Review Committee and the development of the Revised National Curriculum Statements (RNCS) in 2002.

The revised curriculum statements outlined new simplified set of learning outcomes for each of the eight learning areas in grades R to 9. The learning outcomes are derived from the critical and developmental outcomes. These learning outcomes describe what knowledge, information, skills, attitudes and values learners should know and be able to do at the end of a grade in a specific learning area.

The Revised National Curriculum Statement for technology clearly states that the purpose of technology is to contribute to the learners' technological literacy through experiencing problem solving skills, understanding the technological concepts and knowledge and using it responsibly and purposefully and appreciate the interaction between people's values and attitudes, technology, society and the environment. The essence of technology as a learning area is the application of the design process. This entails the identification of everyday problems and the use of resources, skills and values to develop practical solutions. The design process develops critical and creative thinking skills. Secondly, technology offers opportunities for learners to interact with each other and the community when they develop technological solutions. Thirdly, they become aware of their responsibilities within their classroom, school, family and society. Technology develops the learners' verbal and graphical communications skills. Through evaluating products, learners explore the positive and negative impacts of technology on their political, social, economical and biophysical environment. Lastly, technology provides learners with opportunities to interact with business and the industry who could help them to understand and adapt to changing economic realities.

Further unique features of technology include the opportunities for learners to:

- Learn by solving problems in creative ways,
- Use authentic context in real situations,
- Combine abstract concepts to concrete understanding,
- Expose learners to different learning styles when they investigate, design, make, evaluate and communicate.
- Apply knowledge in a purposeful way.
- Deal direct with inclusivity, human rights, social and environmental issues in their project work.
- Use a variety of life skills such as decision-making, critical and creative thinking, co-operation and needs identification.
- Create a positive attitude towards technology-based careers.

(Department of Education 2002: 5).

2.6 LEARNING OUTCOMES FOR TECHNOLOGY

As mentioned in the previous chapter there are three learning outcomes for the technology learning area (Department of Education 2002: 5).

- The first learning outcome, also known as the design process and the backbone of the technology learning area, is the creative and interactive approach of solutions to identifying problems for human needs. Skills associated with the design process are to investigate, design, communicate, make and evaluate.
- The second learning outcome deals with the content on structures, processing, systems and control. Structures focuses on practical solutions that involve supporting loads and ways of making products that are stiff, stable and strong when forces are applied to them. Processing focuses on practical ways in which materials may be processed in order to improve their properties to make them suitable for their intended use. Processing of many materials can be integrated with structures or systems and control. Systems and control is divided into mechanical systems and electrical systems. Mechanical systems focus on producing movement and examine how energy sources can be used to power products to produce movement. Electrical systems focus on the practical use of electrical energy in circuits to satisfy specific needs.
- The third learning outcome requires learners to understand the interconnection between technology, society and the environment.

It is important to know that there should be integration between these three learning outcomes. In applying the technological process, learners should have knowledge of technology and use these knowledge and skills ethically and responsibly.

2.7 The Technological Process

Edwards (2001) states that technology should be viewed as a process or approach, which aims to teach pupils to identify needs or problems, to propose, plan and work through practical solutions and to be able to evaluate the outcome. Sadeck (2001) emphasises the importance of teaching the learners to investigate, do research, analyse and make drawings to communicate their ideas. In Table 2.1 below, McCormick (1996) describes the technological process in the following order of sequence: identifying needs and opportunities, generating a design proposal, planning and making, evaluating and presenting and communicating. The following table reflects a summary of the technological process.

Table 2.1

THE TECHNOLOGICAL PROCESS	
1. Needs analysis and Description	• Identify a need or problem • Writing a design brief • Analysing the problem • Drawing up specifications
2. Design and Development	• Doing research • Generating ideas • Developing ideas and select best idea • Communicating your ideas
3. Planning and making	• Planning – choosing materials and equipment, working out cost, making a working drawing • Making – quality of construction, accuracy, finishing, appearance, safety
4. Testing, Evaluating and Displaying	• Testing • Evaluating • Displaying

(Source: McCormick 1996: 27)

Explaining the steps that need to be followed when teaching the technological process, McCormick (1996) writes:

The first step in the technological process is **needs analysis and description.** The learner **identifies a problem or need** within a specific context like the home, school, industry, business or sport. The learner **formulates a design brief,** which is a clear single sentence about the problem or need.

In the **analysis stage** of the process the learner identifies the core of the problem by asking questions about the reasons for the problem. At this stage, learners should develop research skills to investigate and seek answers from suitable sources.

Following the analysis stage is the **drawing up of specifications** that entail a number of aims for the solution to the problem. Specifications set the limits within which solutions must be found. During the design process reference is made to these specifications to ensure that the finished product would satisfy the human need or address the problem.

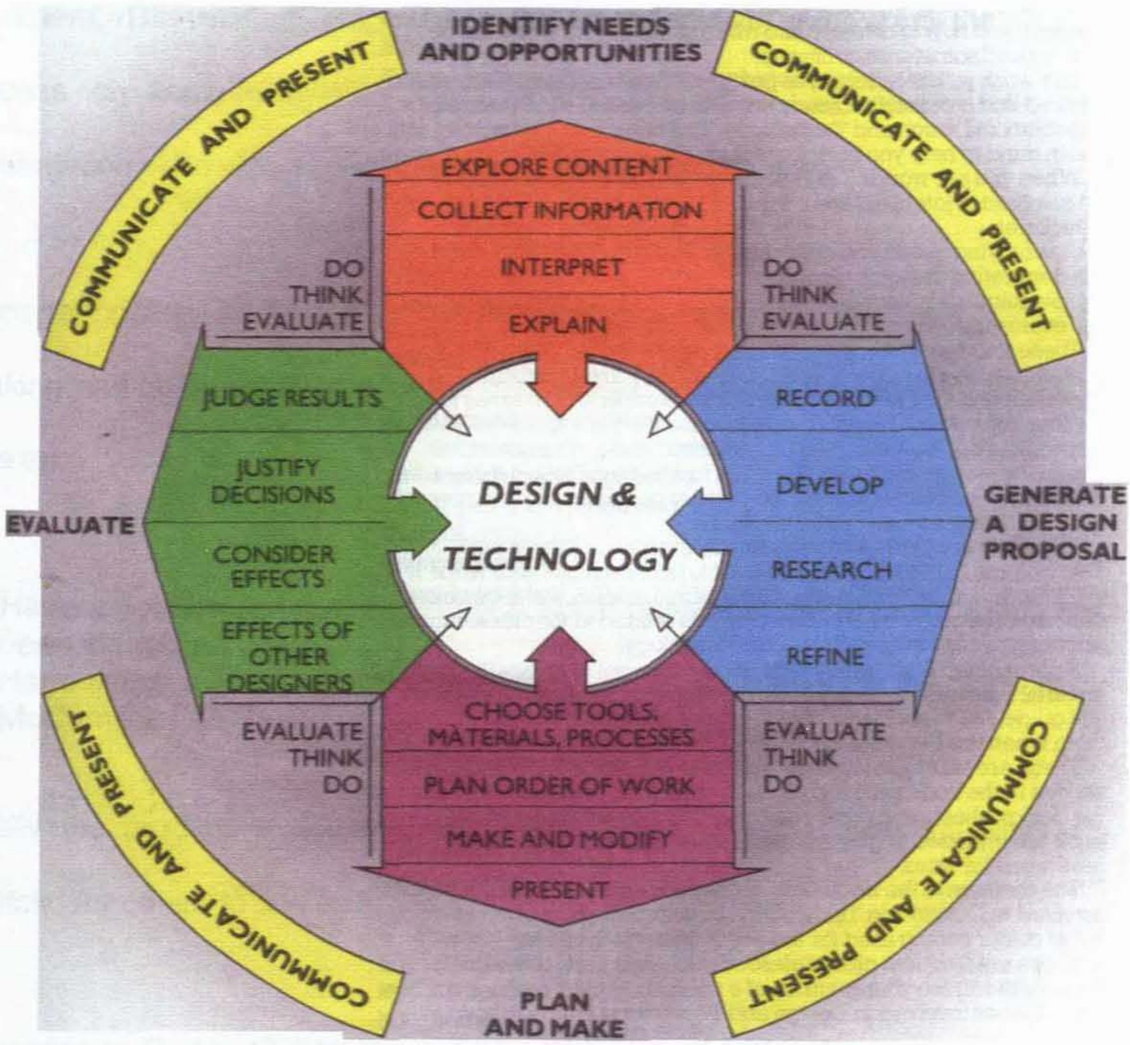
The second step in the technological process entails **design and development** where the learner should be able to **do research** on the relevant problem or need and seek a variety of possible existing solutions to his or her need. During this step the learner should develop research skills such as observation, doing literature surveys, interviews and drawing up a questionnaire. Relevant information should be found to solve his or her need.

Using his or her research the learner should **generate different ideas** to the problem. Checking the specifications that were set will be an indication whether the ideas will satisfy the need. **Communicating these ideas** with other learners and adults will help the learner to choose the best idea to develop as the final design. Communicating these ideas could be done by means of drawing and notes in a sensible and systematic order for others to understand how these ideas developed.

The third step in the technological process is the **planning and making** of the best idea. The learner must have knowledge of the best **materials** that could be used and **the tools** that they may need. The learner further needs to draw up a budget or do a **cost analysis** to determine the cheapest way in making the product. When **making** the actual product factors such as quality, appearance, accuracy, finishing and safety should be considered.

The final step in the technological process is to **test** whether the product will solve the problem or satisfy the need. It is advisable at this stage to check the specifications that were set earlier in the process.

Figure 2.2 below explains how evaluation could be carried out during the technological process.



(Figure 2.2)

(Source: Wright and Royle 1990).

Figure 2.2 illustrates that **evaluation** could be done continuously throughout the design process. The significance of this design process is the fact that after every step, the learner would communicate and present his or her work to be evaluated by others. This method emphasises the importance of evaluating the design process on completion after each of the four steps. Communication and presentation skills will develop throughout the design process.

Since technology is the interaction between the hand and the brain, between thinking and doing, at the end of the technological process the learner should be able to:

- Have a solution (product or artefact) which is a result of the need, which has been identified.
- Have a design portfolio, which shows the design process as in the diagram by McCormick (1996).

Finally the product or solution will be **displayed,** together with the learner's portfolio for others to see and to test.

According to Reddy (2001), the nature and scope of technology dictates a wide range of skills that could be acquired by learners in order to develop capability. Throughout the design process the teacher should teach the learner the skills to observe, do research, communicate verbally and graphically, choose tools and materials and evaluate the finished product. He classifies three categories of the skills that are considered for meaningful learning; cognitive, practical (motor) and related skills. Reddy (2001) also emphasises the fact that the process of problem solving and design are universally recognised as critical elements of and instruction in technology education. The ability to think conceptually, critically and creatively is fundamental to problem solving in technology education. Reddy (2001) argues that practical work leads to the development of motor skills through engagement in hands-on activities and further states that in addition to cognitive and practical (motor) skills other skills are developed such as social skills, communication skills (oral, written and graphic), management and entrepreneurial skills.

2.8 Importance of the technological process in the OBE curriculum

The technological process is seen as an appropriate vehicle for achieving the aims of the OBE curriculum. Dyrenfurth (1995) highlights the potential of the technological process to develop values and skills that can address the needs of the society and enable the learners to meet the critical cross-field outcomes. Reddy (2001) also explores OBE related programme development in technology education. He identifies the following OBE related content areas, skills and values as most important.

- **Knowledge**, which consists of general dimensions (including energy and power, information, and materials) and a specialist dimension (including systems and control, structures, processing and communication).
- **Skills** addressed in technology education which align with the critical outcomes of OBE include effective communication (oral, written and graphic), problem identification and problem solving, working with others, collecting, analysing and evaluating information, the use of science and

technology and understanding the world as a set of related systems. **Values, attitudes and awareness** include the inter-relationship between technology, societies, cultures, economic processes and the natural environment.

Technology is seen as an excellent curriculum vehicle for promoting planning, personal organisation and working with others in order to make things happen. Highlighting the importance of a practical curriculum for all to balance the academic, Black (1995: 4) suggests that technology provides "minds on as well as hands on" opportunities.

Sharing the same view, Mallet (1997) states that technology education emphasises the process (learning how to learn) rather than the end-product, links affective, cognitive and psychomotor skills in a harmonious way through technological activities which enhance problem solving skills and offers an appropriate forum for discussions on issues such as ecology and sustainability, the appropriateness of technology, and knowledge dissemination in countries with limited resources.

From the above discussion it is evident that if the technological process could be taught in an effective way, the goals of OBE could be fulfilled.

2.9 Unique approach to teaching technology

Several authors believe that the approach to the teaching of technology is unique. Sadeck (2001) claims that the approach to teaching technology is different from other disciplines because the primary focus of technology is not only the development of knowledge but also the development of practical skills and values. Waks (1992) also points out that technology has its own body of knowledge and should be taught as a school subject complementary to the scientific and humanistic subjects. The UNESCO (United Nations Educational Scientific and Cultural Organisation) study, done in 1983, categorises three main attributes of technology:

- Knowledge items such as: literacy, technology, scientific principles and concepts, mathematical terms and models, environmental studies, agriculture, materials and economics.
- Skills items such as: observation, design and construction, data collection, analysis, interpretation, research skills, technical and cognitive skills, making and manipulative skills, teamwork, communication, graphic communication and safe work habits.
- Ways of thinking such as: critical thinking, reasoning, decision-making, evaluation, analytical skills, problem-solving, positive attitudes, creative and innovative thinking skills.

Although several studies acknowledge that there are areas in technology that overlap with science and mathematics, they point out that technology education is a learning area with its own knowledge structure and that it should not be considered or taught as part of, or subservient to these learning areas.

Waks (1992) explains the knowledge structure of technology and the interrelationship between Mathematics, Science and Technology by means of the following Venn diagram.

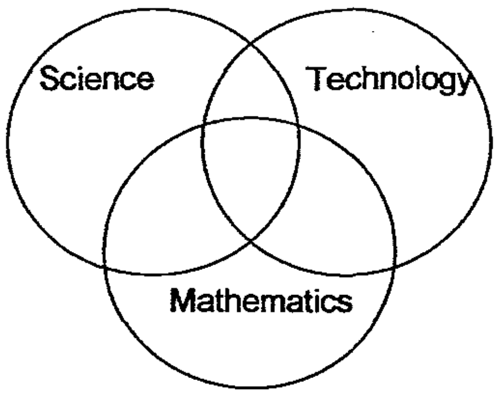


Figure 2.3

Harvey (1991) points out that the domination of technology by its stronger siblings appears to have been achieved in Poland by science, in Sweden by art and craft, and in Belgium by information technology, as such learning areas can use it to their advantage. He further states that the most common threat comes from science with which it forms an obvious partnership, and that care must be constantly exercised to ensure that technology does not lose its identity in science. Harvey (1991) proposes a multidimensional approach for distinguishing between science and technology as indicated in Table 2.2 below.

Table 2.2:

Emphasis in Science	Emphasis in Technology
1. Analysis of existing phenomena	Synthesis of a new "whole"
2. Abstract / theoretical	Concrete / practical
3. Idea initiation and development	Product / process development and implementation
4. Research	Design for application
5. Ideal (perfectionism)	Optimum (maximum possible quality)
6. General problem treatment	Specific problem solution
7. Curiosity as driving force	Need as main driving force
8. Assumptions (reliance on)	Facts (reliance on)
9. Accuracy (demand for)	Tolerance (with compromise)
10. Linkage of any kind	Social / economic linkage

(Harvey, 1991).

2.10 TEACHERS AS KEY PERSONS AND AGENTS OF CHANGE

The RNCS states that all teachers and other educators are key contributors to the transformation of education in South Africa. The Norms and Standards for Educators document (1995) describe the role of educators as being mediators of learning, interpreters and designers of learning programmes and materials, leaders, administrators and managers, scholars, researchers, lifelong learners and assessors. The Committee on Teacher Education Policy (COTEP) (July 1995) states that effective teaching requires knowledge of the learning process and the acquisition of appropriate knowledge, skills, values, attitudes and dispositions which take cognisance of the political, economical, environmental and social context in which the teaching and learning occur.

To be effective in technology, Reddy (2001) states that teachers have to develop three dimensions of knowledge:

- Knowledge about technology,
- Knowledge in technology and
- General technological pedagogical knowledge.

He further supports his argument by stating that teaching begins with an understanding of what is to be learnt and what is to be taught. From the above discussion it is evident that the technology teacher should be an innovative person with sound technological pedagogical knowledge.

2.11 NEED FOR A SPECIAL TECHNOLOGY EDUCATION PROGRAMME

Since Technology Education is a relatively new subject there is a great need to identify a basis for good practice in this area (Siraj-Blatchford, 1993). Teachers will have to empower themselves to become change-agents because the progress of the learners depends on the teachers' "education, motivation and freedom to innovate" (Beeby 1986: 37). It is suggested that educators should therefore be aware that technology centres on people and that people should have knowledge of their environment and problems in their community and globally to improve their living conditions. People's skills should be developed to identify problems, investigate and research situations, communicating their ideas and develop a suitable solution to these problems without any harm to people and the environment. Knowledge of the use of certain materials and technological equipment is also essential. Skills therefore imply not only manual skills but also mental skills.

Since the relationship between mathematics, science and technology could pose problems to technology teachers who do not have maths and science background, a special technology education programme for technology teachers is necessary. There is a general feeling that technology teachers should be trained by means of a specific programme for technology education and that science teachers without additional training would not be able to impart to their students the proper characteristics of technology education (Harvey 1991). Harvey (1991) further argues that whereas science teachers are mostly involved in analytical, theoretical concepts and the laboratory environment, the technology teacher relates these concepts to the world of work, such as marketing, quality assurance, entrepreneurship, safety and ergonomic considerations.

In Figure 2.4 below, Banks (1994) explains four different technology areas that need to be addressed by the professional development structure of technology teachers. All the areas are closely inter-related and depend on one another.

School Technology

Craft orientated approach

Production orientated approach

Applied Science approach

High tech approach

Technological concepts approach

Design approach

Problem-solving approach

Key competency approach

Science, Technology and Society approach

The subject content knowledge of Technology teachers

Nigeria: automobile technology, Food and agricultural technology, Building technology (Balogun, T.A 1989)

Hungary: industrial design, agriculture and technology; theory of systems, workshop in digital and analogue electronics. (Kedves, F.J., Gergely, L. and Kiss, S. 1989)

England and Wales: Control systems; (mechanism, pneumatics & electronics) Structures; Resistant materials (metal, wood & plastics); Textiles; Food technology.

Why teach Technology?

Its intrinsic value

Education for citizenship

Education for capability

Economic importance

Pedagogic knowledge

General pedagogy:
Classroom management
Lesson planning
Teaching Strategies
Assessment & Evaluation
Pupil's understanding.

Subject method:
Circuit board & Kits
Demonstration & use of analogies
Construction techniques
Teaching designing
Addressing values.

Curricular knowledge

Knowledge of syllabus & National Curriculum requirements.
Knowledge of Curriculum resources.

(Banks 1994)

Philosophy Psychology Sociology

There is a feeling that it is of utmost importance that educators must be trained and re-trained to make technology education work in schools. Banks (1994) suggests that the technology teacher who is currently a "wood expert" or a "metal expert" should be re-trained to develop science and engineering knowledge. According to Sadeck (2001) teachers have a lack of understanding of technology, they have low literacy levels in technology, they know what technology is, but they do not understand it.

From these comments it is clear that technology capacity in South Africa will depend solely on the quality of our technology education, and its stands to reason that without a solid curriculum and education in technology the development of the discipline will be doomed to fail.

2.12 ASSESSING THE TECHNOLOGICAL PROCESS

Assessment is described as a continuous planned process of gathering information about the performance of learners measured against the assessment standards (Department of Education 2002). The role of the teacher is to state what the learners are expected to achieve and teach in order to help learners to satisfy the requirements of the assessment standards. It is believed that in order for the learners to reach their full potential, assessment should be transparent, integrated with teaching and learning, based on predetermined criteria, varied in terms of method and context and valid, reliable, fair and flexible to allow expanded opportunities (Department of Education 2002). In technology the purpose of assessment is mainly to enhance individual growth and development, to monitor the progress of learners and to facilitate their learning (Banks 1994). The portfolio has become one popular way of assessing the learners. According to Van Dyk & Van Dyk (1998) the learner portfolio describes the ongoing interaction between the hand and the brain. It indicates what happens the moment the problem or need is identified, through all phases of the design process up to the evaluation of the final product or solution. It tells the story about the learners' attempts, thoughts, ideas, problems, drawings, designs, models and research. Van Dyk & Van Dyk illustrates an assessment model of the portfolio as in Figure 2.5. This model uses a mark allocation out of ten for each step in the design process, which can be converted into a percentage and then into a code. Each of the four code system represents the level at which the learner has achieved the outcome. The following codes are prescribed by government policy documents (Department of Education: circular 0225: 2003).

4 - Have exceeded the requirements of the learning outcome
3 - Have satisfied the requirements of the learning outcome
2 - Have partially satisfied the requirements of the learning outcome
1 - Have not satisfied the requirements of the learning outcome

During the design process learners may have the opportunity for peer assessment and self-assessment.

2.13 Assessment of learner portfolios.

The Department of Education (2001) describes various kinds of assessment that can be applied to the learner portfolios:

2.13.1 Diagnostic assessment.

The teacher uses diagnostic assessment to determine the nature and cause of the learning barriers experienced by a specific learner. This allows the teacher to support, intervene, guide or refer the learner to specialist help.

2.13.2 Formative assessment.

This is the process that monitors and support the process of learning, and is used to inform teachers and learners about a learner's progress so as to improve learning.

2.13.3 Summative assessment

This type of assessment gives an overall picture of a learner's progress specifically at the end of a year, or on transfer of a learner to another school. Summative assessment should be planned carefully at the beginning of a year and a variety of assessment strategies should be selected which will provide learners with a range of opportunities to show that they have learnt.

According to the Department of Education (2001) policy document, journals, written and oral reports, graphic communication, presentations, debates,

conducting research and analysing problems are examples of assessment strategies that can be used in the design process. In the planning and making stage of the technological process, assessment strategies include building models, testing the functionality of the model and evaluating the product.
Van Dyk & Van Dyk (1998), figure 2.5 lists all the steps of the technological process and from this list, teachers could make selections of the types of assessment strategies that can be used to assess learners through out the year.

This research will make an attempt at finding out how technology teachers plan and conduct assessment that relates to the application of the technological process by the learners.

Assessment: Portfolio

1. Needs analysis and description
   Learner will be able to:

	1	2	3	4	5	6	7	8	9	10
• Identify a need /problem										
• Write a design brief										
• Do a needs analysis										
• Draw up specifications										

2. Design and develop
   Learner will be able to:

	1	2	3	4	5	6	7	8	9	10
• Do research										
• Generating ideas										
• Developing ideas & select best idea										
• Communicating ideas, orally, drawings etc.										

3. Planning and making
   Learner will be able to:

	1	2	3	4	5	6	7	8	9	10
• Select material										
• Use processes										
• Do a cost analysis										
• Do working drawings										
• Produce a high quality product										
• Consider neatness & appearance										
• Finishing the product										
• Use time effectively										
• Consider safety										

4. Testing, evaluating & display
   Learner will be able to:

	1	2	3	4	5	6	7	8	9	10
• Consider the specifications										
• Make the product functional										
• Consider marketing possibilities										

Skills

Aspects where learner did good: ______________________________

____

Aspects which can still be developed: ______________________________

____

FIGURE 2.5 (Source: Van Dyk & Van Dyk 1998 p. 55)

From the above discussion, it is evident that the role of technology teachers is important both in terms of facilitating and assessing learning. The success of the learners depends on the teachers' knowledge, skills, attitudes and values. It is against this background that the manner in which technology teachers facilitate and assess one of the learning outcomes of the technology learning area was investigated. The details of the investigation and procedures that were followed form the subject of Chapter 3.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

As stated in the first chapter the primary focus of the research was on the first learning outcome in technology (i.e. the application of technological processes and skills) with the purpose of investigating how grade seven teachers and learners work towards the achievement of this outcome. In order to achieve the objective mentioned above, data collection and production methods were used. This chapter analyses and reflects upon these methods and in addition, examines data analysis and interpretation as well as the limitations of the study.

3.2. QUANTITATIVE AND QUALITATIVE METHODOLOGICAL PARADIGMS.

Current educational research supports different orientations to inquiry which have been classified as scientific versus humanistic, quantitative versus qualitative and positivist versus post-positivist. The following section captures the essence of the differences among quantitative and qualitative paradigms since they inform debate about research in education.

3.2.1 The quantitative paradigm

The quantitative paradigm places emphasis on the quantification of constructs. The quantitative researcher believes that the only best way of measuring the properties of phenomena is through quantitative measurement, i.e. assigning numbers to the perceived qualities of things. Central to this paradigm is the control for sources of error in the research process. The nature of the control is either through experimental control or through statistical controls (Babbie and Mouton 2001: 49).

The quantitative approach has been linked to positivism. Positivist forms of inquiry within educational research assume that educational contexts contain law-like generalisations, which are identified and manipulated as systems of distinct, observable empirical variables. The task of educational research is seen as quantification of these variables.

Positivist studies generally attempt to test theory, in an attempt to increase the predictive understanding of phenomena. In line with this Orlikowski and Baroudi (1991) classified Information Systems research as positivist if there was evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population.

Many assumptions of positivism have been criticised and arguments for post-positivism and its links to quantitative approaches are discussed below.

3.2.2 The qualitative paradigm

Qualitative researchers attempt to study human action from the insiders' perspective. The goal of research is defined as describing and understanding rather than the explanation and prediction of human behaviour and the emphasis is on methods of observation and analysis that "stay close" to the research subject (Babbie and Mouton 2001: 53). This would include observational methods such as unstructured interviewing, participant observation, and the use of personal documents. In the analysis of qualitative data, the emphasis is on grounded theory and other more inductive analytical strategies. Other terms that are used as synonyms for qualitative research are ethnography, field research and naturalistic research. The origins of qualitative research can be traced back to the pioneering work of sociologists who placed emphasis on doing fieldwork in the natural setting of actors. These researchers first brought to prominence the use of various qualitative methods that include the use of personal documents (Babbie and Mouton 2001). Qualitative approaches are linked to post-positivist research orientations which call for a shift from the notion that science alone is a measure of reality, knowledge and truth, to a notion that reality and knowledge *are socially constructed (Berger and Luckman 1973; Boland 1985; Kaplan and* Maxwell 1994), that knowledge is problematic and contested (Lather 1988), and that truth is locally and politically situated (Popkewitz 1984). Socially constructed knowledge is not considered to be a matter of deriving abstract principles, but rather about uncovering the historical, structural and value bases of social phenomena (Green 1990; Popkewitz 1990).

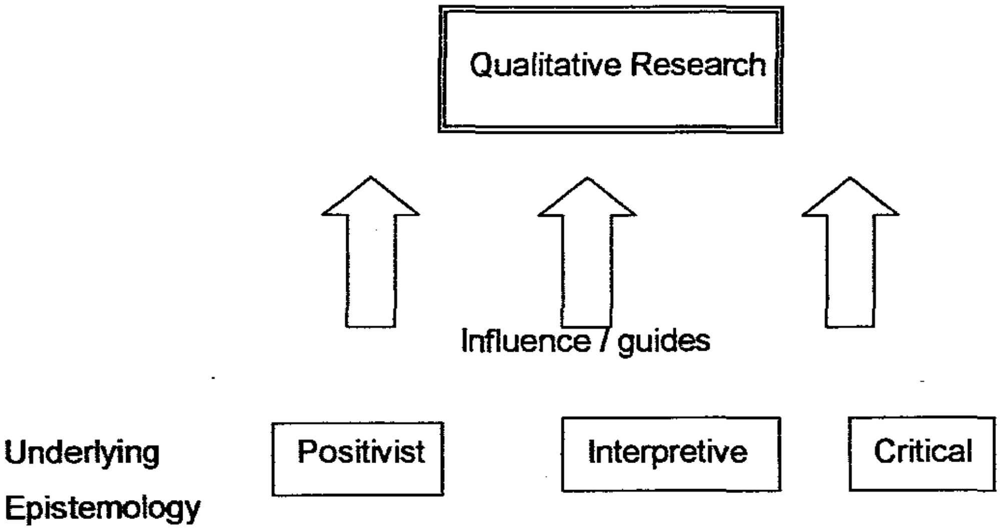
Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative research methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and text, and researcher's impressions and reactions. The motivation for doing qualitative research, as opposed to quantitative research, comes from the observation that, if there is one thing that distinguishes humans from the natural world, it is our ability to talk. Qualitative research methods are designed to help researchers understand people and the social and cultural context within which they live. Kaplan and Maxwell (1994) argue that the goal of understanding phenomena from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified.

Qualitative data involves words and quantitative data involves numbers. Another major difference between qualitative and quantitative research is the underlying assumption about the role of the researcher. In quantitative research, the researcher is ideally not an objective observer that participates in or influence what is being studied. In qualitative research, however, it is thought that the researcher can learn the most about a situation by participating and being immersed in it. These underlying assumptions of both methodologies guide and sequence the types of data collection methods employed.

3.3. PHILOSOPHICAL PERSPECTIVES

All research, whether qualitative or quantitative, is based on some underlying assumptions about what constitutes valid research and which research methods are appropriate. In order to conduct and evaluate qualitative research, it is important to know what these, sometimes hidden, assumptions are. The most pertinent philosophical assumptions are those, which relate to the underlying epistemology, which guide the research. Epistemology refers to the assumptions about knowledge and how it can be obtained.

Lincoln and Guba (1985) suggest four underlying paradigms for qualitative research: positivism, post positivism, critical theory and constructivism. Orlikowski and Baroudi (1991) suggest three categories, based on the underlying research epistemology: positivist, interpretive and critical. Qualitative research can be positivist, interpretive or critical. The following diagram illustrates the underlying philosophical assumptions for qualitative research:



(Source: Myers, M 1993)

(Figure 3.1)

3.4 DEBATES ON THE USE OF QUANTITATIVE AND QUALITATIVE APPROACHES

Many researchers support the idea that there is a human need to use both qualitative and quantitative research method. According to Miles and Huberman (1994) some researchers believe that qualitative and quantitative methodologies cannot be combined because the assumptions underlying each tradition are vastly different. Others think they can be used in combination only by alternating between methods and argue that qualitative research is appropriate to answer certain kinds of questions in certain conditions and quantitative is right for others He further states that some researchers claim that both quantitative and qualitative methods can be used simultaneously to answer a research question

Although most researchers do either quantitative or qualitative research work, some researchers have suggested combining one or more research methods in one study and that is called triangulation. Triangulation is defined by Denzin (1989: 236) as:

> the use of multiple methods, is a plan of action that will raise sociologists (and other social science researchers)above the personal biases that stem from single methodologies.
> By combining methods and investigators in the same study, observers can partially overcome the deficiencies that flow from one investigator or method. We can triangulate according to paradigms, methodologies and researchers.

Triangulation is generally considered to be one of the best ways to enhance validity and reliability in qualitative research. It is defined as the application and combination of several research methodologies in the study of the same phenomenon and can be employed in both quantitative (validation) and qualitative (inquiry) studies.

3.5 THE RESEARCHER'S POSITION

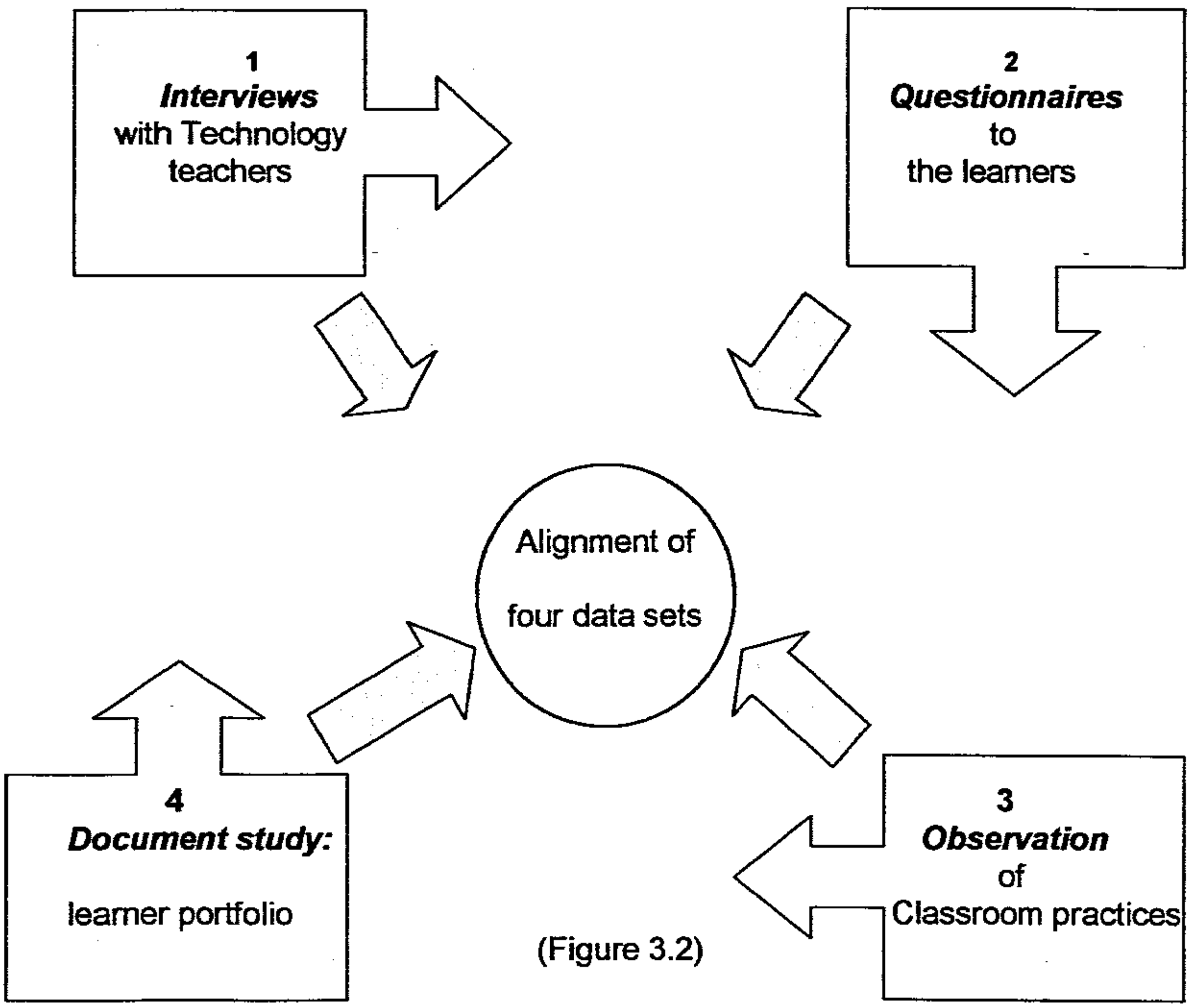
In this study, the researcher has subscribed to the idea of triangulation. A combination of research methods has been used and the study is characteristic of both positivist and post-positivist research. The research was conducted in the natural settings of social actors and the primary aim was an in-depth description and understanding of action and events. The aim of the researcher was to understand social action in terms of its specific context rather than attempting to generalize to some theoretical population. The natural setting of the social actor is the classroom. The purpose of this classroom research as clarified by Hopkins (1993) is an act undertaken by the technology teacher to enhance his or her own teaching. Hopkins (1993) further states that this research is a vision of teachers who have extended their role to include critical reflection upon their craft with the aim of improving it. Understanding research in their own and colleague's classroom is a way which teachers can take increased responsibility for their actions and create a more energetic and dynamic environment in which teaching and learning can occur.

3.6 THE RESEARCH GROUP

Cohen and Manion (1989) describe a sample as the population upon which the study focuses attention. The research group or sample in this study consisted of five technology teachers who taught grade seven learners and planned their activities in accordance with the National Curriculum Statement document in five different schools of the Paarl-Valley area. The schools that were under the control of the Department of Education and Training (DET) were selected randomly. Two teachers, who previously taught a practical subject before technology was implemented and three teachers, who taught academic subjects were selected. In each school ten grade seven learners were selected to investigate their learning experiences in the technology learning area at their schools. A total of fifty learners participated in the study.

3.7. THE RESEARCH DESIGN

The research design was characteristic of both quantitative and qualitative approaches and attempted to find out how the technological process is taught, learned and assessed. The research design could be represented diagrammatically as follows:



(Figure 3.2)

The above diagram illustrates that four data collection instruments were used to find out how technology teachers and learners worked towards the achievement of the first learning outcome in the technology learning area. By combining multiple observers, theories, methods and empirical materials, the researcher attempted, like other sociologists, to overcome the weakness or intrinsic biases and the problems that come from single method, single-observer, and single-theory studies.

3.8 DESIGN OF THE RESEARCH INSTRUMENTS

The design of the questionnaire and interview schedule was based on the steps that need to be followed when teaching and learning the technological process. The questions (Appendix 1) guided and enabled the respondents to indicate whether or not they were learning or teaching the technological process in a way that is stipulated in the Revised National Curriculum Statement for the technology learning area. The questions also attempted to find out how the teachers were learning, teaching and assessing the technological process. The questionnaire was pre-tested with one group of grade seven learners who were not going to participate in the study in order to find out if there were no ambiguous or difficult questions that the learners could not answer.

The researcher designed the following two observation schedules:

- An observation schedule (checklist) of the classroom practices (Appendix 3) of each of the technology teachers. The following items were listed to be observed and described: Content used in technology, types of resource tasks planned to enhance learners' skills, facilitation methodology used by teacher and the type of assessment.
- The second was a document study of the learner portfolio (Appendix 4). For the learner portfolio observations the plan was to select three learners' portfolios from each school randomly and evaluate the design process on the following aspects: Needs analysis and description, design and development, planning and making, and testing and evaluating.

3.9 DATA PRODUCTION METHODS AND THE RESEARCH PROCEDURE

Before conducting the research, permission to execute the investigation was sought from the director of the research centre in the Western Cape Education Department (WCED). A letter was sent to the directorate where the researcher explained the purpose and value of the study and the reasons why the specific schools were selected for the study (Appendix 5). Permission was also obtained from school principals and technology teachers.

The WCED granted permission (Appendix 6) subject to the following conditions:

- Respondents should not be identifiable in any way from the results of the investigation.

- Educators' programmes should not be interrupted.

- No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations.

As mentioned earlier, a variety of techniques were used to collect and produce data. The data was derived from interviews, questionnaires, observations of classroom practices and learner portfolios. The purpose of the interview was to investigate the way teachers plan, teach and assess the technological process. The questionnaire to learners was designed to find out the experiences of the learners with regard to teaching and assessment, and compare the responses of the learners with those of their teachers. The document study serves as a data collection method to validate the responses of the learners and the teachers and to determine differences and similarities. Data collection and production was done in a series of the following four phases.

3.9.1 Phase 1: The Interviews with grade seven technology teachers.

In this study, semi-structured interviews (Appendix 1) were used to investigate the planning of technology learning activities, the method used to teach the technological process and the process used to assess the design process. According to Cohen and Manion (1989) semi-structured interviews are less formal; the interviewer is free to modify the sequence of questions, change wording, explain questions and add to the questions; the interviewer can also probe for more specific answers to clarify and eradicate any misunderstanding.

Before the interviews were conducted, appointments were made with each of the respondents. The researcher assured the respondents of anonymity to their responses. Five teachers were interviewed over a period of five days from 7 June 2004 to 11 June 2004. Each respondent had the opportunity to elaborate on each question in accordance with his or her experience. The interviews were recorded on videotape for two purposes: to replay the interviewee's responses during data capturing and to view the responses' physical reaction to the questions.

3.9.2 Phase 2: The questionnaires to the learners.

According to Vermeulen (1998) in the questionnaire the response is more direct than indirect, data can be easily analysed and classified, the number of possible responses is limited and the respondent must make a choice between alternative responses that are given.

The questionnaires were used to collect information that related to the learners' experiences with regard to the teaching and learning of the technological process. (Appendix.2). The administration of questionnaires took place from 26

July 2004 to 30 July 2004. A class list of the Grade seven learners (boys and girls separated) in each school was used and every tenth learner on the list was selected to complete the questionnaire. A total of ten learners per school were selected and all learners completed the questionnaire. At the end of the process fifty questionnaires were completed.

The researcher did not post any of the questionnaires to the school, but took the questionnaires to the various schools and supervised the completion of the questionnaires himself. All the questionnaires were identical for the five schools, except the cover page, which was marked: A, B, C, D and E to identify the responses from each school and for comparison with the data from the interview, the observation schedules and portfolio survey.

3.9.3. Phase 3 (a): Observation schedules of classroom practices.

Observation is a method used by qualitative researchers to become more involved personally in their research and be more critical towards their methodology. According to Babbie and Mouton (2001) observations compel qualitative researchers to think more systematically about the epistemological assumptions and the methodological consequences of their practice. Classroom observations were conducted by the researcher from 26 July 2004 to 30 July 2004 to gather information that related to the teaching and learning processes.

Observations were also used to supplement the researcher's other data sources and to gain a deeper understanding of the practice of technology educators.

3.9.4. Phase 3 (b) Document study

A study of learner portfolios was also conducted from 26 July 2004 to 30 July 2004. A checklist (Appendix 4) was used to observe the aspects of the technological process that were learned and assessed. The data from the document study was compared with the responses of the interviews with teachers and the learners' responses to the questionnaire.

3.10 ANALYSIS AND INTERPRETATION OF DATA

Data collected through the use of questionnaires was analyzed quantitatively. The responses from the questionnaires were coded and presented in the form of tables and graphs. A computer was used to set up tables and graphs. When the graphs were set up the researcher realized the truth in Babbie and Mouton's (2001: 410) statement which reads as follows: "What the microscope was to biology, what the telescope was to astronomy – that's what the computer has been to quantitative social research". Column graphs were used to illustrate the different responses of the learners.

Data from the interviews and observation schedules was qualitatively analysed (Babbie and Mouton, 2001). The responses were put into different categories and summarised, and emerging themes (Strauss and Corbin, 1990) were identified by means of thematic analysis. The thematic analysis of data enabled the researcher to identify patterns and similar ideas that emerged from the teachers' point of view in their teaching and facilitation of the technological process.

3.11 DATA VERIFICATION

According to Bell (1993) the procedure for collecting data should always be examined critically to assess to what extent it is likely to be reliable and valid. In this study validity and reliability were ensured through the use of a variety of data generating methods. The use of multiple research methods has been mentioned as one strategy of promoting qualitative research validity (Burke 1997: 292-293). In an attempt to improve validity of this research data from the interviews with technology teachers were compared with data from the learners' questionnaires. Data from the observation schedules were also compared with the responses of both the teachers and the learners. The aim for comparing data from the various research instruments used was to find similarities and differences in responses and establish the reasons behind such similarities and differences.

3.12 LIMITATIONS OF THE STUDY

The only limitation of the study was the reluctance of some of the teachers to make available the learners' portfolios and completed products. This made it difficult for the researcher to give a comprehensive report on the findings of the document study. The researcher thus had to abide to approval conditions from the WCED which states that teachers and learners are under no obligation to assist the researcher in his investigation.

Both the quantitative and qualitative approaches were useful for the purpose of the study. The results from these data generating methods will be documented in Chapter 4.

CHAPTER 4

THE RESEARCH FINDINGS

4.1 INTRODUCTION

As indicated in the previous chapter the purpose of the study was to investigate how grade 7 teachers and learners work towards the achievement of the first learning outcome of the Technology learning area. This chapter gives a brief description of the research findings on how the teachers plan, teach and assess the technological process and how the learners experience teaching and assessment. The chapter is divided into four sections. The first section focuses on the responses of Technology teachers to the interviews (Appendix 1). The second section deals with the learners' responses to the questionnaire (Appendix 2). In the third section attention is focused on the research findings from the observation of classroom (Appendix 3) practices and the fourth section presents the findings derived from the study of learner portfolios (Appendix 4).

4.2 RESPONSES OF TECHNOLOGY TEACHERS TO THE INTERVIEWS

The research findings from the interviews with the five teachers were divided into the following three sections:

- Planning learning activities for teaching the technological process
- Teaching the technological process, and
- Assessing the technological process

4.2.1. Planning Learning Activities

The section on the planning of the learning activities for teaching the technological process focused on the content area that the teachers preferred to use, reasons for content preference, types of planned resource tasks, and the manner in which the teachers planned to encourage their learners to identify human needs.

4.2.1.1. Most preferred content area.

The Revised National Curriculum for the technology learning area lists three content areas for technology. These are processing, systems and control and structures which teachers have to teach and assess. The first question attempted to find out find out which content area teachers feel most confident to plan and teach. Responses from two teachers indicated that the content on structures was easier to plan and teach while two teachers preferred to teach processing. Only one teacher indicated a preference in planning and teaching systems and control.

4.2.1.2 Reasons for the content preference

The second question aimed at getting the reasons for the preference of the content area mentioned in the first question. Two teachers stated that they preferred the content on structures because they previously taught woodwork. The reasons given by two teachers who preferred to teach processing were that they were female teachers who had experience in food processing at home and who were involved in teaching Home Economics before technology was introduced as a learning area. One teacher who mentioned systems and control as her favourable content area stated that she was familiar with scientific terms such as leverage, forces, friction, pneumatics and hydraulics, etc. as she had a qualification in Mathematics and Physical Science.

4.2.1.3. Types of resource tasks planned for mastering the technological process.

The teachers were asked to explain the types of resource tasks they planned to teach learners in order to master the technological process. Resource tasks are small-scale activities that aim at developing the learner's skills needed to accomplish the design and making of a technological product. Examples of such skills include measuring, cutting, folding, soldering and joining materials. Two of the five teachers who were interviewed stated that they provided their learners with opportunities to practise how to measure, cut, fold and join materials such as paper and cardboard before giving the learners the capability task of designing and making the technological product. Three of the teachers admitted that they did not allocate time for the resource tasks in class as they assumed that learners would be able to develop practical skills during the design and making processes.

4.2.2. Teaching the technological process

This section examines the way teachers teach the design process, the making of the product, and evaluation of products.

4.2.2.1. How teachers facilitate the design process.

The aim of the fourth question was to gain an understanding on the way teachers facilitate the design process in their classes. The first step of the design process is to identify a human need with the aim of proposing, planning and working through practical solutions. Three of the five interviewed teachers stated that they start the design process by encouraging their learners to identify needs that could be addressed to improve the learners' immediate environment. This involved designing and making a low cost house for a family, an apparatus to irrigate a community garden, a pencil holder, and a rain-proof school bag. Then they asked their learners to provide the solution to the problem by formulating the design brief and setting up specifications for the product. After the learners have written the design brief and specifications of products, they are required to make various illustrations of possible design ideas, discuss and select the best idea and then make the product. The responses from two teachers indicated that they followed the same process but instead of using the learners' environment they used case studies documented in books by writers from other parts of the world and did not involve the learners in the making of products.

4.2.2.2. How teachers facilitate the making of the product.

The fifth question was asked to find out how teachers facilitate the making of the designed products such as low cost houses for families, apparatus for irrigating community gardens, pencil holders, and rain-proof school bags. One teacher indicated that he encouraged his learners to use the design portfolio in order to ensure that the product is made according to the way it was designed. One of the respondents stated that learners are encouraged to use recycled material to build their technological products. Another teacher stated that she supplies materials to the class and the learners all make the same pencil holder, with some changes to the appearance and finishing of the product. Two teachers pointed out that time and resources were a major problem and the learners seldom made the products.

4.2.2.3. How teachers encourage learners to evaluate products.

The sixth question attempted to gain an insight into the way the teachers encouraged the learners to evaluate their finished products. All the teachers who were interviewed stated that they did not place much emphasis on the evaluation of the product. They indicated that they become satisfied as long as the finished product complies with the specifications of the design process.

4.2.2.4. Most challenging section to teach in the technological process

The seventh question was asked to investigate the most challenging section of the technological process. The two sections that the teachers were asked to compare were the teaching of the design process and the teaching of the making process. All the teachers mentioned that the design process is challenging and time consuming due to a variety of skills that need to be addressed.

4.2.3 Assessing the technological process

Attention in this section is focused on what is assessed and how assessment takes place.

4.2.3.1 Sections of the technological process teachers assess

The eighth question aimed at finding out which sections in the technological process the teachers assessed. The sections are indicated as sections A, B, C, and D in Table 4.1 below.

THE TECHNOLOGICAL PROCESS	
Section A Needs analysis and Description	• Identify a need or problem • Writing a design brief • Analysing the problem • Drawing up specifications
Section B Design and Development	• Doing research • Generating ideas • Developing ideas and select best idea • Communicating your ideas
Section C Planning and making	• Planning – choosing materials and equipment, working out cost, making a working drawing • Making – quality of construction, accuracy, finishing, appearance, safety
Section D Testing, Evaluating and Displaying	• Testing • Evaluating • Displaying

Table 4.1

All the teachers stated that they assess their learners on sections A and B. In section A the teachers indicated that they focus attention on identifying a need or problem, writing a design brief and drawing up specifications of the product. In section B assessment was conducted on generating ideas and selecting the best idea. Only two teachers indicated that they focus attention on section C and none of the interviewees mentioned assessment on section D.

4.2.3.2. How teachers assess the technological process

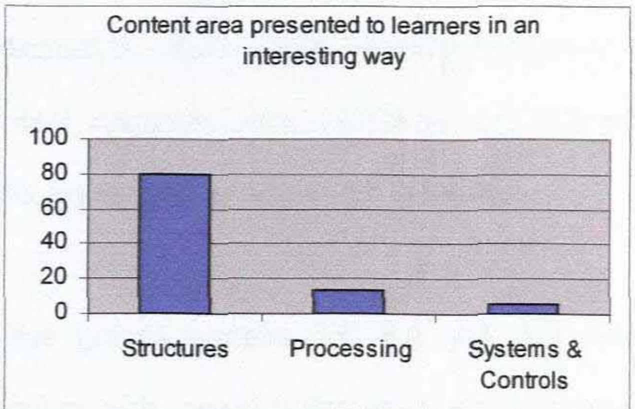
In the last question the interviewees were asked to explain how they assess the learners. All the teachers who were interviewed mentioned that they assessed the design process by means of learner portfolios and that they used communication by means of written work and graphical illustrations as main assessment activities in the design process. Two teachers pointed out that they experienced confusion with regard to assessment practices.

4.2.4 Learners' experiences towards teaching and assessment

The following graphs represent the responses of fifty learners to the questionnaire on their learning experiences.

4.2.4.1 Interesting content area

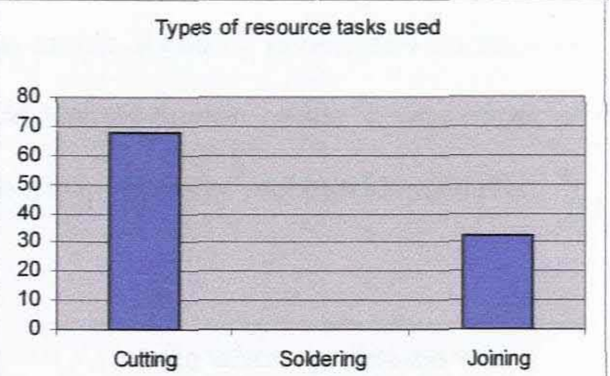
The learners were asked which content area in technology was presented to them in an interesting way. The responses of the learners to this question are reflected in graph 4.1 below.



Graph 4. 1

Graph 4.1 indicates that 80% of the learners find structures interesting and that they enjoy the content of this area. Processing was enjoyed by 14% of the learners and 6% enjoyed systems and controls.

4.2.4.2. Types of resource tasks used.



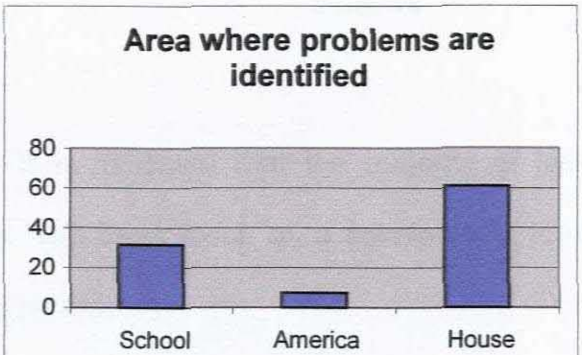
Graph 4.2

Practical skills enable learners to make the model or the product, which they have designed. The question, on the most frequently used resource task, was asked to find out the type of practical skills the learners were frequently exposed to, in order to be capable in making their final product. About 68% of the learners indicated that cutting was the most frequently used resource task. Joining of different materials was mentioned by 32% of the learners and soldering was not mentioned by any of the learners.

The following five graphs (graphs 4.3, 4.4, 4.5, 4.6, and 4.7) present the learning experiences with regard to the teaching of the design process. They show various steps that need to be followed by the learners when they design their products.

4.2.4.3 How learners identified human needs or problems

The third question aimed at getting information on places in which the learners are encouraged to identify human needs. It was expected that the responses would indicate the environment of problem identification.

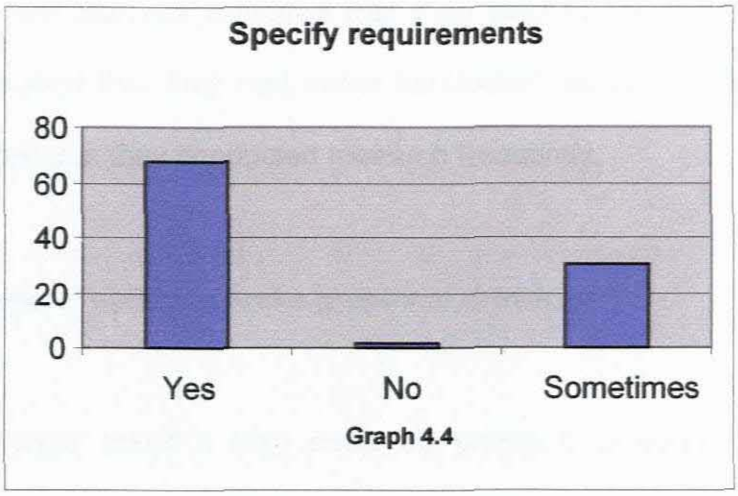


Graph 4.3

In graph 4.3 it is reflected that 61% of the learners indicated that they identified house-related human needs while 32% identified school-related human needs. Only 7% of the learners stated that they used other places like America as the source of problem identification.

4.2.4.4 Setting up specifications

In the questionnaire the learners needed to indicate whether they specify certain requirements that the product they design should have. The learners' responses are reflected in graph 4.4 below.

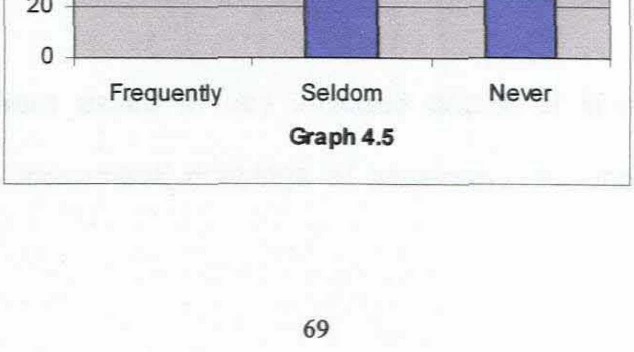


Graph 4.4

From graph 4.4 it is indicated that the majority of learners use a set of specifications that help them focus on a solution that is intended to satisfy a need or address a problem.

4.2.4.5 Conducting research during the design process

The learners were asked how often they were required to conduct research when they learned the technological process.

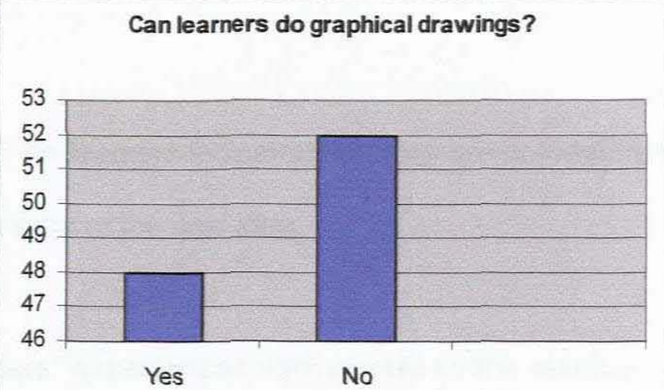


Graph 4.5

About 75% of the learners indicated that they seldom conducted research while 25% indicated that they had never conducted research. None of the learners indicated that they conducted research frequently.

4.2.4.6 Learners' ability to make graphical drawings

The learners were asked if they could do graphical drawings during the design process and they responded as reflected in graph 4.6.

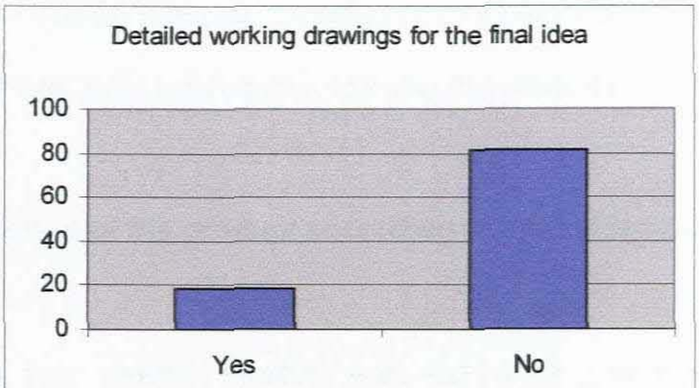


Graph 4.6

About 48% of the learners indicated that they could do graphic drawings while 52% stated that it was difficult for them to do graphic communication.

4.2.4.7 Detailed working drawings for the final idea

The learners were asked if they included details of illustrations, such as measurements, movement, drawings of assembly, etc when they draw their final ideas. The final idea is a detailed and logical drawing of information that illustrates the plan on how the product should be made.

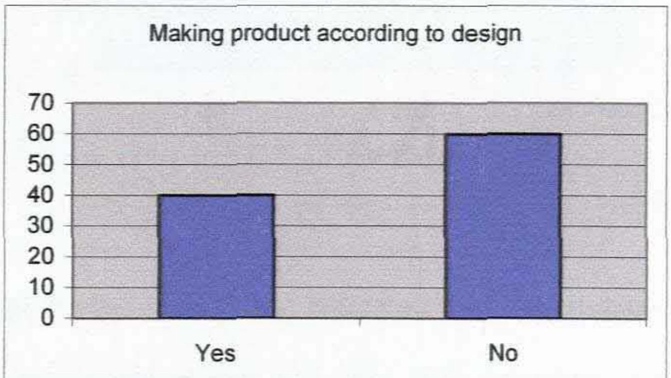


Graph 4.7

The majority of the learners indicated that they are not required to provide detailed illustrations of the final idea.

4.2.4.8 Learners' experiences with regard to the making process

Learners were asked if they make their product according to what they designed in their portfolio.

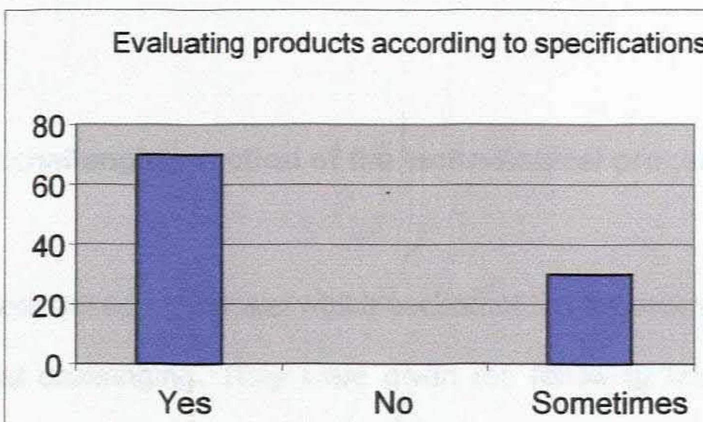


Graph 4.8

Only 40% percent of learners make their product according to their design. About 60% of the learners indicated that they do not make their products according to the design portfolio. Included in this percentage are the learners who stated that they were not required to make the products.

4.2.4.9 Evaluation of the product according to specifications

The following two graphs (graphs 4.9 and 4.10) present the learning experiences that relate to the evaluation of the made products. Firstly the learners were asked if they continuously evaluated their products according to the specifications they had set and secondly if they evaluated their products to test their functionality. The responses of the learners to the first question are reflected in graph 4.9 below.

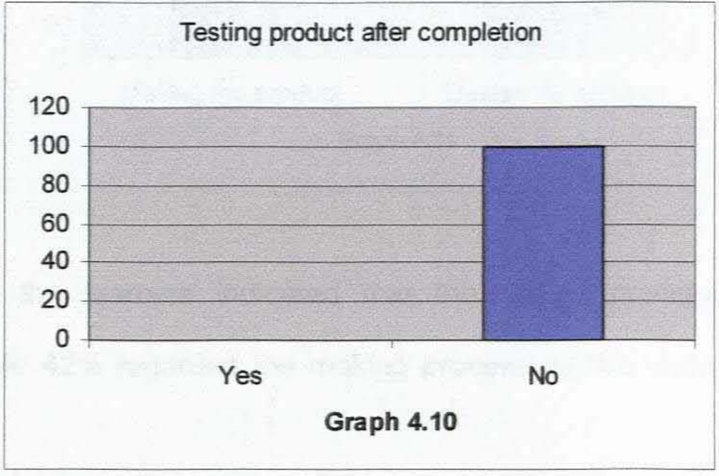


Graph 4.9

The majority of the learners (70%) indicated that they evaluated their products according to the specifications and only 30% admitted that they sometimes use the specifications to evaluate their products.

4.2.4.10 Evaluation of the product according to functionality

Graph 4.10 shows the responses of the learners to the second question.

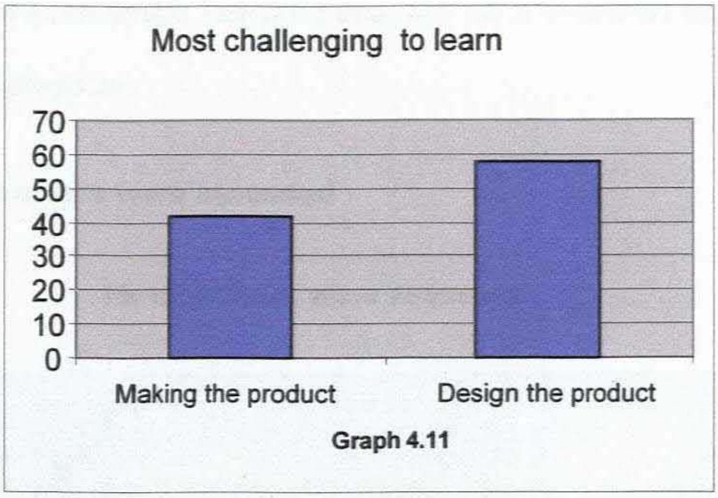


Graph 4.10

Almost all the learners stated that they were not required to evaluate their products to test if they function or satisfy the need that they were designed and made for.

4.2.4.11 Most challenging section of the technological process

The learners were asked to indicate which section of the technological process they found most challenging. They were given the following two sections to select: (a) The design process and (b) The making process.

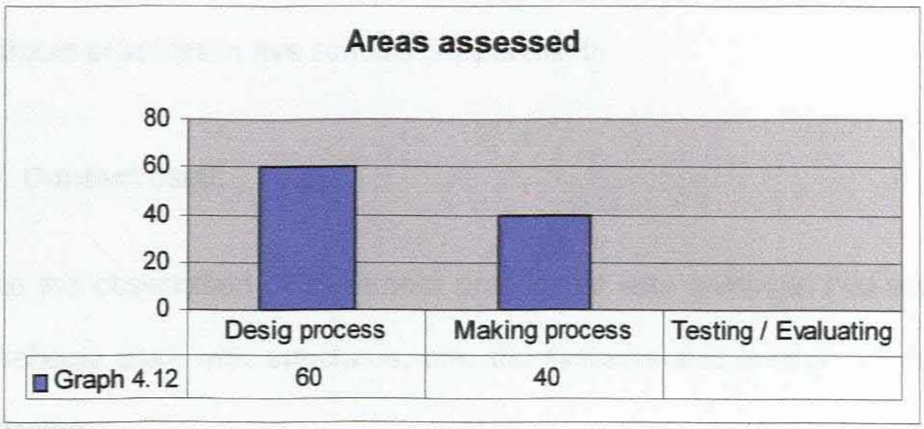


Graph 4.11

About 58% of the learners indicated that the design process was most challenging while 42% regarded the making process as the most challenging section.

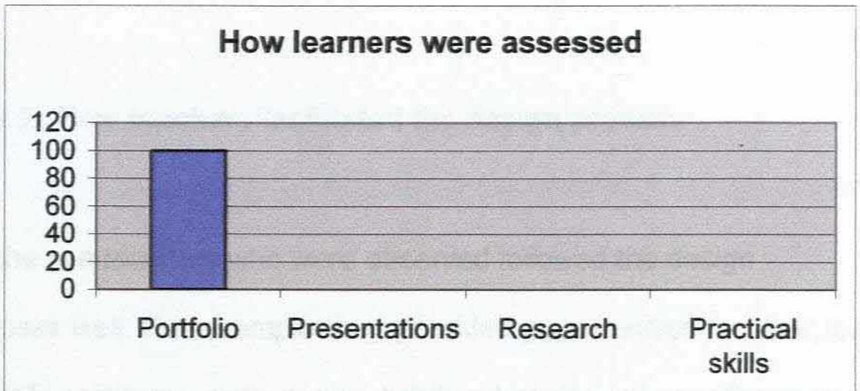
4.2.4.12 Sections of the technological process that were assessed

The learners were asked to indicate the section of the technological process they were assessed on.



About 60% of the learners indicated that they were assessed on the design section while 40% stated that they were assessed on the making of the product. None of the learners indicated that they were assessed on testing and evaluating their products.

4.2.4.13 How learners were assessed



Graph 4.13

All the learners indicated that they were assessed on their learner portfolio and no assessment was on presentations, research or on their practical skills.

4.3 Observation of classroom practices

The following section presents the research findings from observations of classroom practices in five schools (Appendix 3).

4.3.1. Content used:

During the observation of classroom practices it was observed that two of the five schools dealt with structures, one did systems and control, two did food processing.

4.3.2 Types of resource tasks used.

It was observed that only two teachers used resource tasks to develop measuring, cutting, folding and joining skills. Three of the five teachers did not use resource tasks.

4.3.3 How teachers facilitated the design process

All the five teachers who were observed followed the design process well. For example they provided opportunities for their learners to identify problems, write design brief and setting up specifications. Three of the teachers used the learners' environment to identify problems whilst two used case studies from foreign countries.

4.3.4 How teachers facilitate the making of the product

It was observed that three teachers require their learners to make products for their immediate environment such school or home. Examples of the products included school bags, pencil holders, and products to irrigate gardens. The learners were encouraged to use recycled materials for making the products. No making of products was observed at two schools.

4.3.5 How learners were encouraged to evaluate their products

Only two teachers gave the learners opportunities to evaluate their products and the evaluation was only limited to evaluation according to specifications. No evaluation of products according to functionality took place during the observations at all the schools.

4.3.6 Sections of the technological process that were assessed

All the teachers were assessing different aspects of the design process. These included writing the design brief, drawing up specifications and generating ideas.

4.3.7 How learners were assessed

It was observed that all the teachers used the learner portfolios as the major form of assessment.

4.4. Study of learner portfolios

This section presents the findings from the study of learner portfolios in five different schools. The study of learner portfolios focused on the following three sections:

- Section A: Needs analysis and description
- Section B: Design and development

- Section C: Planning for making the product

4.4.1 Section A: Needs analysis and description

In Section A, attention was focused on how the learner identified the need or problem, developed the design brief, analyse the problem and set up specifications for the product.

4.4.1.1 Identifying a need or problem.

The portfolios in all the schools indicated that the learners were assessed on need or problem identification. Three schools used their immediate environment for problem identification and two schools used case study documents as samples for problem identification. Learner portfolios in two schools indicated that the learners used the content on structures while two schools used the content on processing. Only one school used the content on systems and control.

4.4.1.2 Design brief

Two of the schools where the research was conducted had a design brief where learners had to write a paragraph on what they had to design. This activity was assessed in the portfolio. Three schools did not require the learners to write the design brief.

4.4.1.3 Problem analysis

None of the schools had problem analysis in their portfolios.

4.4.1.4 Specifications

All the schools required their learners to specify requirements for the final product.

4.4.2 Design and development

The focus of attention in this section was on evidence in learner portfolios that the learners had conducted research, generated ideas, developed and selected best ideas, and communicated the ideas.

4.4.2.1 Conducting research

Two of the schools' portfolio had research as part of the design and development section in their portfolios. This type of research consisted of pictures of products that were on the market. Three of the schools had no research in their portfolios. None of the schools assessed learners in this area.

4.4.2.2 Generating ideas

None of the learners' portfolio at the five schools addressed this part of the design process.

4.4.2.3. Developing ideas and selecting the best idea.

It was evident from the learner portfolios that this section which entails graphic ideas from learners on possible ideas to address the need, consisted of the basic drawings for the solution. All the portfolios had some drawings that were relevant to the solution, although essential illustrations did not include information such as measurements, movement and ways in which the parts should be assembled

From the study of learner portfolios it became evident that the design process was the only activity that was assessed. There was no evidence of planning for making the product in learner portfolios.

CHAPTER 5

SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The research findings from the interviews, questionnaire, classroom *observations and learner portfolios were documented in the previous* chapter. This chapter presents the summary of the findings, conclusions and recommendations. The chapter is divided into two sections. The first section deals with the summary of the research findings and conclusions and the second section puts forward some recommendations that could improve the situation portrayed in the previous chapter.

5.2. SUMMARY OF THE FINDINGS AND CONCLUSIONS

By comparing the data collected through the use of four different research instruments mentioned in chapters 3 and 4 with the aim of finding similarities and differences, derived the summary of the findings and conclusions outlined below.

5.2.1 Most preferred content area

The examination of data from the interviews, questionnaire, classroom observations and learner portfolios revealed similarities with regard to the most preferred content area. The teachers stated that they were more comfortable with teaching structures and 80% of the learners found the content on structures interesting and enjoyable to learn. When classroom observations were conducted and learner portfolios consulted the teaching and learning of structures was prevalent. The content on systems and controls was the least preferred to teach and learn.

It can be concluded that both teachers and learners find it easy to use the content on structures to teach and learn the technological process.

5.2.2 Reasons for content preference

The teachers who preferred to teach processing had experience in food processing at home and had been involved in teaching Home Economics. Teachers who preferred the content on structures had previously taught woodwork. One teacher who preferred to teach the content on systems and control had a qualification in Mathematics and Physical Science. The response of the teacher who had the science background was in line with Waks' (1992) argument that there is interrelationship between Mathematics, Science and Technology.

It can be therefore concluded that there is a relationship between content preference and subject specialisation in teacher training and that teachers who do not have Mathematics and Science background might find it difficult to teach the content on systems and control. The findings also reveal that it might not be easy for one teacher to master all the prescribed content areas of the technology learning area.

5.2.3 Types of resource tasks used.

Cutting, joining, folding and measuring were mentioned as the types of resources that were frequently used by some teachers. According to the learners more emphasis was placed on the skill of cutting while soldering was not given attention at all. Some teachers pointed out that they did not allocate time for resource tasks in class although Sadeck (2001) states that the learners should be taught all the skills that are required for the design and making processes. Reddy (2001) also emphasizes the importance of practical work which leads to the development of skills as learners who are not exposed to resource tasks might struggle to design and make their products and could ultimately loose interest in the technology learning area. Supporting the same view, Waks (1992) also points out that the approach to teaching technology is different from other disciplines because the primary focus of technology is not only the development of knowledge but also the development of skills and values.

From the above discussion the following conclusions can be drawn:

Some of the teachers have little or no understanding that the development of skills is a process and that the learners should be given sufficient time to master the skills before they are required to design and make technological products. Skills development is a new challenge that needs attention in the teaching profession.

5.2.4 How teachers facilitate the design process.

The following section is a summary of the findings that relate to some of the procedures that need to be followed by teachers when then they facilitate the design process. The learners also need to follow these procedures (presented in Table 4.1) when they learn to design their products.

5.2.4.1 Identification of human needs or problems

The responses of the learners correspond with those of the teachers who indicated that they used the learners' immediate surroundings in order to familiarise them with their community needs or problems that need to be solved. Although the majority of the teachers who were interviewed indicated that they encouraged the learners to identify needs in their immediate environment, there are still those teachers who make little or no use of the learners' immediate environment. This is a cause for concern as learners need to be educated to solve problems in order to enhance the society's quality of life. The importance of identifying needs or problems within the learners' immediate surroundings is emphasized by Kwende (1996) who states that the quality of a culture or society is related to the ability of its members to solve problems. Sharing the same view, Dyrenfurth

(1995) points out that technology should enhance the quality of life of all citizens and make them serious economic competitors. These arguments suggest that the teachers should have knowledge of environmental issues, locally as well as globally, and in their planning should engage learners in these issues.

5.2.4.2 Formulating the design brief

From the responses of the teachers to the interviews, classroom observations and learner portfolios, the majority of the learners were given opportunities to write a design brief.

5.2.4.3 Setting up specifications

The findings from all the research instruments indicated that the majority of the learners were encouraged to use specifications for their products. The use of specifications is recommended as it helps learners to work systematically towards a solution and is also important for the evaluation of the finished product (McCormick 1996).

5.2.4.4 Conducting research

The responses of the learners to the questionnaire and the study of learner portfolios revealed that some of the teachers paid little attention to the teaching of the skill of doing research on technological products. These responses and the study of learner portfolios revealed a gap in the teaching of the technological process. This gap could be filled if the learners are encouraged to conduct interviews with experts, use the internet, consult documents and make observations from other sources such as shops and flea markets in order to enrich their ideas for the design and making process.

5.2.4.5 Making graphical drawings and detailed working drawings for the final idea.

From the learners' responses to the questionnaire and the study of learner portfolios it became clear that not all learners have developed the skill of graphic communication and the natural talent to communicate graphically. It also became apparent that the learners are not required to provide detailed illustrations of the final idea although the official documents (Department of Education 2002) expect the learners to be able to provide detailed working drawings that indicate how the product should be made, materials and tools that need to be used and illustrations of how the parts of the product should be assembled. This design and development process is important in the design process as it portrays the learners' ability to plan all aspects of their product logically and systematically.

The findings from all the research instruments indicate that teachers have a general understanding of how the design process should be taught. In their teaching, they follow Edwards' (2001) suggestion that Technology should be viewed as a process or approach, which aims to teach pupils to identify needs, or problems, to propose, plan and work through practical solutions and to be able to evaluate the outcome. However, there are important areas of the design process that are given little or no attention. Such areas include research, the refining of the best idea by showing movements, measurements, three-dimensions and a detailed work plan. The omission of these areas could deprive the learners of developing important graphical and communication skills that are needed to produce the best solution. Lack of emphasis on such skills could be attributed to the limited time allocated to the teaching of technology.

5.2.5 How teachers facilitate the making of products.

It became evident from the responses of the teachers, learners and learner portfolios that the majority of the learners do not make the products which they had designed and that some of those who make products, do not use the design portfolio as the guide. Limited teaching time and lack of necessary resources such as materials and tools were mentioned as factors that made it impossible for teachers to provide opportunities for their learners to make products, thus hindering the development of the learners' practical skills that are related to the making process. Another response from one teacher also highlighted that lack of materials compelled her to let her learners make the same product instead of letting the learners to come up with a variety of products that could develop their creativity and critical thinking skills. If the teachers concentrate more on the design process and less on the making of the product, they are partially teaching the technological process. The making of the product forms part of the technological process and is regarded as important as the design process. As Ginner and Klasander (2001) state, technology is a human activity, which is a multi-disciplinary subject that forms a seamless web of intellectual skills and knowledge with hands-on experience.

5.2.6 How learners are encouraged to evaluate products

Alignment of data from different research instruments indicated that teachers only encouraged the learners to evaluate their products in accordance with specifications, and not in accordance with functionality. McCormick (1996) stresses the importance of evaluating functionality of products in the technological process. He states that evaluation is a process where learners would be able to determine how successful they have satisfied the need. He further states that evaluation ensures that the finished product is functional and would be able to serve the purpose it was designed for. Testing and displaying the product is also regarded as an essential part of the technological process. (Department of Education 2001) as it ensures that made products satisfy the needs or address the problems.

5.2.7 Most challenging section to teach and learn

Both teachers and learners regarded the design process as the most challenging section of the technological process. It can be concluded that it is not easy for the teachers to teach the design process which involves graphic illustrations of two dimensional and three dimensional drawings, accurate measuring, movement of parts and methods of assembling the parts of the designed product.

Although all the teachers indicated that the making process was not as challenging as the design process, some of the teachers were not able to expose their learners to the making process due to the fact that they spent most of their time on the design process. In addition the fact that the making process depends on the design process could have made it impossible for some of the teachers to embark on the making process. The technological process is a systematic process which starts with analysis and description, followed by design and development, then by planning and making and finally by testing and evaluating (McCormick 1996). It might therefore be impossible for the teachers to focus attention on the making process before giving attention to the design process. As mentioned by Reddy (2001), both the design process and the making process are crucial for the development of a wide range of skills that should be acquired by learners to master the technological process.

5.2.8 Sections of the technological process that are assessed

The responses of both teachers and learners indicated that attention was focused more on the assessment of the design process than on the making of the product and no attention was given to testing and evaluation of products.

Although the majority of the teachers indicated that they assess their learners on the design process, it became clear that the learners were not assessed on problem analysis, on doing research and on making a detailed working drawing. It can be concluded that some of the teachers regard the making of the final product as the end of the technological process although it is documented that the technological process ends with the testing, evaluating and displaying of the final product (McCormick 1996).

5.2.9 How teachers assess the technological process

The examination of data from the different research instruments indicated that the learners were assessed on their learner portfolios and that teachers used communication by means of written work and graphical illustrations as the main assessment activities in the design process. Very little attention was given to the assessment of presentations, research and practical skills although the Department of Education (2001) states that teachers should use a variety of assessment methods such as journals, written work, graphical illustrations, and research or investigation into a problem that needs to be solved. In addition the Department of Education's (2002) places emphasis on the assessment of skills such as cutting, joining, soldering materials, and presenting oral and written work.

The responses from some of the teachers made it clear that teachers were unclear on what to assess and how to assess in the technology learning area. The responses highlighted confusion on the interpretation of policy documents on assessment due to the continuous revision of assessment policy documents. The confusion could be attributed to the fact that the teachers were introduced to new assessment guidelines in 2004 (Department of Education 2004) while they were used to the previously recommended assessment guidelines. The new assessment guidelines require teachers to allocate marks to the assessment activity and then convert them into a percentage. The percentages are then converted into the following codes:

Percentage	Code	Description
0% - 35%	1	Learner is beyond the requirements of the learning outcome.
36% - 39%	2	Learner performance has not satisfied the requirements of outcome.
40% - 69%	3	Learner has satisfied the requirement of the learning outcome
70% +	4	Learner has far exceeded the requirement of the learning outcome.

Table 5.1

The previously recommended assessment guidelines (Department of Education 2002) expected teachers to use assessment codes that indicated the different levels of learner performance.

5.3. RECOMMENDATIONS

The following recommendations could improve the planning, teaching and assessment of the technological process:

5.3.1. Teachers should be trained to facilitate the technological process. Graphic communication and the content on systems and control seem difficult for the teachers to teach and assess. Teachers need training in these areas so that they could be able to teach learners how to do graphic communication. The WCED should be a leading role player in this training and provide schools with the necessary guidance and support.

5.3.2. School principals need to support technology teachers in their efforts to make technology interesting to the learners. Technology teachers should be allowed to become specialist in this learning area by giving more attention to it. Currently teachers are expected to teach three or four learning areas in addition to technology and this makes it impossible for them to give attention to all the aspects of the technological process.

5.3.3. Technology teaching requires a spacious venue that would enable the learners to work with tools and materials when they do their practical work. Where schools have a woodwork room, it could be transformed into a technology laboratory.

5.3.4. Teachers should place emphasis on the teaching and development of skills that are needed to master the technological process in order to ensure quality designing and making on the part of the learners.

5.3.5. The learners should be provided with opportunities to develop research skills. In addition to a library search, learners should conduct interviews and make observations.

5.3.6. Teachers should expose learner to group work to allow them to interact with their classmates and promote communication, peer evaluation and support amongst themselves. Children should learn from each other.

5.3.7. More attention should be focused on the following steps in the design process:

- Analysis of the problem or need
- Evaluation of each idea in order to arrive at the best solution to the problem
- A work plan with a detailed list of materials and tools needed to make the product, and
- Measurements of the parts of the drawing.

The completed portfolio should be systematically structured from the problem identification to the solution and the evaluation of the product.

5.3.8. Sufficient time should be allocated for the learners to present, test, evaluate and display their final products. This will enable the learners to present their ideas to their classmates, to the whole school and to the members of the community.

5.3.9. Learners should be made aware of the career opportunities that technology holds and excursions should be arranged to visit businesses and industries where technological development is applied to encourage learners to engage in similar professions in order to contribute to technological development in South Africa.

5.3.10. The WCED should assist teacher in the application and interpretation of assessment policies. Assessment seems to be a major problem which needs attention.

5.4 RECOMMENDATIONS FOR FURTHER RESEARCH.

The following area in technology education needs to be investigated to make technology education more effective for learners:

5.5.1. An investigation into the use of limited resources to make technology interesting for learners.

5.5.2. A program for technology teachers to engage in community activities in order to solve problems or needs through the technological process.

In order to accomplish the goals of technology, teachers need to equip themselves with the necessary skills and knowledge to teach and facilitate the technological process to enable the learners to be responsible citizens who would make a positive contribution to the South African economy.

REFERENCES

AFRICAN NATIONAL CONGRESS, 1994: EDUCATION DEPARTMENT: A policy framework for education and training: Pretoria: Government Printers.

AFRICAN NATIONAL CONGRESS, 1994: Policy framework for education and training.

AFRICAN NATIONAL CONGRESS, 1955: Freedom charter: Skotaville Press.

BABBIE, E. & MOUTON, J. 2001: The practice of social research. Cape Town: Struik.

BAILEY, K.D. 1987: Methods of social research. London: Collier Macmillan Publishers

BANKS, F. 1994: Teaching Technology. London and New York: The Open University.

BEEBY, C.E. 1986: The Stages of Growth in Educational Systems. In Heynemans, S.P. and D.S. White (eds). The Quality of Education and Economic Development. Washington DC: World Bank. 37- 44.

BLACK, P. 1995: Technology ITE Course pp 300 Milton Keynes: The Open University

BOLAND, R. 1985: A methodology for a new microeconomics. The critical foundation. Boston: Allen and Unwin.

BOYWER, J. 1990: Scientific and Technological literacy: Education for change. Paris: UNESCO.

Clinton, W. 1993: Technology for America's economic growth: A new direction to build economic strength. Washington, DC: The White House.

COTEP. 1995: Norms and standards & governance structures for teacher education.

DENZIN, N.K. 1989: Interpretative interactionism. Newbury Park: CA: Sage publications.

DEPARTMENT OF EDUCATION 1995: Norms and standards and governance structures for teacher education. Pretoria: Government Printers.

DEPARTMENT OF EDUCATION 1997: Curriculum 2005: Lifelong learning for the 21st century. Pretoria: Government Printers.

DEPARTMENT OF EDUCATION AND TRAINING. 1997: White Paper on Education and Training 3. Pretoria: Government Press.

DEPARTMENT OF EDUCATION 2002: Revised National Curriculum Statement Grades R-9 (schools) Policy. Pretoria: Government Printers.

DODD, T. 1978: Design and technology in the school curriculum. London: Hopper & Stroughton

DYRENFURTH, M.J. 1995: Technology education: A primary vehicle for engineering South Africa's immediate and long-term future. Proceedings at: Learning Technology. University of Pretoria.

EDWARDS, G. 2001: The curriculum for Technology Education. Proceedings on the international conference on Technology Education. Cape Town.

GINNER, T. & KLASANDER, C. 2001: Frameworks and Matrices in the Technology Education curriculum – A Swedish approach and a test. Proceedings on the international conference on Technology Education. Cape Town.

HARVEY, R.O. 1991: A study of the state of and possible future directions for technology education in European countries and suggestions for possible ways and means of reinforcing European co-operation in this field. Paris: UNESCO.

HEDCOM TECHNOLOGY EDUCATION PROJECT, 1996: Draft national framework for curriculum development.

HOPKINS, D. 1993: A teacher's guide to classroom research. 2nd Edition. Buckingham: Open University Press

KAPLAN, B. & MAXWELL, J.A. 1994: Qualitative research methods for evaluating computer information systems. Thousand Oaks: Sage.

KHAN, M.J. 1995: The system initiative – turning disadvantage into advantage. Proceedings at university of Pretoria: Pretoria.

KWENDE, T.G. 1996: Towards Scientific and Technological literacy for all in Africa pp.3 UNESCO Dakar.

LEEDY, P. 1980: Practical research: Planning and designing. New York: Macmillan

LINCOLN, Y.S. and GUBA, E.G. 1985: Naturalistic inquiry. Newbury Park, CA: Sage publications

MALLET, D. 1997: The identification of principles for the development and implementation of Technology education: A case study in Mauritius: http://education.cutin.edu.au/waier/forums/1997/mallet.html

McCORMICK, R. 1996: Conceptual and procedural knowledge. Proceedings on Technology education for a changing future: Jerusalem.

MIDDLETON, P. 1993: The development of a technology short course in South Africa, no. 1 pp. 130-135.

MILES, M.B. and HUBERMAN, A.M. 1994: Qualitative data analysis: An expanded scourcebook. Thousand Oaks: Sage

MYERS, M.P. 1993: Qualitative research in information systems. London: Sage publications.

ORLIKOWSKI, W.J. & BAROUDI, J.J. 1991: Studying information technology in organizations: Research approach and assumptions information systems research (2) pp. 1-28.

PYTLIK, E.C 1983: The role of technology education in the third world development. Journal of Epsilon Pi Tau. 9.

RAUTENBACH, W.L. 1991: Technological education for development in South Africa: Proceedings on Relevant Technological Education in South Africa: Cape Town.

REDDY, K. 2001: OBE related programme development in Technology Education: The role of the essential features: Proceedings on the international conference on Technology Education. Cape Town.

SADECK, O. 2001: A Technology Curriculum – South Africa: Our world – First world – Third World: Proceedings on the international conference on Technology Education. Cape Town.

SIRAJ-BLATCHFORD, J. 1993: Constructing Design and Technology an early years perspective: International journal of Technology and design education, no.3, pp.19-28.

STRAUSS, A. & CORBIN, J. 1990: Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park: CA: Sage.

UNESCO. 1983: Science and technology education and national development: Paris UNESCO.

VAN DYK, A. & VAN DYK, G. 1998: Ontwerp en tegnologie in die klaskamer vandag: Goodwood: Via Afrika

WAKS, S. 1992: Curriculum design – from an art towards a science. Hamburg: Tempus Publications.

WRIGHT, K. & ROYLE, G. 1990: Approaching Design & Technology: London: John Murray Publishers.

YIN, R.K. 1984: Case Study research: Design Methods. Thousand Oaks: Sage

http://www.geocities.com/zulkardi/submit3.html
http://seamonkey.ed.asu.edu/~alex/teaching/assessment/relaibility.html
Reliability and Validity. :2004

APPENDIX 1: INTERVIEWS WITH TECHNOLOGY TEACHERS

Interview questions:

1. Which content area do you feel comfortable and confident to use when planning to teach the technological process?
2. Give a reason for your answer to question one.
3. Which type of resource tasks do you plan to teach your learners in order to master the technological process?
4. Could you briefly explain how you facilitate the design process in your class?
5. How do you facilitate the making of the product?
6. How do you encourage learners to evaluate their products?
7. What is the most challenging to teach, the design process or the making of the product?
8. Which sections of the technological process do you assess?
9. How do you assess your learners on the technological process?

APPENDIX 2: QUESTIONNAIRES TO THE LEARNERS

Questionnaire.

1. Which content area in technology is presented to you in an interesting way?

Structures	
Processing	
Systems and controls	

2. The resource tasks that are frequently used in class are the following:

Cutting	
Soldering	
Joining	

3. When you identify problems or needs do you use problems in:

Your school	
America	
Your house	

4. Do you specify certain requirements that the product you design should have?

Yes	
No	
Sometimes	

5. How often are you required to conduct research during the design process?

Frequently	
Seldom	
Never	

6. Can you graphically communicate, by means of three-dimensional drawings, your design ideas?

Yes	
No	

7. In your final idea of your design, do you include details of illustrations, such as measurements, movement, drawings of assembly?

Yes	
No	

8. When you make the product that you have designed, do you work from your design portfolio according to shape, measurements and materials?

Yes, I make my product according to my design.	
No, I change my design when I make my product.	

9. Do you continuously evaluate your product to see that you work according your specifications?

Yes	
no	
sometimes	

10. After completing your product, do you test it to see if it satisfies the need?

Yes	
No	

11. What do you regard as most challenging? Is it the design process or the making process?

Designing the product	
Making the product	

12. Which section of the technological process were you assessed on?

Design process	
Making	
Testing/Evaluating	

13. Indicate the part of the design process that you were assessed on.

Portfolio	
Presentations	
Research	
Practical skills	

		Teacher 1 (A)	Teacher 2 (B)	Teacher 3(C)	Teacher 4 (D)	Teacher 5 (E)
1	Content used e.g.. Structures, Processing Systems & Control					
2	Type of resource task used					
3	How teachers facilitate the design process.					
4	How teachers facilitate the making of the product					
5	How learners are encouraged to evaluate their products					
6	Sections of the technological process that were assessed.					
7	How the learners were assessed.					

LEARNER PORTFOLIO

Teacher One

A

		Learner One	Learner Two	Learner Three
Needs analysis and description	Identified the problem			
	(type of environment)			
	Design brief			
	Problem analysis			
	Specifications			
Design and develop	Research			
	Generating ideas			
	Developing ideas selecting best idea			
	Communicating ideas			
Planning for making the product	Choosing materials and equipment			
	Cost analysis			
	Working drawing			

Remarks

APPENDIX 5

Murray Street 20
Charleston Hill
Paarl
7646
21 May 2004

Dr. Ronald Cornelissen
Research Unit
Western Cape Education Department
Private Bag X 9114
Cape Town
8000

Dear Dr. Cornelissen

I am a registered M-Tech: Education student at the Peninsula Technikon who which to do my research at five Primary schools in Paarl. The topic of my research is: **Teaching the technological process in grade seven.**

I hereby seek permission from the Western Cape Education Department to conduct my research at the following schools where interviews will be conducted with the technology teachers, questionnaires be completed by the learners and observation of classroom practices and learner portfolio's will be done.

- **Charleston Hill Primary School** — **Principal: Mr. J. Sonday**
- **Amstelhof Primary School** — **Principal: Mr. C. De Jager**
- **Orleansvale Primary School** — **Principal: Mr. Cairncross**
- **Paarlzight Primary School** — **Principal: Mr. M. Julies**
- **Nederburg Primary School** — **Principal: Mr. E Daniels**

Included in this application are:

- Title and Mini Proposal of my research
- A copy of the interview questions to the teachers, questionnaires to the learners and observation schedules.
- A letter from Dr. J. Nduna my supervisor at the Peninsula Technikon.
- My contact number.

Research will be conducted during July and August 2004.

Thanking you in anticipation.

Christopher Colin Jacobs

Appendix 6

Navrae
Enquiries Dr RS Cornelissen
IMibuzo

Telefoon
Telephone (021) 467-2286
IFoni

Faks
Fax (021) 425-7445
IFeksi

Verwysing
Reference 20040617-0034
ISalathiso

Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Mr Christopher Jacobs
Beukes Street
PAARL
7646

Dear Mr C. Jacobs

RESEARCH PROPOSAL: TEACHING THE TECHNOLOGICAL PROCESS IN GRADE SEVEN.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **21st June 2004** to **31st August 2004**.
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December 2004).
7. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the Principal where the intended research is to be conducted.
9. Your research will be limited to the following schools: **Charleston Hill Primary, Amstelhof Primary, Orleansvale Primary, Paarlzight Primary, Nederburg Primary.**
10. A brief summary of the content, findings and recommendations is provided to the Director: Education Research.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:
    The Director: Education Research
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

for: HEAD: EDUCATION
DATE: 17th June 2004