Teachers' understanding and implementation of the Design Process as it relates to teaching Technology Education in the Intermediate and Senior Phases (Grades 4–9) in the General Education and Training Band in KwaZulu-Natal

Submitted in fulfillment of the requirement of the degree of Magister of Technology: Language Practice in the Faculty of Arts and Design at the Durban University of Technology

Maria Louisa Elizabeth de Jager

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SUPERVISOR: Prof. P. Singh
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I, Maria Louisa Elizabeth de Jager, do declare that this dissertation is a representation of my own work in both conception and execution.

Signed: ______________________ Date: ________________
M. L. E. de Jager

Approved for final submission

Signed: ______________________ Date: ________________
Prof. P. Singh
PhD (Education)

ABSTRACT

Outcomes-based education compelled South African teachers to make an important paradigm shift in education from a teacher-centred approach to a learner-centred approach. This paradigm shift in teaching and learning emphasised an active participation of learners which necessitated Technology Education (TE) teachers to restructure their teaching strategies in terms of the National Curriculum Statement (NCS).

Conducted within a constructivist paradigm, this study was based on Shulman's (1986, 2004) theory of pedagogical and content knowledge, and Vygotsky's (1978) zone of proximal development within social constructivism. Using a mixed method approach, this study investigated teachers' understanding and implementation of the design process as it relates to teaching TE in the intermediate and senior phases (Grades 4–9) of the General Education and Training Band in KwaZulu-Natal. The study also considered the training of TE teachers in a bid to facilitate teaching and learning in the classroom and to enable learners to become creative and critical problem solvers.

Analysis of the questionnaire and semi-structured responses revealed that teachers were interpreting and implementing policy differently and that they were not adequately trained to teach TE. As a result, classroom practice in terms of teaching and learners' experience of the design process in TE also differed.

Valuable lessons were learned in this study for the structuring of training programmes for teachers in Technology Education to enhance teaching and learning in the classroom. Therefore, based on the findings, this study makes

recommendations regarding teaching, learning, assessment, and training of teachers in TE.

DEDICATION

- To my heavenly Father for granting me the strength and perseverance to complete the dissertation.

"Here, U is my lewe, U sorg vir my. Wat ek ontvang, kom alles van U af.

Psalm 16:5

- To my late father, Deon Joubert, for instilling in me the principle of life-long learning from an early age.

- To my children, Johann, Sharlene and Marlise, for their love, support and encouragement. Love you unconditionally.

"You give but little when you give of your possessions. It is when you give of yourself that you truly give".

Kahlil Gibran

- To my grandchildren, Megan and Sarah, for their unconditional love and understanding while ouma was busy she didn't always have the time to visit or enjoy the normal activities.

"Success takes growth and development. It's using an achievement as a stepping stone to rise higher up the mountain of accomplishment".

John Maxwell

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- My supervisor, Prof. P. Singh for her patience and encouragement throughout the study. It has been a long and challenging journey, but we both survived!

"The leader's growth determines the people's growth."
John Maxwell

- Reshina and Preggie for being so helpful and efficient in response to all my queries.
- The KZN Department of Education for granting permission for me to conduct the research.
- Durban University of Technology for the financial support to complete my studies.
- The respondents to the questionnaires for providing information on which this study was based.

- My friends for their encouragement and support during the study period. I have done it!

"A man's merit lies in his knowledge and in his deeds, not in his colour, faith, race or descent".
Kahlil Gibran

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

All students can learn and succeed, but not all on the same day in the same way (Spady, 1994; 2008).

For many educationists the name Spady is synonymous with outcomes-based education. As Spady (2008:2) said, outcomes-based education means clearly focusing and organising everything in an educational system around what is essential for all learners to be able to do successfully at the end of their learning experiences. He adds that successful learning promotes even more successful learning and that schools play an important role in controlling conditions for successful learning and what and whether learners learn is more important than when and how they learn. This means starting with a clear picture of what is important for learners to be able to do, then organising the curriculum, instruction, and assessment to make sure this learning ultimately happens (Spady, 1994:1). This approach suggests that teachers can determine the content and skills essential for all learners, and that it is possible to achieve this through an appropriate organisation of the education system and through appropriate classroom practices (Killen, 2000:2). The purpose of teaching is to prepare the learners for their lives after school such as being a productive worker or a responsible citizen or a parent. Spady (1994:18) explains that learning is not significant unless the outcomes reflect the complexities of real life and give prominence to the life-roles that learners will face after they have finished their formal education.

As learners come into the classroom from different backgrounds and indeed different learning styles, the primary responsibility of the teacher is to create and maintain a collaborative problem solving environment where learners are allowed to construct their own knowledge in their own way and their own time. In the constructivists classroom the teacher acts as a facilitator who guides learner to become active participants in their learning and make meaningful connections between prior knowledge, new knowledge, and the process involved in learning (Van Wyk, 2007:1; Von Glaserfeld, 1987:14).

According to Vygotsky (1986), good instruction enables the teacher to determine where each learner is in his or her development and then builds on that learner's experiences. Teachers need to present the learners with activities which they need to complete with the assistance of the teacher but within each learner's zone of proximal development. He explains the discrepancy between a child's actual mental age and the level he reaches in solving problems with assistance, indicates the zone of his proximal development (Vygotsky, 1986:187). Teachers must therefore have pedagogical content knowledge (PCK) (Shulman, 1986; 2004) to guide learners and facilitate learning in the classroom.

In describing the South African education system prior to the democratic elections in 1994, Dekker and van Schlakwyk (1989:476) state that the curriculum was too academic and therefore failed to prepare the learner for skills needed in the real world. They add that 95 % of grade 12 learners followed a broad academic course and only 9% of White and 1 % of African learners followed a technical course which resulted in unemployment for many learners leaving school. Viljoen (1997:6) asserts that Technology Education can assist our people, particularly our young learners in need of relevant and useful education and training to prepare them for their roles in society and in the world of work. She states further that modern economies throughout the world rely increasingly on developing, adapting, and using technology to create jobs, wealth and an acceptable quality of life for people. Wealth generating countries such as Germany and Japan create 7 technicians to every 1 university graduate, while South Africa creates 0.8 technicians to every 1 university graduate. Rambrij (2006:3) describes Technology Education (TE) as a subject can contribute towards challenges such as skills training, good work habits and work skills which are essential in the workplace today irrespective of the type of employment one is in. Acknowledging the above, the focus of this study therefore is the teacher as facilitator within TE.

1.1 BACKGROUND TO THE STUDY

The Constitution of the Republic of South Africa (Act 108 of 1996) provides the basis for curriculum transformation and development in South Africa. The curriculum plays an important role in developing the full potential of each learner as a citizen of a democratic South Africa. One of the critical outcomes in the National Curriculum Statement, deriving from the constitution, is that it envisages the development of learners who identify and solve problems and make decisions using critical and creative thinking (DEC, 2002:5). With this outcome in mind, it is important to determine what training teachers receive in the implementation of the design process in the classroom.

As few teachers in South Arica have received formal pre-service training in this field, it makes implementation of TE in this country difficult (Chapman, 2002). According to MacGregor (2002), this problem is also experienced in Australia. McCormick, Murphy and Hennessy (1994:6) explain that the problem is related to teachers' limited understanding, their struggle to conceptualise the learning area in accordance with the curriculum framework and their limited knowledge of specific tools and practice skills. McCormick (2004:23) states that it is normally teachers' personal understandings that impact on the way in which the learning area is taught in the school and that this is also commonly seen in South African schools.

The researcher has been involved with TE since 1997 when it was a pilot project of the Department of Education (DoE) before the National Curriculum was introduced in schools. For the past 12 years, as a member of the Provincial Task Team, and later on as Deputy Chief Education Specialist, the researcher has noticed that teachers, in South Africa and globally, interpret the learning outcomes of TE differently which has led to confusion regarding implementation and instruction in the classroom.

1.2 TECHNOLOGY EDUCATION IN THE GET BAND

Many changes were made in the country after 1994, especially in the education and training sector (Naicker and Waddy 2003:08). Education and training became a national system incorporated within a credit-based qualifications framework, known as the National Qualifications Framework. In this framework, the General Education and Training Band (GET) is referred to as level 1 education and is compulsory for all learners in South Africa.

In GET there are now 8 learning areas, namely: languages, mathematics, natural science, social science, arts and culture, economic and management science, life orientation and technology. A learning area is what we used to call a subject and incorporates relevant content linked to the focus of teaching. This study focused on technology as a learning area.

TE as taught in the GET in Grades R-9 is defined as the use of knowledge, skills and resources to meet people’s needs and wants by developing practical solutions to problems, by taking social and environmental factors into consideration (DEC, 2002:4). TE as a relatively new learning area in the school curriculum comes with new demands and challenges if we compare it to science and mathematics where the content is still the same and only the methodology has changed.

Within the TE curriculum, the design process is the main focus. In fact in most overseas countries it is called Design and Technology (Norman and Schmidt, 2000). The NCS (DEC, 2002:6) defines the design process as a creative and interactive approach used to develop solutions to identified problems of human needs. The skills associated with the design process are: investigation, design (development of the initial ideas), making/manufacture, evaluation and communication. The design process of TE is specifically concerned with learners' capability to investigate, design, make and solve problems with the use of materials available in their community.

1.3 THE DESIGN PROCESS WITHIN TE

Some teachers regard the design process as a linear process, from investigation of the problem context, to designing, to making and evaluating the product to solve the problem and then lastly communicating or explaining what has been done. Others regard the design process as cyclical where the steps are followed but one is allowed to go back to the previous step when needed, yet a third group regards the design process as starting where ever one wants to and not necessarily following the process as a whole. (Davies, 2002; De Vries and Tamir, 1997; Hill and Smith, 1998; McCormick, 2004).

In South Africa we need to establish a common understanding of the design process. While studies (Chapman, 2002; Nkosi, 2005; Rambrij, 2006) have been conducted on TE in South Africa, to the best of the researcher's knowledge no studies have been conducted in South Africa on teachers' understanding of the design process in TE. The focus of this study therefore was teachers' understanding and implementation of the design process in the grades 4-6 classroom.

1.4 DEMARCATION OF THE PROBLEM

TE was implemented in South African classrooms in 1998 with the start of the first National Curriculum namely, Curriculum 2005 (C2005). With the new curriculum came new terminology and a new approach to teaching and learning in the form of outcomes-based education. Tertiary institutions did not have time to prepare teachers for implementation of C2005 as it was introduced in a short space of time (Rambrij, 2006:3). Teachers were exposed to five days of training (which focused on orientation to C2005) from the Department of Education and were then expected to implement the curriculum in the classroom. This posed a challenge to teachers as the training did not prepare adequately for implementation in the classroom. The other problem was that as the majority of teachers had received their teacher training during the apartheid era, they were ill-prepared to teach within the new democratic dispensation. Prinsloo and Janks (2002:20) and Stevens (2005:1) explained that the apartheid era marked an education system organized in terms of race with unequal distribution of materials and resources. The challenge for teachers was therefore not only skills but also knowledge, methodology and resources. Also, TE is not a theoretical subject but involves practical skills which teachers were not exposed to during their training by the Department of Education.

Vinjevold and Taylor (1999:160) and Jansen (1999:149) concur, that many teachers welcomed the idea of the new curriculum but found it difficult to put it into practice in the classroom. The DEC (2001:18) acknowledged these concerns and commissioned a review of C2005, which gave rise to a streamlined and strengthened curriculum. This Revised National Curriculum

Statement (RNCS) was implemented from 2002. The name changed in 2006 to the National Curriculum Statement (NCS).

Unfortunately, although all the changes made to the curriculum, teachers were not trained to implement TE in their classrooms. As a result, to date interpretation and implementation of curriculum in respect of TE differs from one school to the next and indeed from one teacher to the next.

TE consists of three learning outcomes namely: technological processes and skills; technological knowledge and understanding; and technology, society and environment (DEC, 2002:6-9). In this study the researcher focused on the technological processes and skills. The process referred to was the design process which is a problem solving process used in engineering, architecture, science, product development etc.

The aim of this study was to examine teachers' understanding and implementation of the design process as it relates to teaching TE in the intermediate and senior phases (Grades 4–9) in the GET band in KwaZulu-Natal.

In order to achieve the above aim, the following objectives were addressed:

- to determine teachers' perception of the design process in TE
- to determine whether teachers can identify the design process
- to investigate the methods used by teachers in the implementation of the design process in TE in their classroom

The researcher hopes that the findings of this study will benefit the future training of teachers in KwaZulu-Natal and in other provinces. It is also hoped that the findings of this study will give teachers, learners, parents and other education specialists an insight into the perception of teachers' understandings and pedagogy of the design process as it relates to TE in the GET band. If learners are taught the correct way of designing at school level, South Africa could benefit from these much needed skills.

1.5 EXPLANATION OF KEY TERMS

The following terms are explained as they are used in this study. Detailed definitions and explanations follow in the body of the dissertation.

1.5.1 Assessment

Assessment is defined by the South African Department for Basic Education (DBE, 2011:3) as the process of collecting, analysing and interpreting information to assist the teacher to make decisions about the progression of the learner.

1.5.2 Outcomes-based Education (OBE)

OBE refers to an approach in which curriculum development occurs in a retrospective sense, starting with the required learning outcomes and working back to the anticipated learning experience. It is a learner-centred, results-oriented system based on the belief that all individuals are able to learn. The requirement is that learners must be able to demonstrate or apply specific knowledge, skills and values at the end of the learning process (Spady, 1994:1). Learning programmes are developed to assist learners by means of specific learning processes to master the requisite knowledge, skills and attitudes.

1.5.3 National Curriculum Statement (NCS)

The NCS is the curriculum followed by all learners in all phases in South Africa.

1.5.4 Curriculum and Assessment Policy Statement (CAPS)

The CAPS document is the latest in terms of curriculum development and will be implemented as follows: in 2012 in the foundation phase (grades 1-3) and grade 10, in 2013 in the intermediate phase (grades 4-6) and grade 11, and in 2014 in the senior phase (grades 7-9) and grade 12. The outcomes-based education (OBE) principle is still applicable and the curriculum is still the National Curriculum Statement (NCS), the CAPS document simplifies the curriculum for easier implementation.

1.5.5 General Education and Training Band (GET)

This refers to grades R-9 in the South African education system. It includes foundation (grades R-3), intermediate (grades 4-6) and senior (grades 7-9) phases. The South African Qualifications Authority (SAQA) refers to these phases as basic education or level 1 education.

1.5.6 Further Education and Training Band (FET)

Grades 10-12 are included in the FET band and SAQA regards this phase as level 2 education.

1.5.7 Technology Education (TE)

TE is one of the eight compulsory subjects in the GET band. The areas of knowledge contained in this subject are: processing, structures, mechanical systems and control, and electrical systems and control.

1.5.8 Technology Association of South Africa (TASA)

TASA is a support group for teachers who implement TE in their schools by conducting workshops on Saturday mornings. These workshops provide content and skills training and are conducted by lead teachers currently teaching TE. The organisation has branches in different provinces in South Africa and the researcher is involved with the KwaZulu-Natal (KZN) branch. The KZN branch holds once a term a Saturday workshops and one conference per year for the teachers of KZN.

1.6 OVERVIEW OF THE STUDY

The first chapter outlined the context, rationale, significance of the study and presents a brief overview of forthcoming chapters.

Chapter two reviews seminal as well as current literature in the field and discusses the theoretical framework underpinning this study.

Chapter three discusses the research methodology and design, sampling, data collection instruments used and analysis of data.

Chapter four presents the findings of this study.

The last chapter concludes the study and makes recommendations for further research.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The Minister of Higher Education and Training, Dr. Blade Nzimande called for the prioritising of skills development in 2010 to achieve high levels of growth and development in South Africa (News24, 2010). He added that due to low skills development at school level, learners are ill-prepared to undertake further studies when they leave school.

One of the subjects in the South African curriculum where skills training can take place is TE. According to Mahlke (1993:6) and Potgieter (1999:85) TE can help learners to engage in the development of new skills from an early age in schools. Not only does TE teach basic skills needed in our daily lives, but it allows learners opportunities to engage with critical, creative, and thinking skills, an example of which is the design process. The design process is a basic skill used in many careers, such as engineering, architecture and product design to mention a few. As in any learning situation, the role of the teacher is vital in the teaching of TE. The purpose of this study therefore is to investigate teachers' understanding and implementation of the design process in TE in the GET band, grades R-9 in KZN.

The previous chapter gave an overview of this study by providing a general introduction and background to the study, including methodology, theoretical framework, key terminology and limitations. In this chapter the researcher attempts to briefly clarify the difference between Educational Technology (ET) and TE, before presenting the South African and international perspectives on the development of TE. The important features of the TE curriculum in South Africa are then discussed. The focus of this study is the design process and is clarified by examining what is meant by design, the design process, and different models of the design process. The approach to teaching and learning of the design process and some challenges already identified in this regard are discussed before presenting the theoretical framework underpinning this study.

2.2 TECHNOLOGY EDUCATION (TE) *VERSUS* EDUCATIONAL TECHNOLOGY (ET)

For most people, there is confusion between TE and ET. ET relates to computers and other electronic devices that may be used to enhance teaching and learning in the classroom. In South Africa, the NCS in the FET, Grades 10–12, offers two possible computer related subjects namely Computer Applications Technology (CAT) and Information Technology (IT). These two subjects are also included into the latest CAPS. In GET, there are no subjects offered where skills and knowledge regarding the computer can be studied, therefore although computers can be used to enhance TE in GET, TE is not about the use of the computer. Reeve (2001:136) explains that TE is much more than computers.

TE may be described as actions modifying or changing the natural world to satisfy our needs (DoE, 2002). TE refers to the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants (International TE Association, 2002:2). Technology is innovation in action. Learners apply their technological knowledge, use tools, machinery, equipment, and skills to solve problems and to extend human capabilities.

The computer is an important product of technology, and so are telephones, electricity, airplanes, bicycles, cell phones, even knives and forks, automated teller machines, digital cameras, wireless communication, and the internet. It can be said that TE is typically used to solve problems and improve our lives (Hooghoff, 2002:19). The Qualifications and Curriculum Authority of the United Kingdom (1999:3) defines TE as a subject that prepares learners to participate in tomorrow's rapidly changing world, and to become autonomous and creative problem solvers as individuals and as members of a team. Lewis (2006:262) adds that technology, science and engineering all work together to make our lives better, in fact, technology is a product of science and engineering.

In science, people study the universe in an attempt to understand how it works. According to Rose and Dugger (2002:1), mathematics is the principal tool and language that scientists use in their inquiries, while engineering is the application of scientific knowledge to solve a problem or to improve our lives, either by creating a new technology or by exploiting an existing one. Mioduser and Levi (2008:263) concur that in a broader sense TE is about the effect of the recursive interaction between "inventors mind" and "invented world" on the construction of the world as well as on the construction of the mind which includes human knowledge, perceptions, beliefs, thinking processes and skills. TE as a subject is the study of technologies by learners to understand their world and to solve real world problems by inventing products to make the world better. Now that the difference between ET and TE is clarified, it is important to look at the background of TE.

Mahlke (1993:6) and Potgieter (1999:85) propose that the development of critical thinking skills and creativity as early as the foundation phase should be one of the main objectives for engaging in TE in primary school. TE worldwide and in South Africa aims to supply the youth as future citizens with the necessary resources to live effectively and meaningfully in a technological world which is becoming increasingly more complex (Dugger and Yung, 1995:4; Savage, 1993:41) and it is here that TE has the potential to make education more relevant to society. It is therefore important to examine the development of the TE curriculum internationally and the reasons for including TE as a subject in schools around the world.

2.3 INTERNATIONAL DEVELOPMENT OF THE TE CURRICULUM

The movement towards including TE as one of the compulsory learning fields started internationally during the 1980s (Mawson, 2003:117). The United Kingdom and Australia underwent major curriculum reform in the mid-to-late eighties, with Canada and New Zealand following in the late eighties and early nineties. Experiences in the United Kingdom had significantly influenced developments in Australia and New Zealand, and to some extent the newly developing TE curriculum in the United States of America (Reeves, 2001:247; Savage and Bosworth, 1995:5). In most countries, TE was introduced in the general school curriculum during the early nineties (Ferguson, 1994:8; Francis, 1994:iii; Shield, 1994:55). Similar curriculum reform occurred in the Netherlands (Hooghoff, 2002:20) and Germany (Sauer and Haupt, 2001:161) during the mid-nineties.

In the early nineties, South Africa also started with curriculum reform including TE as a learning area in the GET band borrowing heavily from curricula designed for Europe and Australia (Chapman, 2002:49). According to Stevens (2005:2) significant changes in the curriculum were mainly influenced by the recommendations of the Walters Report of 1990 which specifically recommended that subjects such as Hand-and-Needlework, Basic Techniques, Technical Orientation and the Handwork subjects be re-curriculated in its entirety according to England's 'Crafts, Design and Technology' approach but taking the South African needs and contexts into account (DEC, 1990:123). The rationale for this recommendation was to provide relevant education to meet the needs of the learners as well as to contribute to the 'person-power' requirements of the country (Stevens, 2005:2).

Worldwide, the curriculum and especially the TE curriculum, underwent more changes in keeping with the industrial developments taking place, and to develop a more technologically aware and adaptable workforce (Hughes, 2005:5). During these changes in TE, more emphasis was placed on the design process (in South Africa called the technological or design process) of design and manufacturing.

The design process (discussed in more detail in 2.8) in TE can be seen as the key pedagogic principle of the subject and helps to distinguish it from other subjects in the curriculum. The Toronto Board of Education in Canada (1993:16) states that technical and technological studies programmes have a value and integrity that rests in their balance of inherent practical ability and creative problem solving. By engaging in the design process, learners develop the capability to operate in the modern technological world. The learners gain technological competencies and capabilities through working with systems (e.g. mechanical and electrical systems), materials (e.g. food, textiles, wood, metal, etc.) and processes (e.g. making paper from trees, etc.) (Hughes, 2005:4).

Davies (2002:159) regards capability as the distinguishing characteristic of the TE subject and sees it as a way that the learners can learn about aspects of the manmade world. He also states that capability is different from pure ability, it is one's capability revealed through action. Kimbell, Stable and Green (1996:18) support this view and propose that capability develops learners' ability to solve problems and work with ‘fuzzy’ tasks. By ‘fuzzy’ tasks they mean ‘open-ended’ and ‘ill-defined’ tasks, where there is more than one solution to a problem. These tasks have elements of complexity and uncertainty and are the sort of tasks and competencies that are required by a modern and innovative workforce. In TE, the learners have to design and make a product often referred to as an artefact (which means a man-made product) and to solve a problem (Draghi, 1993:85).

Working with the design process in TE to create a product (artefact), empowers the learner to take a task from inception to delivery. This helps them to think creatively, manage their resources, work confidently on their own or in teams, and helps them to integrate knowledge across domains (Hughes, 2005:5). In other words, the learner has to apply theoretical knowledge gained to create an artefact to solve the problem. Draghi (1993:85) and Norman (2000:94) add that TE addresses the problem of coping with changes and has the capability and potential to establish and nurture a culture of lifelong learning.

Draghi (1993:85) and Norman (2000:94) state that lifelong learning refers to the ability of individuals to use formal and informal learning opportunities throughout their lives to foster continuous development and improvement of their knowledge and skills needed for employment and personal fulfillment. Nováková (1999:78) agrees that the importance of TE lies in the fact that this subject develops competencies, knowledge and skills through problem solving which enriches each learner and prepares them for the world of work. She states further that TE taught at school should enable the learner to be able to participate as a problem solver, decision maker, engineer, fabricator, evaluator and consumer in the real world.

The TE curriculum must be in a “real life” context for the learners as this will give them knowledge which will serve as a foundation from which they can draw to build on over their lifetime and thus become lifelong learners (Norman, 2000:94). In this regard Nováková (1999:77) suggests that within general education TE should create a “bridge” between school and real life and that it should form an important part of acquiring technological literacy for lifelong learning. TE in general can thus be used as a vehicle to teach knowledge, skills and attitudes in which technological information can be manipulated and processed by creating a learning environment that enhances motivation and positive attitudes (Starko, 1995:119). Benson and Benson (1993:3) therefore suggest that TE can form the basis for what they call ‘know how’ and can lay the foundation for the designers and problem solvers of the future, no matter what particular occupation they might want to qualify themselves for in the future. Wright (1994:3) thus calls TE the new basis of the 21st century.

The curriculum determines what learners experience in schools to prepare them for the real world. It is therefore necessary for the school curriculum to change in-keeping with changes outside the school.

2.4 CHANGES IN THE SOUTH AFRICAN CURRICULUM

One of the key and enduring characteristics of education throughout the centuries has been its ability to adapt to changing demands (Van der Merwe, 2007:32). This is also true of the South African education system that has been characterised by an unprecedented transformation process since 1994 which not only involves a new curriculum (DEC, National Education Policy Act no. 27 of 1996) but also focuses on a new approach to teaching and learning.

The changes in the South African school curriculum are summarised by the researcher in Figure 2.1 (below) as follows:

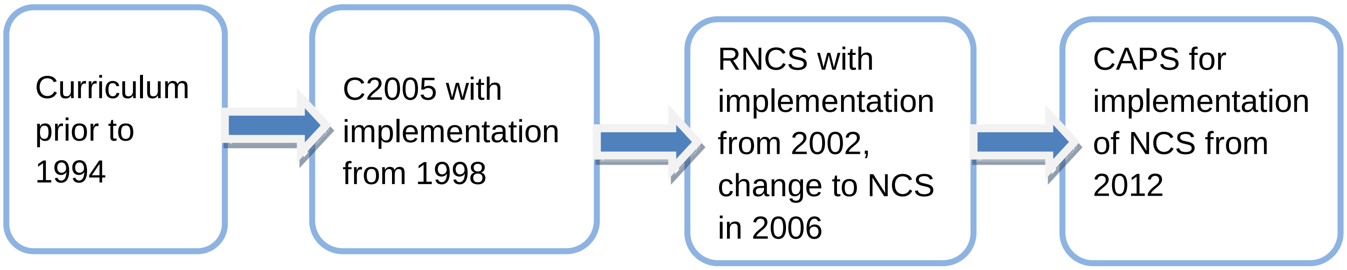

Figure 2.1: Researcher's summary compiled from review of relevant literature.

Mokhaba (2004:28) explains that the main problem in education in South Africa prior to the 1994, was inequality in teaching and resources among the different races. He added that the curriculum was too academic, that it excluded skills development, and it was content-based. Mokhaba (2004) stated further that: learners were passive participants; learning was teacher-centered instead of being learner-centered; that learners were assessed against each other; and that the curriculum was too structured and not easily adaptable.

One common thread throughout these curricula, overseas and in South Africa, is that they were all designed as part of an OBE system. After 1994, the focus of the new curriculum was not only "what" was taught but also "how" it was taught (Mishra and Koehler (2006:1018); Van Wyk, 2007:23). During this transformation process, South Africa's choice of an outcomes-based education (OBE) system arose out of the government's wish to design a unified system of education in schools and across all learning institutions. The OBE system refers to a system based on outcomes, giving priority to the end result of learning as well as the accomplishment and demonstration of learning. Killen (2000:2) states that a curriculum is considered to be 'outcomes' based if it is learner-centered, result-orientated and founded on the belief that all individuals can learn and achieve. Mentz (2004:1) suggests that the learner is assessed against achieving an outcome and enhancing learning rather than checking if learning took place. The OBE system promotes curricula and assessment based on a constructivist method. Outcomes therefore direct all curriculum experiences and activities (Rambrij, 2006:8). The OBE system was entirely a new concept for South Africa. Eight learning areas were defined with TE as a compulsory subject in the GET band (Grades R-9).

Fundamental to the change to OBE were the values of the Constitution of the Republic of South Africa (Act 108 of 1996) which aimed at providing a basis for curriculum transformation and development (DoE, Government Gazette No. 22559, 2001:21). According to Chapman (2002:14) the government sought to integrate 'education' and 'training' and to provide for flexibility and portability of qualifications. South Africa's version of OBE for the GET, grades 1–9, was released in 1997 under the name of Curriculum 2005 (C2005). The name suggested that by the year 2005 the system would be fully implemented in all South African schools. South Africa started implementing C2005 in 1998 (Ankiewicz, de Swart and Engelbrecht, 2005:2).

According to Chapman (2002:19), there were concerns about C2005 which led to the then Minister of Education, Prof. Kadar Asmal to call for a curriculum review in 1999. Chisholm (2003:3) mentions that some of the concerns leading to the review were: policy-overload and limited transfer of learning in the classroom; lack of alignment between curriculum and assessment policy; shortages of personnel and resources to implement C2005; and inadequate orientation, training and development of teachers. While the principles of OBE remained, changes were made to 'streamline' and 'strengthen' the curriculum, and the Revised National Curriculum Statement (RNCS) was introduced in 2002. The name of the document was changed to National Curriculum

Statement (NCS) in 2006 in line with what the curriculum is called in the FET band.

In 2009 a survey was conducted to determine teachers' and parents' experience of the implementation of the NCS. DEC (2009:5) comments on problems experienced during implementation of the NCS which were manifest in teacher overload, confusion, stress, and widespread learner underperformance in international and local assessments. Based on the results of the survey, the current Minister of Education, Ms. Angie Motshekga called for review of the NCS curriculum. Some changes, such as: less assessment tasks; clarity on what to teach; and better assessment guidelines were made to the NCS, and the Curriculum and Assessment Policy Statement (CAPS) was developed in 2010. The curriculum for grades R-12 in South Africa is still called the NCS as that is our national education policy, and the CAPS will assist teachers with implementation of the NCS.

In the context of the changes discussed above, the definitions of TE are discussed in the next section.

2.5 DEFINITIONS OF TE

During the first stages of designing a curriculum for TE, the subject was defined as:

> TE involves humankind's purposeful mastering and creative use of knowledge and skills with regard to products, processes and approaches so as better to control his environment. TE comprises *inter alia* of the utilisation of artefacts and processes

> by means of which labour productivity is increased (DEC, 1991:12).

After the Walters Report of 1990 and with the implementation of Curriculum 2005 in 1998, TE was defined as:

> TE is the use of knowledge, skills and resources to meet human needs and wants, and to recognise and solve problems by investigating, designing, developing and evaluating products, processes and systems (DEC, 1997:37).

The RNCS and NCS define TE as:

> The use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems while considering social and environmental factors (DEC, 2002:4).

In the CAPS documents, TE is defined as:

> The use of knowledge, skills and resources, to meet people's needs and wants, by developing practical solutions to problems, taking social and environmental factors into consideration (DBE, 2010:4).

A common thread throughout these definitions is the use of knowledge and skills to solve real life problems within an environmental and social context. For this study the researcher focused on TE as defined in the NCS and RNCS as this is the curriculum teachers were using during the time this study was conducted.

2.6 TE IN THE NATIONAL CURRICULUM STATEMENT (NCS)

2.6.1 Purpose of TE in the NCS

According to the NCS (DEC, 2002:4) TE will contribute to learners' technological literacy by giving them the opportunity to:

- develop and apply specific skills to solve problems
- understand the concepts and knowledge used in TE, and to use them responsibly and purposefully, and to
- appreciate the interaction between people's values and attitudes, technology, society and environment.

The significance of the TE learning area is directly related to the overall goal of the NCS for grades R-9 schools which is the development of citizens who can display competencies and values encapsulated in the critical and developmental outcomes. The essence of the TE learning area activities according to the DEC (2002) in the GET involves the following:

- The application of the design process: At the heart of the process is the identification of everyday problems, needs and wants of people, and the selection and application of appropriate resources, knowledge, skills and values to develop practical solutions. The design process encourages the development of critical and creative thinking skills.
- TE offers authentic, real-life opportunities for learners to interact with each other within teams when they develop technological solutions. They also interact with their communities when, for example, they test and market products that they make themselves.

- On a personal level, TE learners become more and more aware of their responsibility within their classroom, school, families and society. They learn to manage the technological resources at their disposal when developing products and they also learn to minimize the potentially negative impact that their solutions could have on the environment and on human rights.
- Learners in the TE classroom work in groups to analyse the given information in order to create practical solutions. Learners co-operate and communicate with each other, often combining verbal and graphic modes of communication. Discussing and reporting techniques and the use of appropriate technology are encouraged during the technological activities.
- The TE classroom contributes to the intellectual and practical development of the learners, to enable them to cope with the challenges of a technological society through the open-ended, problem-solving approach. TE link knowing with doing: it affords learners the opportunities to apply and integrate their knowledge and skills from other learning areas in real and practical solutions. These skills can be further developed in various situations throughout their lives.
- Learners explore both the positive and negative impacts of technology on their political, social, economic and biophysical environment. This will be done when they evaluate the product they have made using criteria like affordability, safety, fit for purpose, effect on the environment, and so on. This will enable the learners to develop into critical consumers.
- In TE, learners are provided with opportunities to interact with business and various industries that help them to understand and adapt to changing economic realities. They learn to generate creative and innovative ideas, and to co-operate in translating their ideas into action. Learners gain skills, knowledge, competencies and confidence that equip

them to explore entrepreneurial initiatives which will enable them to contribute to South Africa's social and economic development. The process also allows the learners to explore various opportunities for further education and future careers.

2.6.2 Learning Outcomes

A learning outcome is derived from the critical and developmental outcomes (DEC, 2002:14; Spady, 2008). It is a description of what (knowledge, skills and values) learners should know, demonstrate and be able to do at the end of GET. A set of learning outcomes should ensure integration and progression in the development of concepts, skills and values through the assessment standards. Learning outcomes do not prescribe content or method (DEC, 2002:14).

Learning Outcome 1 constitutes elements from the design process and is the focus of this study. The TE Teacher's Guide states that Learning Outcome 1 is seen as the 'backbone' of TE as it reflects the essence of this learning area. Because of this, 50% of mark and time allocation is awarded to Learning Outcome 1 (DEC, 2003) during the planning and teaching of TE in the classroom. Three outcomes were identified in TE for grades 4-9.

The three Learning Outcomes (LO) of the TE curriculum (DEC, 2002:6-9) are:

LO 1: Technological process or design process, which includes investigating, designing, making, evaluating and communicating.
LO 2: Three areas of knowledge which are structures, processing, and mechanical and electrical systems and control.
LO 3: Technology in society and environment which includes indigenous technology, impact of technology and bias in technology.

Taking into consideration how different countries experienced TE, a unique set of features was put together by the curriculum developers to suit the South African context. This was already discussed in sections 2.1 and 2.2, but is discussed further in 2.6.3.

2.6.3 Unique features and scope of the Technology learning area

According to the NCS (DEC, 2002) TE gives learners the opportunity to:

- learn by solving problems in creative ways (Mahike, 1993:6; Potgieter, 1999:85);
- learn while using authentic contexts that are rooted in real situation outside the classroom (Norman, 2000:94; Nováková, 1999:77);
- combine thinking and doing in a way that links abstract concepts to concrete understanding (Draghi, 1993:85);
- carry out practical projects using a variety of technological skills, such as investigating, designing, making, evaluating, communicating, which also suits different learning styles (Chapman, 2002:47);
- use and engage with knowledge in a purposeful way (Davis, Campbell, McRobbie and Ginns, 2002:81; Hughes, 2005:5);
- learn by dealing directly with inclusivity, human rights, social and environmental issues in their project work (Dugger and Yung, 1995:4; Savage, 1993:41);
- use a variety of life skills in authentic context (e.g. decision making, critical and creative thinking, co-operation, needs identification) (Mahike, 1993:6; Potgieter, 1999:85);
- create more positive attitudes, perceptions and aspirations towards technology-based careers (Hughes, 2005:5).

One of the purposes of TE is to develop and apply specific skills to solve problems (DCE, 2002:4). In the design process, the learners are exposed to the design process to solve problems and it is also the focus of this study. It is therefore important to discuss what is meant by design in the context of this study.

2.7 DESIGN WITHIN TE

Norman (2000:91) defines design as purposeful, problem solving thought and action, or creative thinking and problem solving action, which does not necessarily have a single answer, but may result in one of many effective solutions. Keirl (2002:247) concurs that design is working with imperfect information from an uncertain starting point and without single or “right” answers. According to Lawson, Bassanino, Phiri and Worthington (2003:328) the design world would argue that design is itself also a process of discovery, of learning, and even a form of research. They add that design can be seen as an attempt to close a perceived gap between an existing and a desired object or artefact by inventing a solution.

Not all authors describe design in the same way, for example, Cross (1990:136) states that design is an activity that requires aptitude, skill, creativity and innovation. Aptitude, he says, can be gained from appropriate experience, skill can be developed with time, and innovation is the extent to which the design is a success or failure and depends on the creator’s or learner’s ability which is something that is influenced by nature and nurture. According to Mioduser and Levi (2008:267) design can be either a highly structured and mindful process or an intuitive and unplanned process, or a combination of the two. Lewis (2005:37) argues that design is the single most important content area because it is a concept situated within the engineering domain. TE is an important part of education because education should be about lifelong learning, developing skills to help us in life and creating a better quality of living (Friedman, 2000:20). Keirl (2002:247) concurs that design is educationally very powerful as it can be a tool for lifelong learning.

Mioduser and Levi (2008:267) emphasise that design is at the heart of TE and a skill used in different occupations. Although authors explain design in different ways, one thing they all agree on is that design has always been an integral and necessary part of the curriculum for the training of artists, engineers, architects, industrial designers, clothing designers and so on. Leahy and Gaughran (2007:382) agree that design is something that can be taught and that it is necessary to understand the language of design. They add that the majority of teachers and learners do not fully understand the activity of design in the present education system. The results of their study highlighted a diverse understanding and ability to teach design on a practical level which they found was mainly due to an understanding of the language of design. All elements of language are present in all forms of learning, whether it is learning music or dance they are all made up of their own 'language'. Leahy and Gaughran (2007) state further that a learner's first form of education is language and this consists of the primary elements such as vocabulary, grammar and expression. The ability to use vocabulary and grammar creatively and with intuition shows a person's expression. They explain that language does not have to be present in words to be understood, it can be conveyed through symbols or illustrations. They add that the way in which the elements of language, international icons and symbols are used in the design process will lead to the designing of a successful end product.

Norman (2000:94) states that creative problem solving is often symbolically represented. Lee and Todd (2004:8) agree that teachers recognise the cross-curricular potential of TE with specific reference to literacy and language acquisition. Rowell (2002:216) states that in the classroom setting of a technological activity, teachers turn to language as a critical mediator of leaning. It has been suggested that language may provide the key for linking thought to action. The most important thing about a language is that it conveys meaning to a task.

As can be seen from the above discussion, design is not a single activity but part of a process. To gain an understanding of how to teach design in the classroom we need to look at the design process.

2.8 DESIGN PROCESS WITHIN TE

Barlex (2005:6), Corkery, Grant, Roche and Romero (2006:10); Eggleston (1996:73); Medway (1994:86); and Pendergast (1999:102), agree that the design process could be considered central to the curricula of Science and Technology. According to them, using the design process can provide solid teaching and learning foundations in the TE classroom. The general understanding of the design process continues to evolve as there have been numerous attempts to describe the design process. As an educational skill, the design process has been portrayed as: “fulfilment of a need” (Johnsey, 1995:201), “a problem-solving activity” (Rogers, 1998:132), and developing solutions that meet authentic needs and opportunities (New South Wales Department of Education and Training, 2007). Hill and Anning (2001:121) conducted a study to determine the skills gained when engaging in the design process among learners aged four to nine years of age. They found recurring characteristics of learners who engage in the design process include: good observation skills of their surroundings; capacity for idea generation and effective communication; demonstration of curiosity and the ability to ask questions; and engagement with the iterative process of design.

Williams (2000:53) states that the terms ‘design process’ and ‘problem solving’ are often used interchangeably. This is not correct, as the design process deals with an ill defined problem which might not begin with a problem, while problem solving does. Dagan, Mioduser and Israel (2003:254) explain that one of the main goals of technological literacy is to provide learners with tools for solving technological problems. The main methodological resource for this purpose is the design process as used by technologists who create solutions in response to human needs for the enhancement of the quality of life. Corkery *et al*. (2006:11) add that embedded in the design and making process is the ability for learners to reflect on and evaluate the entire process. They state further that such reflections incorporate a circular or iterative process whereby learners begin to imagine their human-made surroundings, interrogate them, make decisions regarding unanswered questions, and generate activities grounded upon these decisions.

Reflection and evaluation become integral components as they link defined problems with solutions sought (Benenson, 2001:731). Appraisal and reflection by the learner in consultation with the teacher at each step brings continuity to the project. Barlex (2005:5); and Hong, Yu and Chen (2008:289) state that during the design process, the learners speculate about what might be. These speculations are developed, modeled, evaluated for fitness of purpose, realised as a prototype, and evaluated further against intention and impact. Barlex (2005:5) suggests that the design problem interacts with the design solution, with elements of both the problem and the solution only becoming apparent as the solution is developed in response to the problem.

Gruber and Wallace (1999:95); and Hong *et al*. (2008:286) suggest that collaborative learning is the best method for solving problems. They add that learning from the design process will accumulate from the sharing of knowledge among team members. Gruber and Wallace (1999:95) further explain that when people start with a new project, they try to make sense of it, and at the same time they become involved with it, they review what they know, and need to know about the project in order to complete it, and they make comparisons and associations with other experiences. Davis *et al.* (2002:81) agree that an important feature of any technology curriculum is that learners should be provided with opportunities for engagement in meaningful learning experiences. Learners draw upon their existing knowledge of materials, tools, machines and systems, and gather and use information from a variety of sources (Davis *et al.*, 2002:81).

Just as researchers experience design in different ways, so too do they also perceive the design process differently. The following section gives an overview of the structures of the design process as described in the literature.

2.9 STRUCTURE OF THE DESIGN PROCESS

The 'design process' used in most educational systems is linear, however this contradicts the reasoning behind why one 'designs' (Davis *et al.*, 2002:82). Fiell and Feill (2005:16) agree that the design process is not linear, rather it is a complex activity similar to a game's strategy but strangely, it is a game where the rules are continuously changing and that is what makes it so fascinating and mysterious. According to Davis *et al.* (2002:82) literature does not support the idea of linear approaches which may be referred to by some researchers as "design, make, appraise" when referring the design process. Leahy and Gaughran (2007:52); and Williams (2000:382) concur that the design process which is the predominant system implemented by teachers in Engineering and TE should not be linear. Williams (2000:382) adds that the process cannot be linear as the learners do not always start from a human need; neither do they always proceed in an orderly way.

According to the TE Guidelines (DEC, 2003) the design process is called IDMEC, which stands for investigate, design, make, evaluate and communicate (Chapman, 2002:47). Davis *et al*. (2002:82) agree that the process seems to be cyclic, interactive or recursive in nature and is an interaction between head and hand as an interrelated process involving several planning-making-testing loops with the goal of creating a product. On the other hand, Fleer (2000:56) found that learners did not necessarily use designs when making arte-facts. While working with the materials and experiencing the properties of the materials, the learners get ideas of what they should make. Dagan, Mioduser and Israel (2002:255) agree that there is a conflict regarding the nature and qualities of the design process. They examined the relationship between the alternative approaches (functional and structural) towards the teaching of the design process and concluded that a central goal in design process instruction is to facilitate the construction of appropriate mental models of the technological problem solving process. By mental design models they mean systematic structural, functional or causal internal models of the design process. They added that this can be in the form of internal representations of the real world situation and its solution. The teaching of the design process is discussed further in 2.11.

While some researchers (Davis *et al.,* 2002:82; Leahy and Gaughran, 2007:52; Williams, 2000:382) conceive the design process as a creative, branching and cyclical process based on multi-disciplinary knowledge, others (Bosworth and Savage, 1994:11; Winek and Borchers, 1993:23) feel that it has to meet the requirements of product-production processes, clearly product orientated, structured, following stages and meeting time schedules.

Dagan *et al.* (2003:41) summarise the different structures of the design process by identifying four types of models, namely finite linear; cyclic linear; branching; and the forth model which was unnamed.

- Linear model: The learners describe the problem solving process as a series of stages ordered in a linear manner.
- Cyclic model: The learners describe the problem solving process as a series of stages which include return paths to previous stages.
- Branching model: The learners describe the problem solving process with many branching nodes.
- Unnamed model: Verbally description of the design process without any graphical representation (by the researcher named the ‘open model’)

Keeping the models of Dagan *et al.* (2003:41) in mind, the question the researcher wanted to address in this study was whether teachers can identify the design processes, and if they can, how do they teach the learners in their classrooms. The different models of the design process are therefore discussed in the following section.

2.10 MODELS OF THE DESIGN PROCESS

Different models of the design process are found in the literature. The researcher used some of the commonly found models to explain the design process in this section. These models are discussed according to the four models identified by Dagan *et al.* (2003:41).

2.10.1 Linear model

The model of the design process as used in the South African TE curriculum is very general. As previously stated, Davis *et al.* (2002:82) are concerned that the design processes used in most educational systems worldwide seem to be linear. The design process as described in the NCS also follows a linear process (Chapman, 2002:47) and describes the different stages of the design process, according to the assessment standards, which are: investigate; design; make; evaluate; and communicate.

A similar occurrence can be found in the Design and Technology curriculum in the United Kingdom. They use the word 'target' instead of stages of the design process. The design process according to Lewis (2006:266) refers to the following four attainment targets with their focus as follows: need and opportunity identification; generating a design; planning and making, and evaluation of the design effort.

Ankiewicz, de Swart and Stark (2000:128) see the design process as consisting of ten procedural stages through which the learner needs to work. These stages are:

Stage 1: Problem statement – a brief description of the problem or need in short, descriptive sentences

Stage 2: Design brief – a brief description of planning for solving the problem or to meet the need

Stage 3: Investigation – the collection of information concerning the problem or need

Stage 4: Proposal – a written exposition of what needs to be done or designed to solve the identified problem or meet the need

Stage 5: Initial idea generation – where various ideas are generated and analysed, and the best idea is selected

Stage 6: Research – solving specific problems concerning the selected idea

Stage 7: Developing the selected idea to a final idea – adding further detail to the selected idea

Stage 8: Planning how the product will be made

Stage 9: Making the product

Stage 10: Evaluation of the final product based on stated criteria.

The model of Ankiewicz, de Swart and Stark (2000:128) is similar to the general approach adopted by Winek and Borchers (1993:23) where they describe the components of the design process in Figure 2.2 (below).

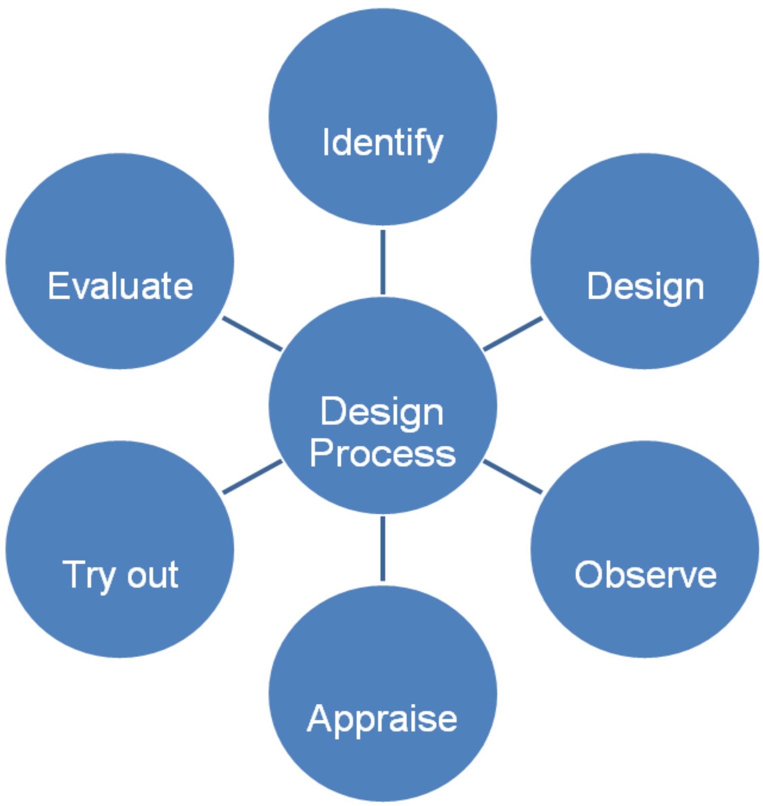

Figure 2.2: Design process according to Winek and Borchers (1993:23)

In Figure 2.3 (below), Bosworth and Savage (1994:11) also show the design process to be linear. They use a more functional approach to describe the design process and recommend steps such as: statement of the problem; gathering of information regarding the problem; analysis of the problem; modeling; problem evaluation; producing prototype; observation; and feedback.

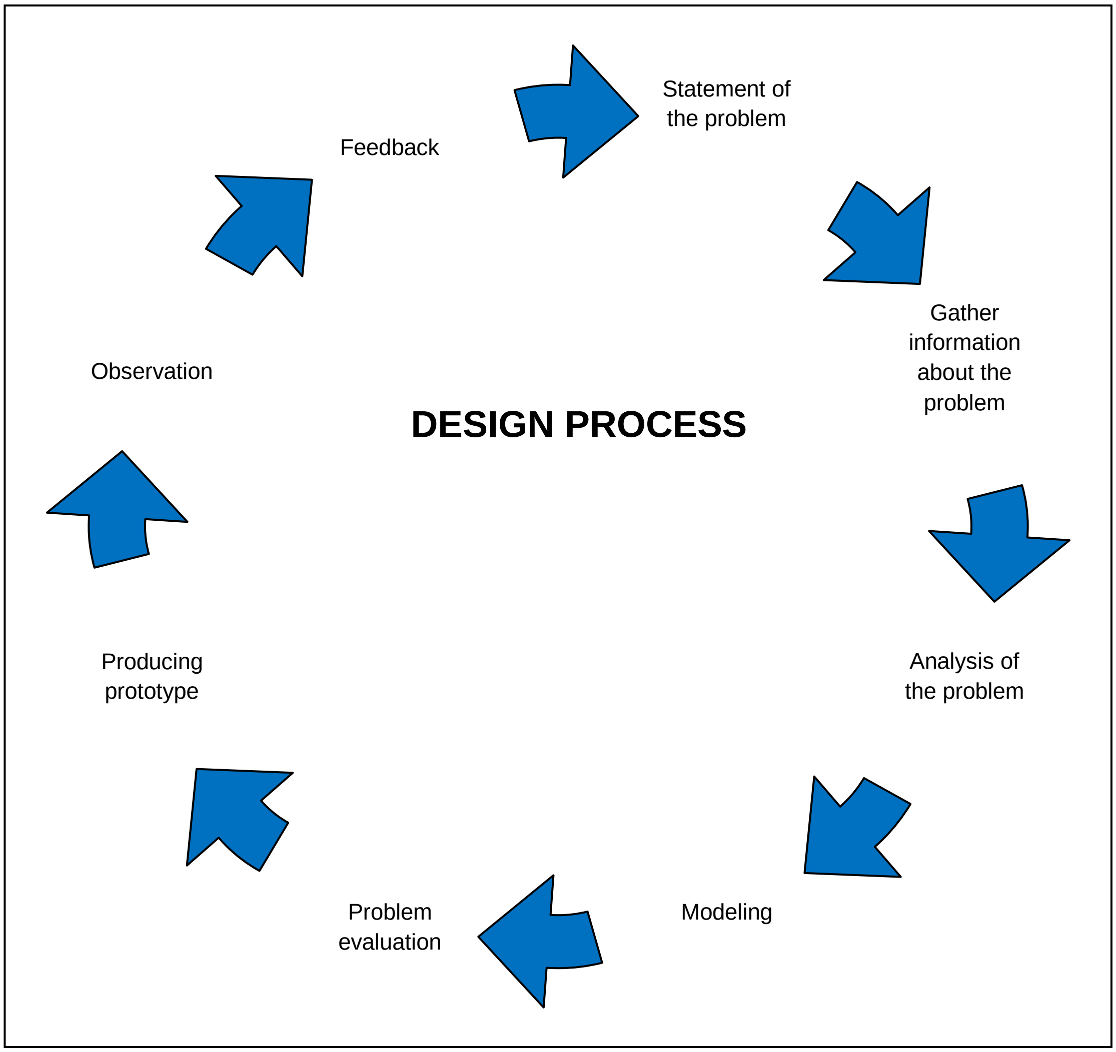

Figure 2.3: Design process according to Bosworth and Savage (1994:11)

The approach by Bosworth and Savage (1994:11) of the design process suggests that the learner should start with the statement of the problem and follow the steps towards the end where the production of the prototype, observation of how the product works and giving feedback as to whether or not the problem stated in the beginning was solved. The arrows point in one direction only, indicating that there is no interaction with the previous steps.

Similar to the design process of Bosworth and Savage (1994:11) is the design process of the Massachusetts Department of Education 2006, Figure 2.4 (below). Tate, Chandler, Fontenot and Talkmitt (2010:390) critique this model from an engineering point of view. They express their concerns regarding steps 1, 5, 7 and 8 which are not compatible with engineering design. Engineering designs are discussed in 2.10.2 and 2.10.3.

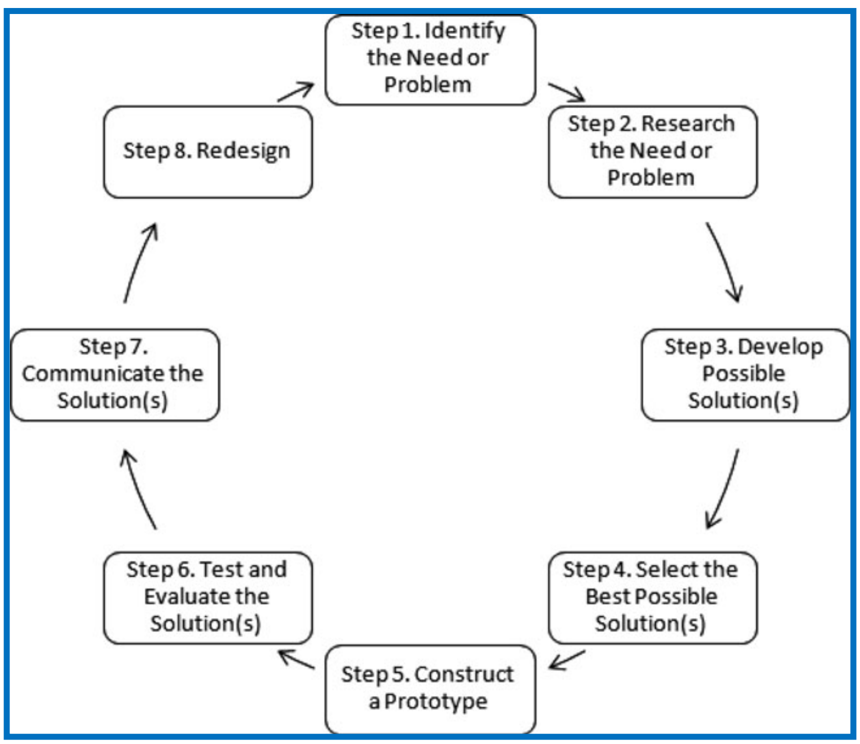

Figure 2.4: Design process according to the Massachusetts Department of Education (2006)

Descriptions of the design process in 2.10.1 are represented as a linear process that is, starting at one point and working through to the end (Ankiewicz *et al*., 2005:2; Mawson, 2003:118). The only difference between the models is the number of stages in each. The linear models above focus more on the end product than on the process. In contrast to the linear process is the cyclical model, the second model identified by Dagan *et al.* (2003:41).

2.10.2 Cyclical model

Fredrik and Sonneveld (2009:220) suggest a cyclical model as can be seen in Figure 2.5 (on page 39). In this model the learners must first be familiar with the different parts of the process and with the whole process (Leahy and Gaughran, 2007:390). Fredrik and Sonneveld (2009:220) suggest that in each stage of the design process, which they call “cyclical zooming”, the learners practice each part of the process by doing short capability tasks where they combine procedural and context knowledge. Once the learner is confident in one activity they move to the next. The learners can at any time go back to the previous stages.

The design process used to solve a problem needs to be a well thought through process. It is both a means of developing learners' knowledge of technology and a critical outcome of a good TE. A technological problem requires the learner to search for a method to solve the problem rather than following a set procedure (Fredrik and Sonneveld, 2009:220). Technological problem solving therefore requires an understanding of relevant concepts, procedures, and strategies (Problem solving, n.d.).

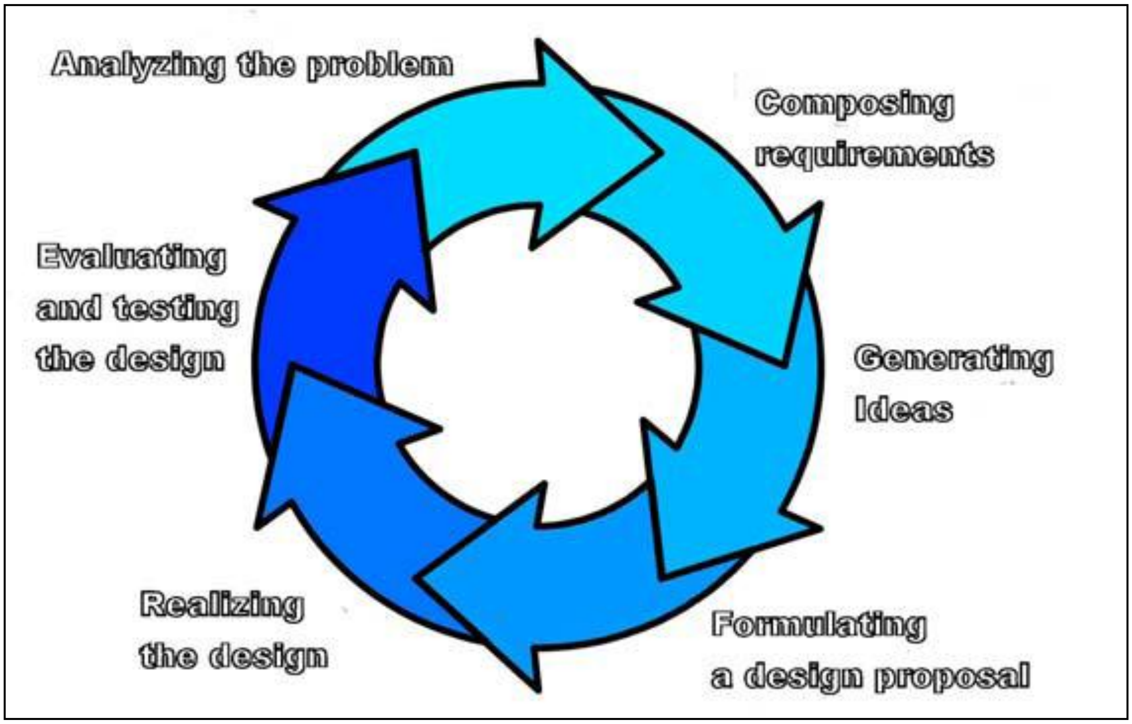

Figure 2.5: Design process by Fredrik and Sonneveld (2009:220)

Figure 2.6 (on page 40) show the cyclical model of the design process by the Colorado School of Mines, 2004 (Tate *et al.,* 2010:390). This model ends at the select of the final design and therefore does not allow the learners to engage in a crucial stage namely, the execution of the design. According to Tate *et al.* (2010:390) when using this cyclical model of the Colorado School of Mines, learners will not be able to verify performance predictions which are a requirement specification for a project. The reason is because they didn't engage with the making and therefore cannot test the performance.

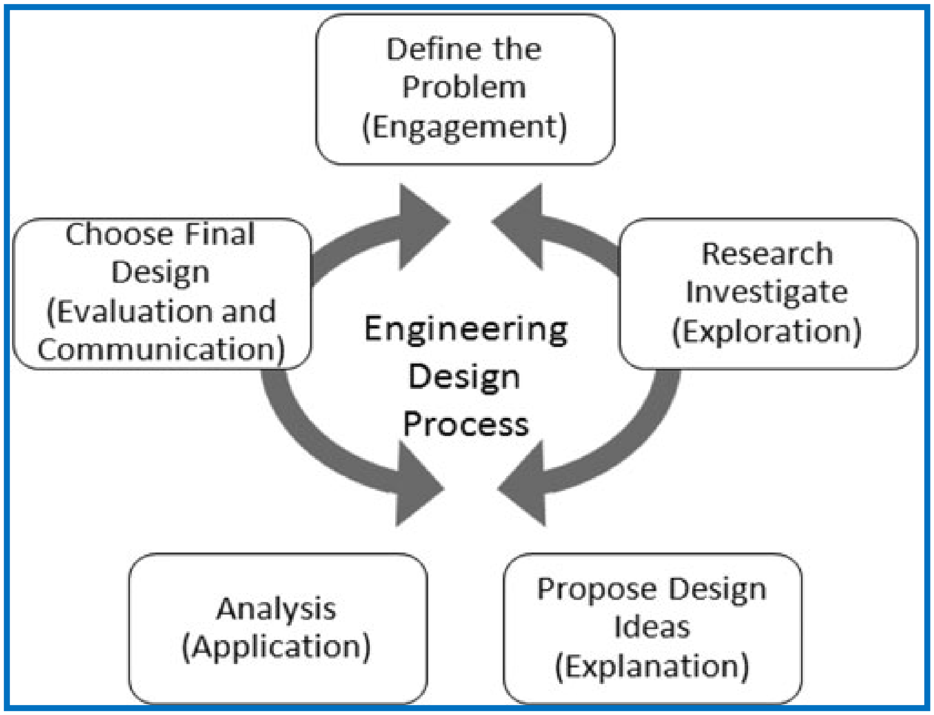

Figure 2.6: Colorado School of Mines model (2004)

According to Tate *et al* (2010:392) the cyclical FRAME design process model, 2009, Figure 2.7 (on page 41) helps the teacher and learner in the classroom to understand and manage a project better and gives the learners justifiable solutions to open-ended questions in the design process. The word FRAME points to the Frame theory developed by Minsky in 1977. The essence of the Frame theory is that one selects from memory, a structure called frame, when one encounters a new problem. In between each step of the design process is an evaluation process to help recalling what was done in the previous step and to test if the process of solving the problem is still on the right track.

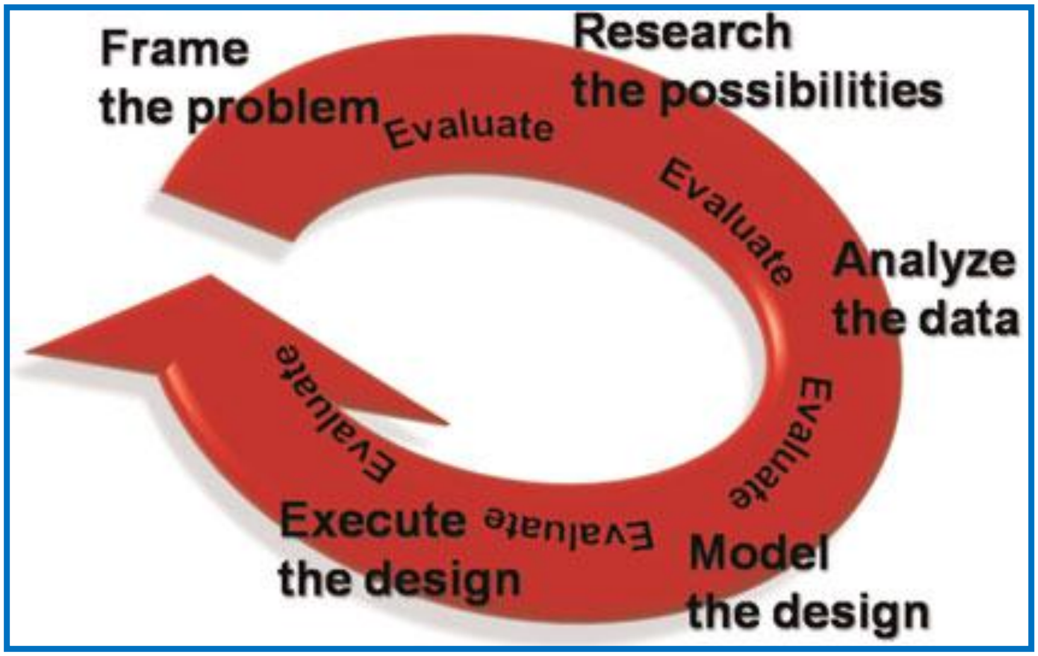

Figure 2.7: The FRAME engineering design process model (1977)

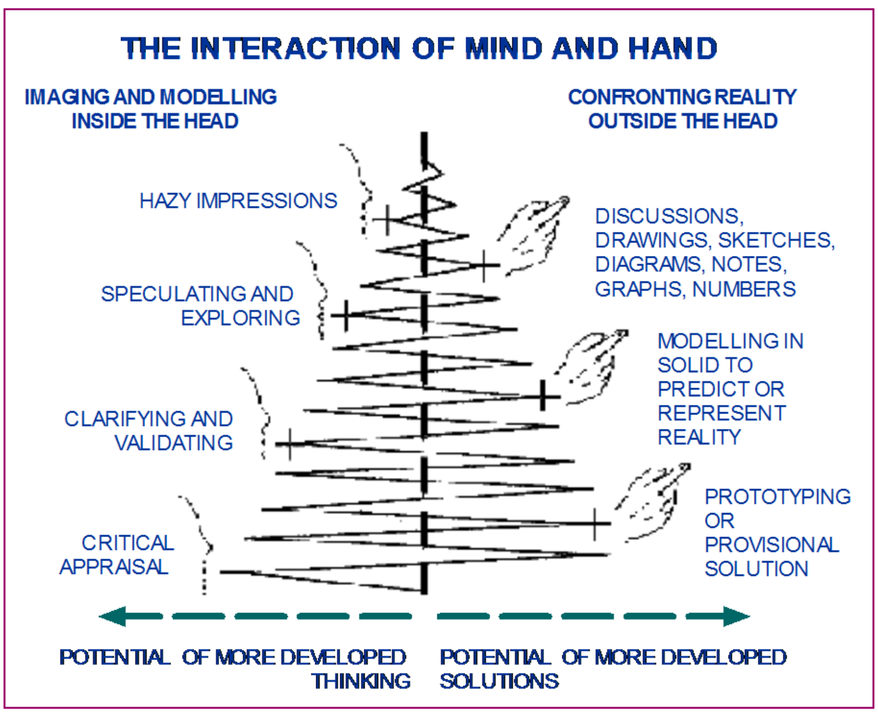

Figure 2.8: Cyclical model by Davis et al. (2002:82)

The third design process model to be discussed is the branching model.

2.10.3 Branching model

Mioduser (1998:180) suggests an alternative model to the cyclical by looking at what the learners actually do. He illustrates the model to the design process in Figure 2.9 (below). In this model, Mioduser suggests that the learner starts with the identification of the problem and then explores the different solutions to solve the problem, each time looking back at the problem to establish if the solution will be suitable to solve the problem. All the steps followed during the design process interact with each other as indicated by the arrows. This allows the learner to check all the time if what they are doing will solve the problem.

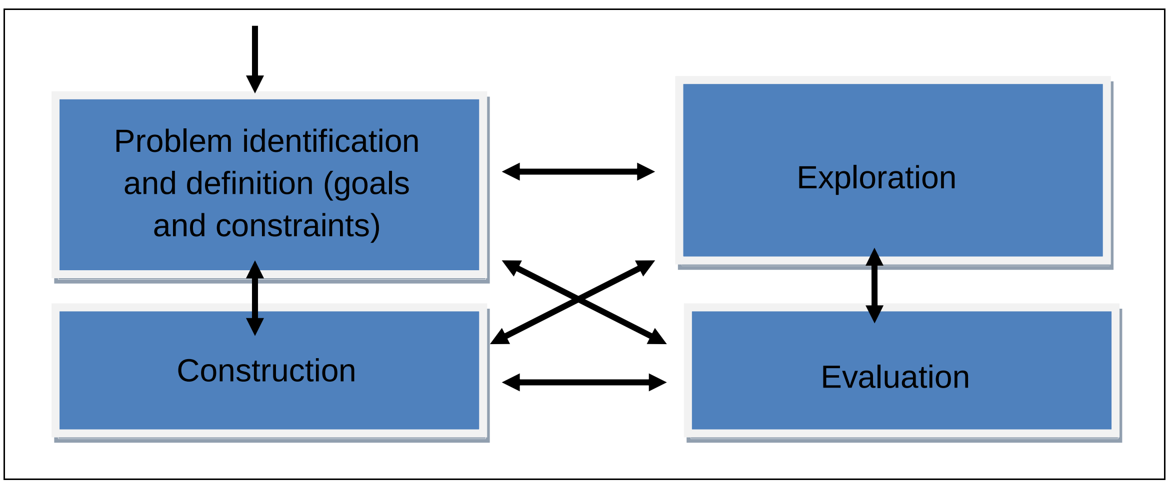

Figure 2.9: Design process according to Mioduser (1998:180)

An easier and more practical branching model is illustrated by Garret and Molwane (2005:24) where he identifies the steps of implementing the design process in the classroom in Figure 2.10 (on page 43).

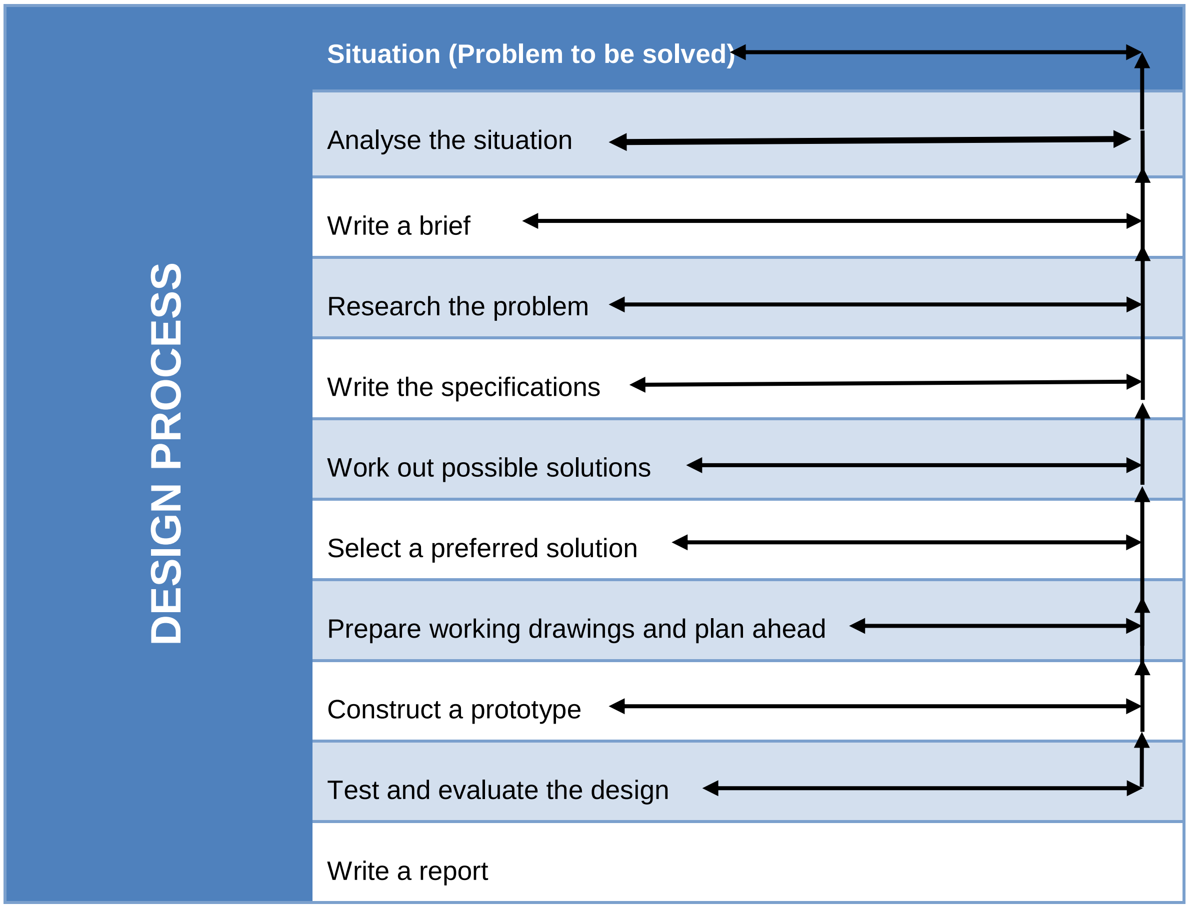

Figure 2.10: Design process according to Garret and Molwane (2005:24)

This design process by Garret and Molwane (above) shows the steps to be followed, but during the design process it is not always as easy as just following the one step after the other. The problem solver will often have an idea, or discover something which will make him or her rethink an earlier step. This feedback is shown by the arrows on the side. This allows the learner to go back and through during the design process to redesign and ensure that the product at the end will be able to solve the problem stated at the beginning of the process. Although it looks like a linear process, the arrows indicate the iterative nature of the model.

Some of the careers in which the design process is widely used as a method to solve problems, are engineering and science, and this has gained momentum since 2007 (Gatti and Wicklein, 2007:6; Kelley and Kellam, 2009:37; Schreuder, 2007:53; Vandeleur, 2007:365). Gatti and Wicklein (2007:17) explain that TE gives the learners multiple career options and ensures that tertiary institutions receive better prepared learners who understand engineering design processes before embarking on tertiary studies.

Engineers are presented with new challenges or problems every day. At first, many of these problems may seem impossible to solve. To find a solution, engineers must use problem-solving techniques and brainstorm as many creative ideas as possible. What seems impossible at first, becomes possible through the use of teamwork, the engineering design process, and learning from past successes and failures (Gatti and Wicklein, 2007:17).

Shiley (1972:4) guards against the recognition of a need and phrasing it as a highly creative act because the need may only be a "vague discontent" or a feeling of uneasiness on the part of the learner, or it may be a response to a disturbance that a person experiences. He states further that there is a distinct difference between a statement of the need and the identification of the problem - the problem is more specific. Engineers see the design process as a process which requires recognition, definition, synthesis, analysis and optimisation. At the end of the design process the solution to the problem is evaluated and presented (Shigley, 1972:5). This can be seen in Figure 2.11 (on page 45) as the feedback loops from one step to the other. This loop may have to be traverse many times before the problem is defined. This model is very similar to that of Garret and Molwane (Figure 2.10 on page 43).

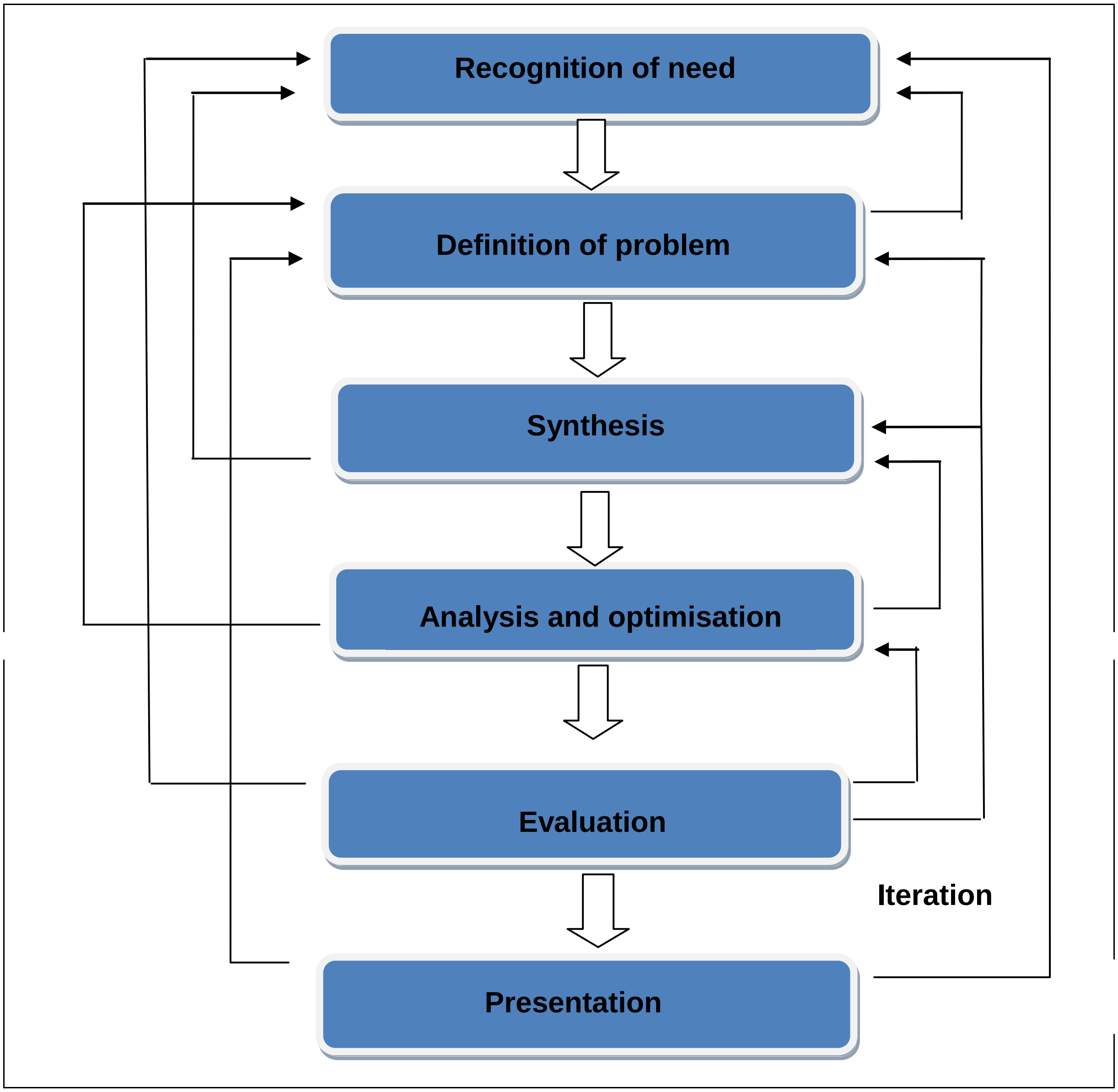

Figure 2.11: The phases of the design process by Shigley (1972:5)

Khandani (2005:5) identifies five basic steps in the engineering design process namely: define the problem; gather pertinent information; generate multiple solutions; analyse and select solution; and test and implement solution. He states that although the activities might give the impression that the steps are sequential and independent from each other, the iterative nature of the application of the process should be kept in mind, which means that while solving a problem, one may find at any point in time that one needs to go back to the previous step. It might mean redefining the problem, gathering more information or generating different solutions.

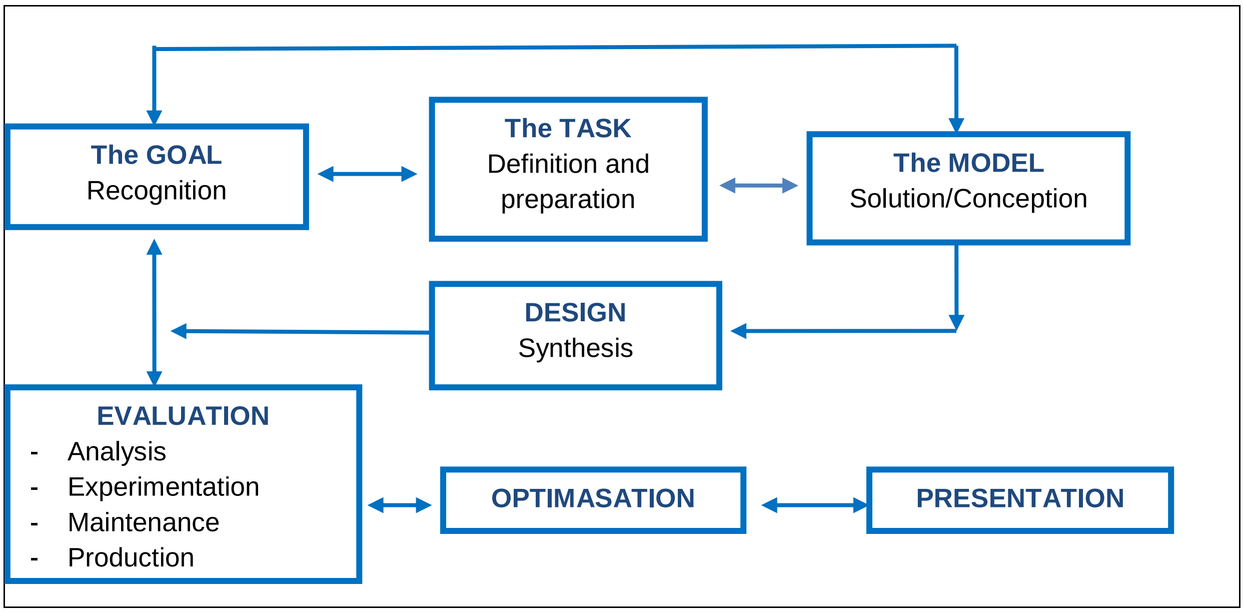

Figure 2.12: Stages of Engineering Design Process by Erden (2004:11)

Erden (2004:11) suggests a design process model with branching nodes were the goal, task and model all interact with each other and from this interaction the product is designed. The design should be evaluated according to the goal. He adds that optimisation and presentation interact with the evaluation and the goal. This model can be seen in Figure 2.12 (above). Each stage in the design process tells the user what to do, which makes it user-friendly for the teacher in the classroom.

Not all people work in the same way, some work in a more structured way than others, there is therefore a need for another model. Dagan *et al.* (2003:41) did not give this model a name. The researcher decided to call this the 'open model' as it leaves the process open for the learners to use the design process in the way they feel comfortable and which suits their learning styles.

2.10.4 Open model

Williams (2000:5) states that most of the learners and designers do not use a predetermined process while working; instead they invent a process as they proceed towards task completion. According to Williams (2000:5) the solutions to a problem involve more variables that can be presented in a sequence of process steps.

The technology process or design process should, according to Williams (2000:52), be seen as activities and not as stages or steps. He suggests that the learners do not necessarily have to do all the activities each time they complete a task and they do not have to do these activities in the same order. According to Williams (2000:52) the nature of the learner and the problem will determine the activities the learners will do. The most important activities in the design process are: evaluation; communication; modeling; generating ideas; research and investigation; production; and documenting. He prefers to use the word 'activities' rather than 'stages' or 'steps' as the latter gives a sequential connotation. If learners are forced to all do the design processes in the same way as predetermined by the teacher, the teacher is stifling the cognitive development, critical, creative, reflective and independent problem solving skills of the learner these are all skills that learners will need in a career (Williams, 2000:52).

According to Atkinson (2000:256) the way in which the design process is executed, changes according to factors such as: the nature of the problem; the resources available; the personal attributes of the learners; and external influences such as culture. There should therefore not be a one-fits-all approach to the design process.

Although all the models discussed above vary, there is also a great deal of consensus regarding their basic elements or essential parts. It is apparent that the design process is seen as a very important process in solving problems. To become good problem solvers, learners need many opportunities to formulate questions, model problem situations in a variety of ways, generalise technological relationships, and solve problems in both technological and everyday contexts. One of the critical outcomes in the NCS derived from the Constitution, is that it envisages the development of learners who identify and solve problems and make decisions using critical and creative thinking (DEC, 2002). With this outcome in mind, it is important to find a suitable way to train teachers in the implementation of the design process in the classroom.

Teachers often prefer a linear process which emphasises the stages of planning and drawing, then construction and finally, testing. Lee and Todd (2004:9); and Moreland and Jones (2000:292) and agree that teachers still structure design activities as sequential rather than iterative processes. The reason in trying to find a suitable model for the design process is mainly to make the teaching and assessment in TE easier for the teacher (Mawson, 2003:119). Mawson continues to caution teachers to see the design process as a ‘helpful guide’ and not to see it as prescriptive stages to be followed as this can turn the design process and TE into a series, ending in a product rather than a process to solve a problem. Van Dyk and van Dyk (1998:51) urge teachers to guard against putting too much emphasis on the end product, as it is the process that is more important. They add that a teacher that has too much of the end picture in mind may stifle the learner's creativity and not allow them to freely express their ideas. Johnsey (1997:204) agrees that a design process model can be very helpful for a non-specialist primary school teacher as it provides a sense of security and some guidance to proceed, but also warns against the danger of seeing the design process in a simplistic way.

2.11 APPROACHES TO TEACHING AND LEARNING OF THE DESIGN PROCESS IN TE

Designers come from a wide spectrum of careers which make it difficult to decide on one definition or strategy for the design processes. Leahy and Gaughran (2007:390) suggest that a definition may have to be replaced by a generic description of activities both cognitive and practical. Teaching is a complex activity which needs to be taken into consideration when looking at the practical implementation of the design process. What works for one teacher may cause the opposite effect for another. Leahy and Gaughran (2007:390) suggest that a deeper understanding is required of what is in design, how it works, and how learners and teachers can make it work for them. According to Felder (1993:110) learners whose learning styles are compatible with the teaching style of a teacher, tend to retain information longer, apply it more effectively, and have a more positive attitude toward the subject. This finding is supported by Seery, Gaughran and Waldmann (2003:332).

Leahy and Gaughran (2007:384) suggest that it is firstly important to determine the way one prefers to learn, whether by reading, writing, seeing, hearing or doing, and that this should influence the teaching of the design process. The teacher needs to acknowledge each learner's preferential learning style which will increase learning and understanding. They add that if we want to establish design methodology it is important to understand how learner’s best take in information. If the teaching style is harmonised with the learners’ learning style it improves the learning and understanding for the learner at all levels. At the same time, varying ones’ teaching style helps learners develop learning styles in addition to their preferential learning style which will benefit them later on in life (Leahy and Gaughran, 2007:384).

Dagan *et al.* (2002:255) identify two main methodological approaches for teaching the problem solving process, namely: the structural (stage-by-stage) approach, and the functional approach.

According to Dagan *et al.* (2002:255) learning in the structural approach to the design process takes place in a more ordered way. They add that different models (differing from each other mainly by the number of stages into which the process is divided) were developed all over the world as a tool for teaching the design process, and where learning takes place in a linear manner by gradually going from one step to the other. This they feel, might restrict the creativity of the learners.

With regards to the functional approach, Dagan *et al.* (2002:255) feel that learning is taking place by studying the design functions rather than following the stages of problem identification and definition, investigation, decision making, planning, making and evaluation. They add that at every stage of the process, learners may use more than one of the design functions as this will allow more flexibility and follow a cyclical model. In the functional approach the learners use a way that best matches the problem, the situation, and their own personal style.

In South Africa according to the Department of Education (2002), the approach to the teaching and learning of TE should be ‘project-based’ and ‘hands-on’.

According to Frank (2005:12), project-based learning promotes technological literacy. Buck (1999:1) concurs that those learners who engage in project-based learning, engage in active learning and gain multidisciplinary knowledge while working in a real-world context. Polman (2000:32) defines project-based learning as instruction which translates questions pertaining to the learners' lives into classroom projects. In a project-based approach, learners do their own investigation which leads to valuable research skills. Learners engage in design, problem solving, decision making and investigating activities. They can either work in groups or as individuals to come up with ideas and realistic solutions to problems. This approach centres on the learners who must organise their work and manage their own time. Norman and Schmidt (2000:723) noted that project-based learning increases motivation to study and helps learners to develop long-term learning skills. Hill and Smith (1998:8) also found that the project-based learning environment increases self-confidence, motivation to learn, creative ability and self-esteem of the learner.

The literature highlights some challenges that teachers experience when teaching the design process.

2.12 CHALLENGES IN TEACHING THE DESIGN PROCESS

Corkey *et al*. (2006:11-12) identified four challenges when teaching the design process namely, personal understanding of the design process; context-specificity; sequence of the design process; and assessment.

2.12.1 Personal understanding of the design process

The teacher's personal understanding of the design process in TE remains problematic as teachers do not always see the bigger picture of the design process and teach it according to their individual understandings and knowledge (McCormick, Murphy and Hennessy, 1994:6). This they say influences how learners begin to undertake the design process.

2.12.2 Context-specificity

When viewed as problem solving, the design process requires expertise in the context of its application (McCormick *et al*., 1994:7). They state further that teaching general problem solving skills ignores the procedural and conceptual understanding of the design process. Each design problem requires specific knowledge. Learners engaged in design need to understand both the “how’s” (procedural) and the “whys” (conceptual) of the design issue at hand (Lewis, 1997:45). Procedural knowledge is dependent upon conceptual knowledge. The design of the product (i.e. materials and structure) is determined by the learner’s understanding of the proposed function of the product and is contingent upon the design problem at hand as the knowledge demands between each design problem differs (McCormick *et al*., 1994:7). They add that due to the imbalance of understanding between procedural and conceptual concepts, learners fail to experience the aspects of the design process holistically.

2.12.3 Sequence of the design process

Teaching the design process in TE must be seen as the teaching of processes (McCormick *et al*., 1994:8). Although activities in technology are integrated, the design process is often separated into stages. Williams (2000:52) contends that activities are not an end in themselves but rather provide a basis upon which learners build creativity, reflexivity, and critical discernments. He urges that components of the technological process be viewed as “aspects rather than stages” (Williams, 2000:52) as stages have a sequential connotation. A sequential or linear connotation may have the effect of representing the design process as a series of end products. Learners can be focused on design as a product and not on design as a process if they do not interact with the process (Johnsey, 1997:201; Mawson, 2003:119).

McCormick *et al*. (1994:7) investigated how learners perceived and used the design process. Their study highlighted a learner's inability to comprehend the complete design process of making a kite. By focusing on problems that came from making the kite, e.g. deciding on materials and keeping the shape stable, they did not relate the conceptual understanding of kite components to the process of design. They didn't question how it all related to the whole of the design problem. This left learners with individual tasks and they could not see the relationship between the components of the design process or problems of the task. It is important therefore for teachers to explain the link between aspects of the overall design process where a range of techniques are applied.
Benenson (2001:738) states that the design process very seldom progresses from problem to solution. Design is a non-linear messy affair that generally involves considerable backtracking and revision of the original specifications. McCormick (2004:23) suggests that it is important that learners understand the iterative nature of the process of design. He continues to say that in most aspects of their learning, learners are often encouraged to think in absolute terms of right and wrong. According to McCormick (2004:23) are there many right answers in the design process, some more 'right' than others depending on what one is trying to achieve. It is therefore important for the learners to study and practice the different parts of the design process to reinforce the link between problems and solutions. Assessment is an integral part of teaching and the teacher needs to assess the learner throughout the project on all aspects and not only focus on the end product.

2.13 ASSESSMENT

Assessment is defined by the South African Department for Basic Education (2011:3) as the process of collecting, analysing and interpreting information to assist the teacher to make decisions about the progression of the learner. Two types of assessment are highlighted namely: informal and formal assessment. Informal assessment is done on a daily basis and monitor and enhance the learners' progression. During the informal assessment the teacher observes the progress of the learner and determines possible gaps in the learner's knowledge and skills (DEC, 2007:5). Formal assessment is used to determine the learner's progression in a specific subject and grade. The formal assessment can be in the form of projects, tests, examinations, practical demonstrations etc.

Assessment is an integrated part of teaching and learning and when planning for implementation in the classroom, the teacher must also plan for assessment. Therefore when investigating the implementation of the design process, one also need to look at the assessment of the design process. In the OBE system, the teacher needs to look at the learning outcome and the assessment standard to ascertain what needs to be assessed. The learning outcome explains what the learner should be able to do at the end of the learning experience and the assessment standard gives the depth and breadth in which this learning outcome should be achieved (DEC, 2002:53; Van Niekerk, Ankiewicz and De Swart, 2005:2). The learning outcomes for grades 4-9 stay the same, namely: technological processes and skills; technological knowledge and understanding and technology, society and environment, but the assessment standard changes progressively according to the grade (DEC, 2003:15).

With the introduction of the OBE system the teacher had to move away from the traditional pen-and-paper method of assessment to using different assessment instruments to assess the learners' achievement against the assessment standard. In the constructivist classroom, assessment should provide meaningful feedback regarding teaching and learning. This happens through continuous assessment. Neuman (2003:8) states that this can be done by reflecting, testing, modification, re-testing and re-evaluating as learner's progresses through the design cycle of the design process. He adds that if continuous assessment does not take place, the focus will wholly be on the end product and not on the process, and the learners will not analyse the advantages and shortcomings of their product. This may result in the learners not understanding the design process especially during the designing and making process. Welch, Barlex and Lim (2000:144) feel that while learners are engaged in the design process to solve a problem, a weak link occurs between the 'draw-and-make' processes. They observed a group of learners and found that after making a concept drawing, learners seldom referred back to this initial representation of their idea during the 'making' process. They found that learners could not develop full understanding of the design process by just 'doing' and that there need to be an awareness and understanding of the connection between the design problem and the solution. Hill and Anning (2001:120) found that learners use the drawing process to highlight the aesthetics of the project and not to show the strengths or weaknesses of its functional qualities. They feel that learners often just need the teacher and/or peer to talk them through their design ideas. This is supported in part by Vygotsky's (1986) theory of the zone of proximal development (ZPD).

2.14 THEORETICAL FRAMEWORK

ZPD may be defined as the distance between a learners' ability to perform a task under adult guidance and the learners' ability to solve a problem independently (Mavugara-Shava, 2005:68). ZPD is a term for the range of problem solving that the learner can do on his or her own to the range of problem solving done with the guidance of a more-skilled person (Mavugara-Shava, 2005:68). Tam (2000:4) states that the teacher first has to establish at what stage of development the learners are, to be able to give good instructions building on learners' experience. With a young child, more guidance will be given and as the child matures, they will be left to work more independently. This process is also called scaffolding which means when a task is given to a learner on their level, very little learning will take place (Mavugara-Shava, 2005:68) as they will just draw from their knowledge and previous experience, but if a task is set to them higher than their level and guidance from a adult is provided, then learning will take place. In the classroom this means that instructional intervention from the teacher or facilitator must not just match the development level of the learner, but need to increase their cognitive development.

The main goal of the teacher or facilitator must be to help the learners to become active participants in their learning by helping them to make a meaningful connection between prior knowledge, new knowledge and the process involved in learning (Tam, 2000:5). In TE the design process can be seen as a higher cognitive task, therefore the teacher needs to understand the design process very well to be able to assist the learners when engaging with activities around the design process which are investigation; design; making; evaluation; and communication. It must also be borne in mind though, that in the constructivist classroom, the role of the teacher is not to dispense 'truth' but rather to help and guide learners (Von Glaserfeld, 1987) to build on prior knowledge (Roth, 1994). TE is a practical subject and learning by doing is the best way of constructing knowledge.

Learning is located at the meeting point of several theoretical approaches such as the social development theory of Vygotsky, constructivism and social-constructivism to mention a few. Learning is a very complex activity but this body of theoretical and practical knowledge locates the learner (individuals and groups) at the center of the learning process (Mioduser and Levi, 2008:263; Mishra and Koehler, 2006:1019).

In the constructivist classroom, the participants construct their own knowledge through social interaction. The classroom is set in a social context and people work face-to-face with each other learning new concepts in technology by giving meaning to them (Brooks and Brooks, 1993:123; MacKinnon, 2005:90). By using the constructivist learning theory in the TE classroom, one changes from teaching a discipline as a body of knowledge to an exclusive emphasis on learning a discipline by experiencing the processes and procedures of the discipline (De Vries, 1997:24; Lewis, 1999:43). The activities in TE are authentic and an experience of personal relevance to the learner. The teacher guides development until learners can take responsibility for their own learning and utilise meta-cognitive skills (Mioduser and Levi, 2008:263). TE provides an environment that fosters learners' risk-taking. This risk-taking increases learners' self-confidence, motivation to learn, creative abilities, and self-esteem; it moves from a teacher-centred to a learner-centred approach (Hill and Smith, 1998:32; Moti and Barzilai, 2006:39; Wankat, 2002:3).

Mishra and Koehler (2006:1020) allude to the fact that not only is learning seen as a complex activity, but teaching is also a highly complex activity drawing from many kinds of knowledge. The two main kinds of knowledge to draw from are: knowledge of content, and knowledge of pedagogy. Shulman (1986:9) argued that knowledge of content and knowledge of pedagogy cannot be separated when teaching but must be integrated as teachers are confronted with both issues while teaching. This leads to the development of his theory on pedagogical content-knowledge (PCK). PCK means that the teacher needs to interpret subject content and find a way to make it easily understandable for the learner (Mishra and Koehler, 2006:1021). They further explain that to be a successful teacher, one need to deal with the whole teaching process which includes organization, adaptation and representation of subject knowledge for instruction in the classroom to make it accessible for all learners.

From a constructivist perspective then, the primary responsibility of the teacher is to create and maintain a problem solving environment, where learners are allowed to construct their own knowledge and the teacher acts as a facilitator and guide (Van Wyk, 2007:3). Brooks and Brooks (1993:124-125); and Van Wyk (2007:30) agree that a constructivist teacher is someone who will:

- encourage and accept learners' autonomy and initiative; use a wide variety of materials, including raw data, primary sources and interactive materials, and encourage learners to use them;
- engage learners in experiences that show contradictions to initial understandings and then encourage discussion;
- allow time for learners to construct relationships and create metaphors; assess learners' understanding through the application and performance of open-structured tasks;
- enquire about learners' understanding of concepts before sharing his/her own understanding of those concepts;
- encourage learners to engage in dialogue with the teacher and with one another;
- and encourage learner inquiry by asking thoughtful open-ended questions, urging learners to put questions to one another, and seeking elaboration of learners' initial responses

For teachers to have a deep understanding of real-world practices, Mishra and Koehler (2006:1034) suggest that training of teachers take place through design-based activities, in other words, learning by doing. Teachers or learners construct new ideas based on current and past knowledge.

Darling-Hammond (2006:80) states that teacher training should not only give the teacher 'what' (content and preparation) they have to learn, but 'how' they need to learn it. The 'how' to learn it involves processes to develop useful knowledge in ways to respond to the complexity of the classroom, such as: develop teachers' abilities as reflective decision makers; and understand subject content within the subject pedagogy (further discussed in 5.3.4).

Within the social constructivist framework, using Shulman's (1986); and Mishra and Koehler's (2006) knowledge of content and pedagogy, this study investigated teachers' understanding of and implementation of TE in the GET band. Vygotsky's ZPD framed learning within the constructivist classroom.

2.15 SUMMARY

This chapter differentiated between TE and ET and reviewed and analysed literature regarding the design process in TE, and international trends impacting on the teaching of the design process. Different design process models were explained. Using a social constructivist framework, teaching, learning, and assessment were discussed.

Chapter 3 deals with the methodology and instruments of research for this study. Detailed operations and procedures that are to be carried out to generate the data required to answer the objectives posed in this study are provided in this chapter. The methods of investigation and the justification of these methods are fully discussed and explained. Furthermore, the chapter deals with the construction of instruments needed for use in the collection of appropriate data.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

The preceding chapter gave background information on TE and focused on the specific purpose of this study. When investigating the design process the researcher concentrated on what is meant by design in the context of TE, the design process as it occurs in the TE curriculum and different models of the design process. Lastly approaches to teaching and learning of the design process and some challenges already identified were discussed followed by the theoretical framework underpinning this study.

This chapter outlines the methodology used in this study and commences with a discussion of the research design focusing specifically on the mixed method approach used in this study. This is followed by a discussion of the instruments, namely the questionnaire and semi-structured telephonic interview. A discussion of the pilot study is followed by the processes of data collection and analyses. Lastly the sampling method employed, preparing and processing of data as well as reliability, validity and ethical issues are explained.

3.2 RESEARCH DESIGN

Babbie and Mouton (2004:74) provide an insight into what is meant by research design as opposed to research methodology. They contend that research design is a plan or blueprint of how one intends to conduct the research. To make the distinction clearer, they drew a comparison between the design an architect prepares for a house, and linked that to a research design. Pepler (2003:23) maintains that the goal of a research design is to plan the research project and to provide it with a specific structure in order to guide the research process and enhance the validity of the research findings. In a similar manner, Leedy and Ormrod (2005:231) add that the research design of any study refers to a carefully thought-out strategy or a complete strategy of attack on the central research problem. The research design that will be used in this study is described as mixed methods because it uses both a qualitative and a quantitative approach.

3.2.1 Qualitative and quantitative research methods

Qualitative and quantitative research methodologies have their own place in research depending on the approach the researcher wishes to follow, which type of research will be used, and also the type of knowledge the researcher wishes to produce (Jacobz 2005:106). He states further that for many years the quantitative research approach was regarded as the only "true" reflection of the truth, and qualitative research as an assault on the search for "truth". According to Denzin and Lincoln (2000:8) positivists allege that qualitative researchers write fiction, not science, and that qualitative researchers have no way of verifying their truth statement. They add that quantitative researchers thus saw their view of research as the only true search for meaning.

The reason why some quantitative researchers are so negative about qualitative research is because quantitative researchers are seen to have a distinctive view about the nature of our knowledge regarding the physical and the social world (Denzin and Lincoln, 2000:8). Qualitative researchers on the other hand, question the view of the quantitative researchers and often reject quantitative enterprise as 'epistemologically' flawed (Pring, 2000:43). The differences are also reflected in the respective language of each approach, and the way in which key ideas or concepts take on different logical characters. Some of these philosophical concepts link together in logically different ways and take on slightly different meanings. According to Pring (2000:43) words such as ‘objectivity and subjectivity’, ‘reality’, ‘truth’ and ‘verification’, ‘knowledge’ and ‘meaning’ are interrelated and defined differently within the two paradigms. Punch (2004:61) adds that the type of study determines what type of data will be used. It may be all quantitative, all qualitative or it may be a combination of both. He states further that the type of data the study consists of should determine primarily what approach should be followed. The researcher should first of all concentrate on what he/she is trying to find out and not be limited by the rigid application of the research method (Punch, 2004:61).

3.2.2 The combination of qualitative and quantitative research

According to Denzin and Lincoln (2000:8) the effort to describe and render an understandable world of subjective experience is the philosophic cornerstone of qualitative methodology. In quantitative methodology, the researcher tries to discover its “truths” or generalisable cause-effect relationship. When a researcher conducts a qualitative study for example, and makes use of statistical techniques, he/she is also using quantitative techniques. In such a case the researcher is using the philosophy of one research methodology, in this case that of qualitative research, but employing some techniques of another research philosophy, quantitative research.

Babbie and Mouton (2001:271-273); Blaxter, Hughes and Tight (2001:67); and Nyaba (2009:75) agree that a researcher may use different approaches and techniques to give different dimensions of the research process. The researcher may use alternatives from the different dimensions in combination as appropriate to the study. This may include a particular set of research questions and may focus on specific approaches or techniques, or may concentrate on either a qualitative or a quantitative strategy. The researcher may mix or vary the usage of these techniques. In this study the researcher combined the qualitative and quantitative research methods, and it will be referred to as the mixed method. The following data collection instruments were used: questionnaire and semi-structured telephonic interviews. The questionnaire employed closed questions where the data gathered could be quantified, and open-ended questions where information consisted of respondents' interpretations of events (Monnapula-Mapesela, 2002:67). The semi-structured telephonic interviews yielded qualitative data. The following section discusses the data collection instruments used in this study.

3.3 DATA COLLECTION INSTRUMENTS

3.3.1 Questionnaire

A questionnaire is not just a form to be completed, nor is it simply a set of questions which has been casually jotted down without much thought, the questionnaire has a job to do: its function is measurement (Nyaba, 2009:78).

To design a questionnaire is not a simple exercise. According to the Information Systems Services of Leeds University (Burgess, 2001:1); Oppenheim (1992:7-8); and McMillan and Schumacher (2006:195) a questionnaire survey design usually follows the following steps or actions: defining the research aims; identifying the population and sample; deciding how to collect replies; designing the questionnaire; running a pilot survey; carrying out the main survey; and analysing the data.

The format of a questionnaire is just as important as the nature and wording of the questions asked (Babbie and Mouton, 2001:239). Burgess (2001:6) explains that the questionnaire design usually comprises three elements: determine the questions to be asked; select the question type for each question and specify the wording; and design the question sequence and overall questionnaire layout.

As indicated earlier in this section it is important for the questionnaire to be correctly designed because most problems with questionnaires and their analysis can be traced back to the design phase of the project. Surveys should be properly structured to obtain the information that is required according to the aims of the study. This does not mean the outcome of the research is planned, only the process. According to Breakwell, Hammond and Gife-Schaw (2001:158), advantages of using a questionnaire are its apparent simplicity, its low cost as a method of data gathering, and the fact that it is easy to administer. The questionnaire for this study consisted of two types of questions, namely open-ended and closed questions.

3.3.1.1 Open-ended questions

In defining an open-ended form item in a questionnaire or an interview, Breakwell *et al*. (2001:161); McMillan and Schumacher (2006:197); Mouton (2001:233); Nyaba (2009:77); and Reaves (1992:106), attest to the view that open-ended questions give the respondent an opportunity to provide his or her own answers to the question. According to Hay, Herselman, Mbokodi and Fourie (2000:41); and Nyaba (2009:77), open-ended questions are advantageous to research investigation in that they afford respondents the freedom to voice their thoughts freely and unencumbered. Furthermore, once the respondents understand the intent of the question, they respond accordingly.

3.3.1.2 Closed questions

McMillan and Schumacher (2006:197); and Nyaba (2009:78) emphasise that closed questionnaire items (also called structured or selected responses) are items in which a respondent is provided with a list from which an answer must be selected. These items, as opposed to open-ended items, are easy to process because of their uniformity in responses. Mouton (2001:233) also mentions that closed items can be easily processed, depending on the researcher‘s structuring of responses. For example, if there is a category of “if other, specify”, the item will not be easy to process. Breakwell *et al*. (2001:162) however clarify that if this category is not included, the researcher’s list of responses may not include some information that is very important.

Five (5) open-ended and sixteen (16) closed-ended questions were included in the questionnaire in this study. The open-ended questions were used to gain some biographical information from the teachers, for example the district in which they teach, their contact details, and a case study to establish how they teach the design process. The closed questions sought background information of the teacher to establish teaching experience, qualifications, and training in TE. Some of the closed questions were also on the design process and assessment. The layout of the questionnaire is discussed in the following section.

3.3.1.3 Layout of the questionnaire

To facilitate data collection, a covering letter and an Informed Consent Form (*Appendix B)* were attached to the questionnaire (*Appendix A*). The covering letter explained the purpose of the research study, namely to determine how teachers understand and teach the design process. The letter also ensured the respondents of their anonymity and guaranteed confidentiality of their responses. Respondents were required to sign the Informed Consent Form which explained that their rights, welfare and dignity will be protected at all times and that they can withdraw at any time

The questionnaire consisted of 21 questions. On 16 questions, the respondent had to rate the value of each statement on a three, four or five point Likert scale (discussed later in this chapter) according to the degree the statement was characteristic of the individual. Some of the questions had the option of ‘other’ where the respondents had to explain their response.

The open-ended questions, specifically the last eight questions were structured in such a way that the researcher could gain insight into the perception, knowledge and skills of the respondents with regards to teaching the design process in the intermediate and senior phases. This is in line with what McMillan and Schumacher (2006:197) advocate, namely that the questionnaire used in a study must contain various instruments where the respondents must respond to written questions in order to elicit attitudes, beliefs and reactions. These questionnaires gave teachers the opportunity to be “heard”, to reflect on their experiences, their needs, and to provide suggestions and ideas of their vision for TE teaching in the classroom.

Questions 1-12 required background and biographical data of the respondents, for example the district in which they were teaching, their age, qualifications, employment status, and years of teaching TE; phase in which they were teaching; and context of the school. This information helped the researcher to build a profile of the respondents she was dealing with.

Question 13 dealt with general National Curriculum Statement (NCS) training. Specifically of interest here was the response on how many received the training and whether or not it was useful to them. Question 14 also dealt with NCS training, but there the focus was more specifically on the training of TE teachers within the NCS. As the researcher is the co-ordinator of TE in the Department of Education in KwaZulu-Natal it was important for her to determine whether the cascading model as used in the NCS training is working or not. This information was also important because the researcher will be involved in training teachers in 2011 to 2013 in accordance the new CAPS document which will be implemented in 2012 to 2014.

Question 15 was linked to question 14. In question 14respondents were asked if they received training and how effective the training was. In question 15 they had to answer open-ended questions regarding knowledge of the TE curriculum, specifically learning outcome 1 which dealt with the design process. The purpose of this question was to help the researcher to determine if the training really helped to equip them with the knowledge they need to teach TE.

Questions 16-17 dealt with the model of the design process. The purpose of these questions was to give the researcher insight into how the teachers perceive the design process as a whole and to enable comparisons with what the literature suggests.

In question 18, an outline of a project was given and the teachers were asked to explain what they would do in each step of the design process. This gave the researcher the opportunity to establish whether the respondents understood the design process. With question 19 the researcher could establish if the respondents knew how to combine the Learning Outcomes to teach the design process in the classroom.

Question 20 sought to test the perception of the respondents regarding how successful they feel the teaching of the design process is in developing the learners (and teachers) to be critical and creative thinkers as well as problem solvers. This was borne out of one of the main aims of OBE and TE in South Africa as can be seen in the policy and literature documents, both in South Africa and internationally.

Question 21 dealt with the assessment of the design process. The researcher needed to establish how teachers deal with assessment in order to determine the focus of further training on this aspect.

3.3.1.4 Likert scale

The most widely and commonly used scaled item in contemporary questionnaire design is the Likert scale, named after Rensis Likert. Likert developed this scale in 1930 to provide an ordinal-level measure or assessment of a person's attitude, values, interests, and beliefs (Neuman, 2003:197).

The Likert scale requires respondents to indicate whether they agree or disagree with a statement. A Likert scale with three to five categories was used in this study. In the three point scale, dealing with assessment, the categories were: 'always', 'sometimes' and 'not at all'. In the four point scale, dealing with terminology in the curriculum, the words 'very well', 'well', 'fairly well' and 'not at all', were used. In the section where the participant had to give their own opinion regarding the design process, a five point scale was used with the words, 'very well', 'well', 'fairly', 'poor' and 'very poor'. A column for reasons or comments was also included (Maree and Pieterson, 2007:167).

Scaling is a contentious issue in measurement. Some believe the four point scale is a better choice than the five point scale. The choice of the four point scale was influenced by the desire to prevent respondents from what is known as the 'middle of the road' approach where respondents simply mark the middle value (3). Due to the nature of the questions used in the study, it was not possible to always use the four point scale, therefore a combination of the three, four and five point scale were used.

According to McMillan and Schumacher (2006:195), the next step in the study is to pilot the questionnaire. The purpose of piloting the questionnaire was to validate the instrument and to make it more reliable in terms of internal consistency of the results.

3.3.2 Pilot study

The term "pilot" study is used in different ways in social science research. In this study it refers to a so-called feasibility study, which is a "small scale version or trial runs done in preparation for the major study" (Polit, Beck and Hungler, 2001:467). Barker (1994:182-3); and Bless and Higson-Smith (2005:155) agree that a pilot study is a small study conducted prior to a larger piece of research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate. A pilot study can also be the pre-testing or trying out of a particular research instrument. One of the advantages of conducting a pilot study is that it might give an advance warning as to where the main research problem could fail, where research protocols may not work, or are too complicated. In the words of De Vaus (1993:54): "do not take the risk. Pilot test first".

In a pilot study, the entire research procedure is carried out, including analysis of data collected, closely following the procedures planned for the main study. Pilot studies are carried out with fewer subjects than will be employed in the main study. For some pilot studies two or three subjects are sufficient and it is rarely necessary to include more than 20 subjects The pilot study provides additional knowledge that leads to improved research (McMillan and Schumacher, 2001:307; Polit *et al*., 2001:467).

In this study, a pilot study was conducted with a group of five teachers teaching TE in different schools in the Durban area. The responses of the teachers enabled the researcher to change some of the ambiguous questions that appeared on the original questionnaire. The final questionnaire was compiled according to the perspectives gained from the literature on analyses of relevant data and the pilot study.

The researcher also used a semi-structured telephonic interview for collecting data. The interview was only conducted in cases where data on the questionnaire were not clear, incomplete, or required more explanation or substantiation.

3.3.3 Semi-structured interview

In this study the researcher used semi-structured telephonic interviews. This type of interview is more flexible than a structured interview. The interviewer had some structured topics, but this method allowed the researcher to deviate to address emerging topics (Kajornboon, 2005). The purpose was to obtain information of a qualitative and quantitative nature from a predetermined and limited number of people regarding their perspectives on the design process (Niewenhuis, 2007:87). The semi-structured telephonic interview is a social interaction with the respondent and, like any human interaction it includes certain norms, expectations and social roles (Babbie and Mouton, 2001:249). Given the qualitative nature of these interviews, they provided greater latitude of data. Babbie and Mouton (2001:257) as well as Wiersma (1995:201) state that telephonic interviews are certainly worth considering, as they save time, effort and cost. Neuman (2003:290) is of the view that although it is a more expensive method than mailing questionnaires, the researcher saves on traveling cost. Neuman (2003:290) asserts that the telephonic interview is flexible with most of the advantages of a face-to-face interview. The telephonic interviews were used for editing or cleaning data, meaning the checking of data and correcting any errors such as respondents inadvertently failing to answer questions. Only 15 such cases occurred and respondents were traced and corrections made during a telephonic interview.

The semi-structured interviews were used to get more clarity from the respondents where answers were unclear, or not completed in full or required more explanation or substantiation. Respondents may experience an interview as a testing situation. Babbie and Mouton (2001:250-252); and Neuman (2003:293) therefore cautioned that the researcher endeavored not to be intimidating, but to make the respondents feel at ease during the interviews. Redelinghuys (2003:172) states that an advantage of the interview in education is the opportunity it provides for a glance backward as well as forward (speculatively) in time. The telephonic conversations (verbal advice) were not recorded (taped) but backed by written notes.

The following section describes the target population sampling techniques, and the actual data collection used in this study. According to Wimmer and Dominick (2006:155), to define the population of the universe or study, is to “specify the boundaries of the body of content to be considered”. This indicates that it is important to select a specific target population as discussed in the following section.

3.3.4 Target population

In this study the target population was all intermediate and senior phase teachers teaching TE in the GET band (Grade 4-9). The foundation phase teachers were excluded as TE in the foundation phase is incorporated with Life Skills and is not a subject on its own.

3.4 SAMPLING

Choice and selection of information during the research process are crucial aspects. According to McMillan and Schumacher (2006:119), one of the first steps in the design of research methodology is selecting the subjects who will participate in the study. The subjects are usually referred to as the sample and the selection of these subjects as sampling.

Although the researcher has access to teachers attending IN-SET (in service training, where teachers are qualified and teaching in the classroom) and PRE-SET (before teachers start teaching) TE training (Stevens, 2005), she preferred to select the sample from the teachers attending the TASA workshops (explained further in Chapter 4, 4.1.2). The reason for the sample selection is that the TASA workshops are open to all TE teachers. These workshops are practical and hands-on and provide the teacher with lessons they can implement in their classrooms. It is not theoretical as most of the other courses they may attend, there is no accreditation for attendance of these workshops, they have to get to the venue on their own cost, it is not compulsory, and no food is provided. The teachers attending are thus really interested in getting help with the implementation of TE in the classroom. The sample for this study therefore included this cohort as the researcher acknowledges that only teachers, who are motivated to find out more about TE, attend the TASA workshops.

The intention of this study was to accumulate useful knowledge to be used by departmental officials and other stakeholders in the implementation of OBE driven NCS at GET band (Grades 4–9) to make informed decisions regarding future training of teachers in TE. The researcher attempted to obtain a satisfactory number of TE teachers to provide credible results and to shed maximum light on the issue under investigation. The manner in which the researcher conducted this sampling strategy is in line with what Cresswell (2005:204); Henning, van Rensburg and Smith (2004:71); McMillan and Schumacher (2001:207, 403); and Strydom and Venter (2002:207) advocate in selecting a sample.

3.4.1 Sampling technique

According to Trochim (2006) purposive sampling is where we sample with a purpose in mind. He said that we usually would have one or more specific predefined groups we are seeking. He added that the advantage of purposeful sampling lies in the selection of knowledgeable participants who are able to provide the required data for the research as each individual participant has a unique set of data in a particular area that is needed to form a holistic understanding of the phenomenon. In this study, the researcher's selection of the respondents was done purposefully, based upon the participants' experience and expertise in the GET sector and specifically those teaching TE. In this research process, it was of utmost importance for the researcher to select those participants who possessed the necessary information and who were willing to share the information with the researcher in a manner that ensured that all areas of information required by the research topic were covered.

With the questionnaires, covering letter and Informed Consent Forms printed, and the date for the workshop set, the researcher was ready to commence data collection.

3.4.2 Data collection

The TASA workshop on 5 June 2010 where the data was collected was attended by 191 teachers of which 74 were teaching senior phase, 72 were teaching intermediate phase and 45 were teaching foundation phase. Of the 191 teachers, 184 were African, 6 were Indian and 1 was white. 157 of the teachers were females and 34 were male teachers. 25 of the male teachers were teaching senior phase and the other 19 male were teaching intermediate phase or intermediate and senior phase. The TASA workshop caters for teachers from all three phases (foundation phase: grade R-3, intermediate phase: grade 4-6 and senior phase: grade 7-9) and teachers are allowed to decide for which phase they want to attend. The questionnaires were only distributed to the teachers of the senior and intermediate phases, which are 146 teachers in total. The reason for only using the senior and intermediate phase teachers (as already mentioned in the discussion on the target population) was that technology is taught as a subject in these two phases and not in the foundation phase.

When looking at distribution of phase, gender and race of the participants, the researcher made the following observations:

- 146 participants were from the senior and intermediate phases where TE is a learning area on its own. Only 45 teachers were from the foundation phase where TE is integrated into Life Skills.
- 157 were female teachers and only 34 were male teachers. This may be an indication of more female teachers than male teachers especially in the primary schools or it may be that male teachers are busy with sports activities on Saturdays. According to the DBE (2010:20), 62661 of the 89377 teachers in KZN are females. This is a tendency throughout South Africa as 281742 of the 413067 teachers in South Africa are females.
- The fact that the majority of the teachers were African indicate to the researcher that the other teachers were not interested in the support as their schools are well resourced and they are qualified to teach TE or it may give the department an indication of where the need for training is. Statistics of 2006, obtained from the Infra-structure unit in the KZN DoE, indicates that there are 5928 public schools in the province of KZN, of which 4639 of the schools are without libraries, 3080 schools without laboratories, 1586 schools have no electricity and 607 with no water (2011).

The researcher administrated the questionnaires and they were completed by teachers at the venue. As English is the official language of communication of the KwaZulu-Natal Department of Basic Education, the questionnaires were only made available in English. The data were then analysed.

3.5 DATA ANALYSIS

The data collected were subject to descriptive statistics. Leedy and Ormrod (2005:257) state that descriptive statistics describe a body of data. Descriptive statistics is also a method for presenting quantitative descriptions in a manageable form. As the telephonic interviews only sought clarity and completion for selected respondents on certain questionnaires, data obtained were added to the qualitative data obtained from the questionnaire. Wimmer and Dominick (2006:256) add that descriptive statistics condense data sets to allow for easier interpretation and these statistical methods allow researchers to take random data and organize them into some type of order. Trochim (2006) agrees that descriptive statistics helps us to simplify a large amount of data in a sensible way and make it easier to understand. One of the characteristics of descriptive statistics is distribution.

Distribution is a summary of the frequency of individual values or ranges of values for a variable (Trochim, 2006). Frequencies with respect to all the questions in the questionnaire were calculated. These results were expressed as percentages and presented in tables and graphs. For question 14 and 15 a comparison was drawn between how well the respondents felt the NCS training equipped them for teaching TE and the knowledge they have regarding terminology in TE. Comparisons were also drawn between the skills and knowledge of the respondents in the different phases to determine the focus of training in future for each phase. The questionnaire also contained open-ended questions where respondents had to give individual responses, and this had to be analysed using discourse analysis.

3.5.1 Data preparation

Data preparation involves checking, editing or cleaning up and the logging of data. The data for this study were checked for accuracy and then logged on an excel spread sheet to be analysed. This was done by spot checking data on a random basis to check if the data on the spreadsheet corresponded with the data on the questionnaires. Although this process was time consuming, it was deemed necessary in order to avoid having to discover errors after analysis had been done. The data were then coded.

3.5.1.1 Data coding

Data coding means applying a set of rules to data so as to transform information from one form to another. In research, coding usually involves converting responses in questionnaires into numeric form in order to facilitate quantitative analysis. The 3-5 point Likert scale used, took care of this aspect as the scales were in numeric form.

In the questions where respondents' had to give their own responses, an analytic rubric was used to score the answers. The analytic rubric was developed by looking at what literature and policy deemed as being the correct responses. An analytic rubric quantifies levels of performance and gives a description of required levels of achievement.

Questions 15.2, 16.2, 17.2 and 19.3 where the respondents had to give reasons for their answers, a 4 point scale was used with variables of 'good', 'fair', 'poor' and 'no response'. In question 18 where the respondents had to explain what they do in the different stages of the design process, a 5 point scale was used with variables of 'good', 'fair'. 'poor', 'no response' and 'not sure'. After coding the data, the data were logged on an excel spreadsheet for processing.

3.5.1.2 Data processing

The researcher used the Statistical Package for Social Science (SPSS) version 16 to analyse and interpret the responses. The results were interpreted by means of descriptive statistics. Such data are described with the use of frequency tables, bar graphs and pie graphs which help to form impressions about the distribution of data (Rambrij, 2006:72).

Reliability, validity and ethical considerations need to be taken into account in any successful research study.

3.5.2 Reliability and validity

Babbie and Mouton (2001:276) describe reliability and validity as trustworthiness. They state that the basic issue of trustworthiness is uncomplicated. They ask the question how an inquirer can persuade his or her audience (including him or herself) that the findings of an inquiry are worth paying attention to or worth taking account of. They also explain that a quantitative study cannot be considered valid unless it is reliable, and qualitative study cannot be called transferable unless it is credible, and it cannot be deemed credible unless it is dependable (Jacobz, 2005:116).

Credibility has to do with practicality, reliability and validity of the measuring instrument. Because reliability and validity attracts so much attention in research, the following section discusses validity and reliability issues encountered in this study.

3.5.2.1 Ensuring measurement validity

Trochim (2006) defines validity as the degree to which an item measures or describes what it is supposed to measure or describe. According to McMillan and Schumacher (2006:179), validity is the extent to which inferences made on the basis of numerical scores are appropriate, meaningful and useful. Validity is the judgement of the appropriateness of measure for specific inferences or decisions that resulted from the scores that were generated. In other words, validity is a situation-specific concept.

Validity is assessed, depending on the purpose, population and environmental characteristics in which measurement takes place. A survey can therefore be valid in one situation and invalid in another (Nyaba, 2009:86). In this study the researcher tried to ensure validity by firstly constructing the questionnaire in such a way that it would test what it was supposed to. This was tested by conducting a pilot study. Secondly the researcher selected the respondents with similar interests, in this case, the implementation of TE in the classroom. Having ensured validity, the data also needed to be reliable.

3.5.2.2 Ensuring measurement reliability

The reliability of a measuring instrument also impacts on the credibility of research findings. Zikmund (2003:300) defines instrument reliability as the degree to which an instrument is free from errors and therefore yields consistent results. According to Saunders, Lewis and Thornhill (2000:101) the following errors are the major causes of instrument unreliability: subject error; subject bias; observer error and observer bias. In this study only subject error and subject bias needed to be taken into consideration.

Subject errors usually refer to the situation whereby the respondents are not representative of the population under investigation. In order to avoid misrepresentation, only teachers teaching TE in the intermediate and senior phase were selected for this study.

Response or error bias can occur when subjects deliberately provide inaccurate responses, refuse to answer certain questions or when the response rate is very low. Care was taken to frame questions so that respondents did not view them as intrusive. The questionnaires were administered during a TASA workshop where the researcher was the facilitator and therefore on hand to collect questionnaires. When clarity was sought on a question, the researcher explained the question only to all the participants at the same time to avoid bias.

As Dzansi (2004:190) points out, an instrument can never be 100% reliable because it is just impossible to completely eliminate threats to reliability. All attempts were therefore made to minimise the occurrence of errors that could compromise the reliability of the measuring instruments in this study.

3.5.3 Ethical considerations

Neuman (2003:116) indicates that ethics in research denotes the type of research procedures that are morally acceptable, in other words ethics simply refers to "what is or is not legitimate to do". Neuman (2003:110) states further that ethics begins and ends with the researcher himself or herself. His or her conduct before the research, during the research and after concluding the research is of critical importance to the credibility of the study.

The research study should not in any way harm the people in the study. Researchers should always guard against causing embarrassment or danger to participants' home lives, friendships, jobs, etc. (Babbie and Mouton, 2004:522). They further state that researchers who have access to participants' identifications should be trained in terms of their ethical responsibilities. They caution that names and addresses, and in the case of this study, school names should not be reflected on the documents that are accessible to other people as this could be regarded as breach of confidentiality.

During data collection, participants share their knowledge on the subject of the study with the researcher. Neuman (2005:397) argues that the researcher therefore has a moral obligation towards the participants with regard to the information given. Ethical considerations in this study were applied for the purposes of confidentiality of the respondents (Maree and Pieterson, 2007:75). The information they supplied were used for the sole purpose of this study and no other person who was not associated with this study had access to the raw data supplied by the participants. Only the researcher and her research supervisor had access to the data. Ethical clearance for the questionnaire was obtained from the Durban University of Technology. Permission to conduct research with the participants of the TASA workshop was obtained from the provincial Department of Education as this study is straightforward with no ethical problems *(Appendix C)*.

In this study, participation was voluntary and after the researcher explained the purpose of the study, and how confidentiality and anonymity would be maintained, the respondents signed the Informed Consent Form (*Appendix B*). A number was assigned to each respondent's questionnaire. This number was used to identify the respondents for the semi-structured telephonic interview, should the need arise. Only the number appeared on the questionnaire when the data was analysed to ensure anonymity and confidentiality of the respondents. Permission to conduct this study was granted to the researcher by the Department of Education in KwaZulu-Natal *(Appendix C).*

3.6 SUMMARY

The previous chapter focuses on exploring the view of literature on the objectives of this study which is the design process in TE. In doing so, topics such as: design; design process; and design process models, were discussed.

Because assessment is always included in planning for teaching and learning, the researcher investigates this aspect as well.

This chapter focused on the methodology applied in gathering information, as well as the techniques employed to analyse data. It discussed the mixed-method research methodology which was applied in this study. The data collecting techniques used in this study were questionnaires and semi-structured interviews. Both qualitative (open-ended) and quantitative questions (closed questions) were included in the questionnaire. Qualitative and quantitative data analysis techniques were used for a more complete understanding of the teachers understanding of the design process in TE in the GET band.

The following chapter presents analyses of the data and the research findings of this study in order to gain a more complete understanding of the perceptions of the TE teachers' on teaching and implementation of the design process.

CHAPTER 4
FINDINGS

4.1 INTRODUCTION

The previous chapter focused on the research methodology and data collection techniques used to gather data for this study. Chapter four presents the findings from the questionnaire administered and the semi-structured interviews conducted with participants.

The aim of this study was to examine teachers' understanding and implementation of the design process as it relates to teaching Technology Education in the intermediate and senior phases (Grades 4–9) of the General Education and Training Band in KwaZulu-Natal. To achieve this aim the following research objectives were addressed:

- to determine teachers' perception of the design process in TE;
- to determine whether teachers can identify the design process; and
- to investigate the methods used by teachers' in the implementation of the design process in TE in their classroom.

A secondary objective of this study was to analyse the NCS training provided by the Department of Education and other stakeholders such as the TASA of South Africa to TE teachers between 2003 and 2006. The researcher is employed by the Department of Education at provincial level and was involved with the training during 2003 to 2006. She is responsible for the implementation of TE in KZN, and will be involved with the training of teachers on the CAPS document from 2012 to 2014. The findings in this study may therefore assist her with strategic planning for effective training of teachers on the CAPS document.

4.1.1 Training by the Department of Education

The CAPS training will be a four day orientation on the new document and will involve all foundation phase teachers in 2011 and 2012; all intermediate phase teachers in 2012; and all senior phase teachers in 2013. The foundation phase orientation will consist of two days orientation in 2011 and a further two days early in 2012. This will have to be followed by training and support grounded by subject specialists in the district as Prinsloo and Janks (2002:36) alluded to the fact that in-service teacher education training has to go beyond just orientation for effective implementation of the curriculum. The aim of the DoE training is to equip teachers for implementation in the classroom.

4.1.2 Training by the Technology Association of South Africa (TASA)

The TASA is a non-governmental organisation which serves as a support group for TE teachers. The researcher founded the TASA in 1998 when TE was first offered as a compulsory subject in the GET Band. She is currently the national president and chairperson of KZN for the TASA. This organisation was established to help and support teachers with this new subject, workshops are thus held once a term in Durban to offer support and assistance with implementation of TE in the classroom. TE teacher's currently teaching TE conduct training for the TASA on a Saturday morning. A two day conference is also held every year during the September school holidays.

Saturday workshops are content and skills workshops which cover work to be done in the following term. The teachers are exposed to hands-on experiences which they can use in the classroom. Content and skills training in the different areas of knowledge are the main focus of these workshops. Issues such as assessment, methodology and new developments in the subject are also addressed. During the two day conference, the TASA provides a variety of workshops on different areas of knowledge and the teachers may select the workshops they prefer to attend. The conference is attended by teachers throughout South Africa while the workshops are mainly attended by teachers from KZN.

Data for this study was gathered during a TASA workshop held in Durban on 5 June 2010. Questionnaires were administered to the 146 teachers attending the workshop. 114 questionnaires were returned. The researcher chose to hand out the questionnaire at this workshop as all the attendees were teachers teaching TE in their respective schools.

This chapter presents the results of this study based on an analysis of the data obtained from the questionnaires and semi-structured telephonic interviews. Analysis of data is discussed under the following headings: biographical and background information; demographic information; training of the respondents in general, and in TE during implementation of the NCS as well as the effect of this training on teaching in the classroom; understanding of the TE content and design process; and assessment of TE.

4.2 DATA ANALYSIS

Descriptive statistics, percentages (proportions), cross tabulations, and frequency tables were used to organise, summarise and describe results obtained from the data. Frequency tables refer to tables with one variable where cross tabulation tables (also called two-variable tables) refer to where two or more variables are used in data analysis, both these procedures provide numerical and graphic reports (Bhate, 2009:1). In this study, cross tabulation was used to indicate for example how teachers' rate learning outcomes in the phases in which they were teaching. Inferential statistics deals with the kind of inferences that can be made when generalising from data, from the sample to the entire target population (Mouton, 2002:163). Two types of inferential statistics (parametric and non-parametric) may be used in descriptive statistics.

Parametric methods make more assumptions while non-parametric methods make fewer assumptions and the applicability has a much wider range (Mouton, 2002:163). He explains further that non-parametric methods are widely used for studying populations that take on a ranked order, such as the age of the teachers in this study. The use of non-parametric methods was necessary because of the data having a ranking order and no clear numerical interpretation such as the preference of the respondents (Mouton, 2002:163). Gay and Airasian (2003: 478); and Mouton (2002:166) advocate the use of a Chi-square test (a non-parametric statistic) as the appropriate test of significance when the data are in the form of frequency counts. Pearson’s chi-square test is any statistical hypothesis test in which the sampling distribution of the test statistics is a chi-square distribution (Mouton, 2002:166).

Diamantopoulos and Schlegelmilch (2004: 27) argue that with non-metric data (nominal and ordinal), only the less powerful non-parametric statistics may be used. The measuring instrument for this study was a 3–5-point itemised rating scale that generated ordinal data. Based on the above, it was decided that a non-parametric technique (Chi-square test) was the most appropriate test of significance to use. In this study the chi-square test was used to compare the years of experience of the respondents with the context of the school in which they were teaching.

4.3 PRESENTATION OF DATA

All data gathered from the questionnaires administrated to teachers attending a TASA workshop and the semi-structured telephonic interviews were analysed using version 16 of the Statistical Package for the Social Science (SPSS). The SPSS is a computer programme used to simplify repetitive tasks, handling complex data manipulations and analyses. SPSS datasets have a two-dimensional table structure where the rows typically represent cases (such as individuals) and the columns represent measurements (such as age or sex) (Diamantopoulos and Schlegelmilch, 2004: 27).

4.3.1 Biographical and background information

Biographical information required of the teachers were: age, qualification and experience in teaching TE; while the demographic information concerned the district in which the teachers were teaching; phases they were teaching; and their position in the school.

The registers signed at the workshop indicated that 146 intermediate and senior phase teachers attended the workshop of which 115 were females and 34 males. 139 of the participants were African, 6 were Indian and 1 was white. Attendance at the workshops is voluntary, so the racial mix could be attributed to interest. Other reasons for the mix are alluded to in the sections that follow.

4.3.1.1 Age of the teachers

Figure 4.1 (below) indicates that 74.6% of the teachers attending the workshop were older than 36 years. TE is a fairly new school subject, introduced in 1998. The researcher assumes that the reason for the high percentage of teachers over 36 years of age is due to the fact that this group of teachers received their initial professional training between 1993 and 1996, and therefore did not receive TE training during their initial professional training as teachers. This means that they received schooling during the times of apartheid education (before 1994) in South Africa. The apartheid era marked an education system organized in terms of race with unequal distribution of materials and human resources (Prinsloo and Janks, 2002:20; Stevens, 2005:1). This injustice did not only occur in schools but also in disadvantaged universities leading to less qualified teachers teaching in under-resourced schools and can still be seen after sixteen years of independence when looking at the qualification of the former disadvantaged communities (Prinsloo and Janks, 2002:20).

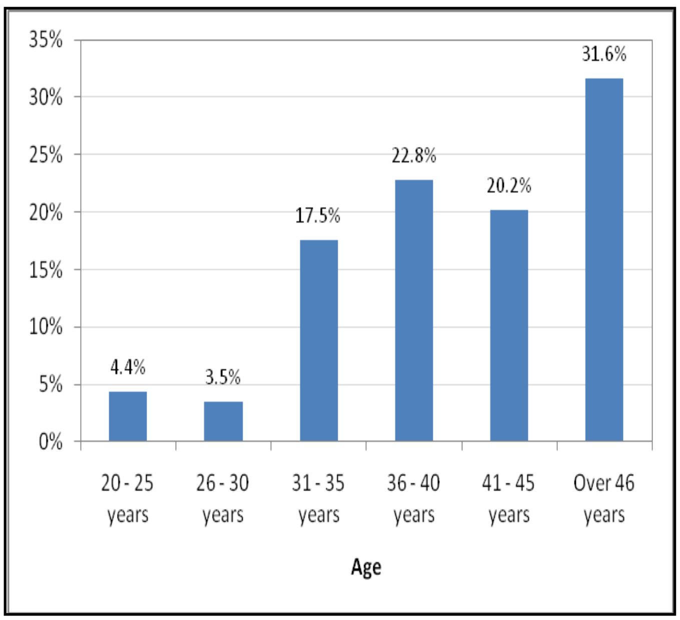

Figure 4.1: Age of the teacher

4.3.1.2 Qualifications and experience

Q6.1 Highest qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4 year Teacher Diploma	1	.9	.9	.9
	ABET	2	1.8	1.8	2.6
	ACE	1	.9	.9	3.5
	B. PEAD	1	.9	.9	4.4
	B. Ped	1	.9	.9	5.3
	B. Tech	1	.9	.9	6.1
	B.Com	1	.9	.9	7.0
	B.Ed	18	15.8	15.8	22.8
	B.Ed Honns	6	5.3	5.3	28.1
	B.Sc	1	.9	.9	28.9
	B.Tech	1	.9	.9	29.8
	BA	10	8.8	8.8	38.6
	BA Honns	2	1.8	1.8	40.4
	Design - fashion design	1	.9	.9	41.2
	FDE	4	3.5	3.5	44.7
	Gr 12	3	2.6	2.6	47.4
	HDE	3	2.6	2.6	50.0
	HED	8	7.0	7.0	57.0
	JPTD	5	4.4	4.4	61.4
	Management Diploma	1	.9	.9	62.3
	N3 Mechanotechnology	1	.9	.9	63.2
	NPDE	4	3.5	3.5	66.7
	NPTD	1	.9	.9	67.5
	NTD	1	.9	.9	68.4
	PTD	7	6.1	6.1	74.6
	SPTD	7	6.1	6.1	80.7
	SSTD	1	.9	.9	81.6
	STD	13	11.4	11.4	93.0
	TD	6	5.3	5.3	98.2
	Teachers Diplo	1	.9	.9	99.1
	Teachers Diploma	1	.9	.9	100.0
	Total	114	100.0	100.0	

Table 4.1: Qualifications of the respondents

As can be seen in Table 4.1 (above), there was a range of qualifications among the 114 respondents. The highest qualifications were Bachelor of Education Honours degrees (5.3%), followed by Bachelor of Arts Honours degrees (1.8%). The majority (61.6%) of the teachers obtained a variety of diplomas and certificates. According to the Employment of Educators Act (DoE, 1998:24) an approved qualification to be a teacher is a degree, a diploma, a certificate or other qualification recognized by the Minister of Education. This means that 97.4% of the respondents are qualified to teach, and the three teachers (2.6%) who were unqualified are currently studying towards an Advanced Certificate in Education (ACE).

Table 4.2 (below) shows that 13.2% of the respondents obtained their TE qualification through an Advanced Certificate in Education (ACE) course, and 10.5% through attending the 1 year ENGEN course to obtain a certificate. The ACE course is a two year qualification which gives the student content and methodology in teaching TE, while the ENGEN (sponsored by ENGEN Petrol) course only covers basic content and therefore cannot equip the teacher to teach technology in the senior phase. Most universities e.g. University of KwaZulu-Natal, University of South Africa and University of the Free State offer a two year ACE qualification in different subjects, such as TE, mathematics and physical science. The ENGEN course is run by a service provider accredited by the University of KwaZulu-Natal and is facilitated at different venues in districts or at the ENGEN plant. This is not an accredited qualification and the teachers attending only receive a certificate of attendance.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		74	64.9	64.9	64.9
	ACE	15	13.2	13.2	78.1
	B.Ed	6	5.3	5.3	83.3
	Diploma	1	.9	.9	84.2
	ENGEN	12	10.5	10.5	94.7
	FDE	1	.9	.9	95.6
	N3	1	.9	.9	96.5
	PGCE	1	.9	.9	97.4
	Statement of Results	1	.9	.9	98.2
	STD	2	1.8	1.8	100.0
	Total	114	100.0	100.0	

Table 4.2: Qualification of teachers in TE

Although 97.4% of the respondents are qualified as teachers, the data in Figure 4.2 (below) indicate that only 35.1% of the respondents teaching TE are qualified to teach the subject. The rest of the respondents (64.9%) indicated that they received specialised training in other subjects. Rambrij (2006:112) found similar results and concluded that 78.6% of teachers in the Umlazi district in KZN, South Africa are not qualified to teach TE. This is a source of great concern for the researcher and emphasises the need for further training of the teachers to enable them to successfully implement TE in the classroom.

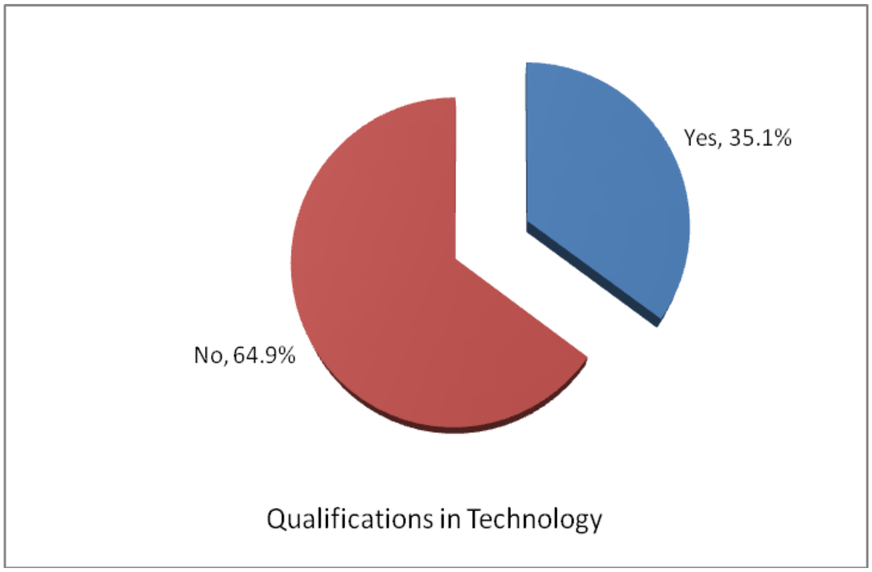

Figure 4.2: Years of experience in teaching TE

Figure 4.3 (on page 93) indicates that the majority of the teachers (33.3%) have only been teaching TE for 2–4 years. This may be due to the fact that teachers are moved from one subject to another especially in the primary schools (Rambrij, 2006:112). This is normally the period it takes for a teacher to develop expertise and become a specialist in this subject. Rambrij (2006:117) states that the long term survival of TE depends on human resources such as trained teachers with specialised content knowledge. The ideal situation in schools should be to allow the teacher qualified in a subject to keep on teaching the specific subject. By changing the teacher, the skills and knowledge for that subject are lost.

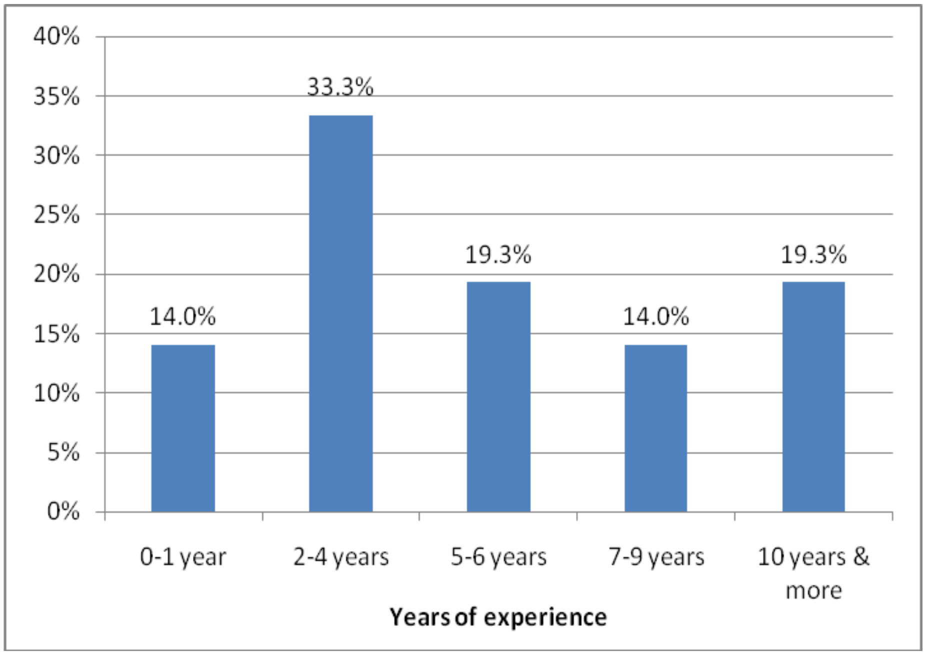

Figure 4.3: Qualifications in TE

Figure 4.4 (on page 94) shows that 74.6% of the teachers attending the workshop came from rural schools, 11,4% from city schools, 7% from city schools, 2.6% from former model C schools, 2.6% from independent schools and 1.8% from farm schools. This indicates that the need for training might be higher in rural schools. This attendance is a common trend in the sixteen years of existence of the TASA. Due to a shortage of manpower and time, the executive committee of the TASA only runs workshops once a term in Durban. Some of the regular attendees of the workshop expressed their concern about the low level of support in implementing TE in the rural areas (teachers interviewed in 2011 at a TASA workshop). They feel that the subject advisors do not visit them often enough for support, and due to inadequate resources it is very difficult to implement TE in the rural schools.

Statistics regarding infra-structure of KZN schools conducted in 2006 indicated that there were 5928 public schools in the province of KZN, of which 4639 of the schools was without libraries, 3080 schools without laboratories, 1586 schools had no electricity, and 607 had no water – this indicates the lack of resources in KZN schools (interview with the Manager for Infrastructure in KZN schools, 2011). Without these basic resources the researcher assumes that the other resources such as textbooks and equipment for the teaching of TE were also not present. TE is a practical subject and needs to be taught in a project-based manner (DoE, 2002). Without the necessary resources, TE cannot be implemented in a constructive way.

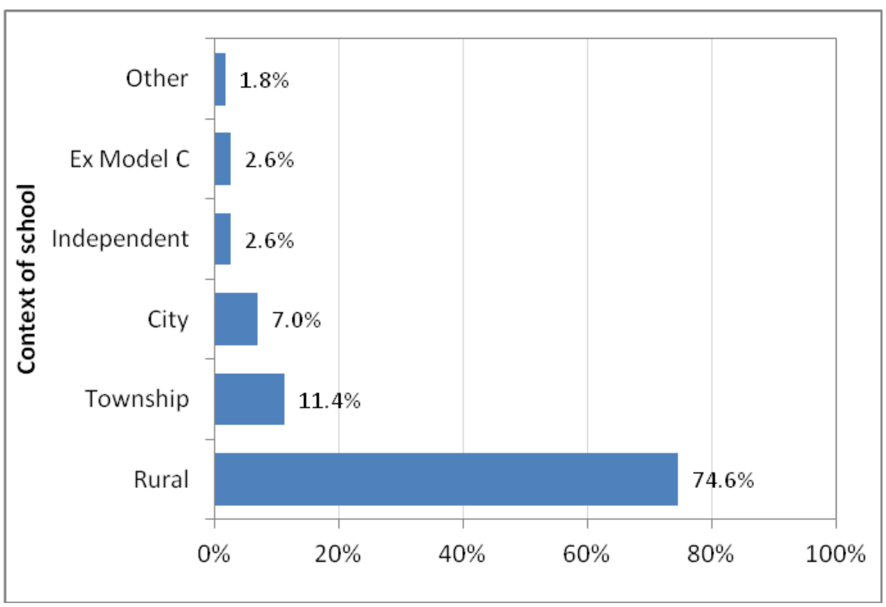

Figure 4.4: Context of the schools

Table 4.3 (below) indicates that the majority (44.7%) of the teachers attending the workshop came from the Ilembe district, followed by the Umgungundlovu district with 22.8%. The data-base of the members of the TASA shows the same trend. In 2010, 40% of the members were from Ilembe, 30% from Umgungundluvu and the other 30% consisted of members from other districts and the Eastern Cape. The subject advisors of Ilembe and Umgungundlovu are members of the executive committee of the TASA. As such, the researcher assumes that they therefore promote the work done by the association in their districts. In the Ilembe and Umgungundlovu districts, circulars are posted at the circuit offices in the pigeon holes of all the schools which are an effective way of distribution.

District	Frequency	Percent	Valid Percent	Cumulative Percent
Empangeni	12	10.5	10.5	10.5
Ilembe	51	44.7	44.7	55.3
Lusikisiki	1	.9	.9	56.2
Obonjeni	2	1.8	1.8	60.0
Othukela	2	1.8	1.8	61.8
Pinetown	7	1.6	1.6	62.7
Umgungundlovu	26	22.8	22.8	68.8
Sisonke	2	1.8	1.8	91.6
Ugu	2	1.8	1.8	92.1
Umlazi	9	7.9	7.9	100.0
Total	114	100.0	100.0	

Table 4.3: District where the teachers are teaching

Figure 4.5 (on page 96) shows that the majority of the respondents teach in the intermediate phase (42.1%). 0.9% of the respondents teach in both the foundation and intermediate phases, and 22.8% of respondents teach in the intermediate and senior phases. The teachers teaching intermediate and senior phases may be added to numbers in the primary schools as they teach grades in the intermediate phase as well as grade 7 which fall into the senior phase. This combination makes the total number of respondents in the primary school 65.8%. This is understandable as there are more primary schools than high schools in South Africa. According to the statistics of the Department of Basic Education (DBE, 2010:22) in 2009, 4341 of the 5928 public schools in KwaZulu-Natal are primary schools. This means that 73.23% of public schools in KwaZulu-Natal are primary schools. 34.2% of the respondents were from high schools. This correlates with the findings of this study.

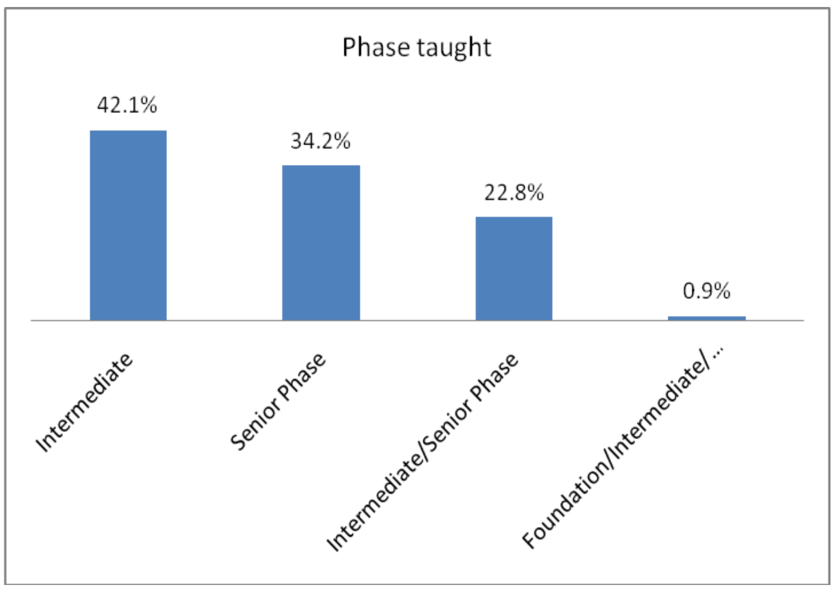

Figure 4.5: Phase in which teachers are teaching TE

It is apparent from Figure 4.6 (on page 97) that 78.9% of the respondents attending the workshop were post level 1 teachers. It is however good to see the interest of heads of departments (17.5%), deputy principals (0.9%) and principals (2.6%) which means that they are interested and want to be kept abreast of what is happening in their schools, but for effective implementation of

TE in schools, training of the senior management team (SMT) of schools are needed (Rambrij, 2006:108).

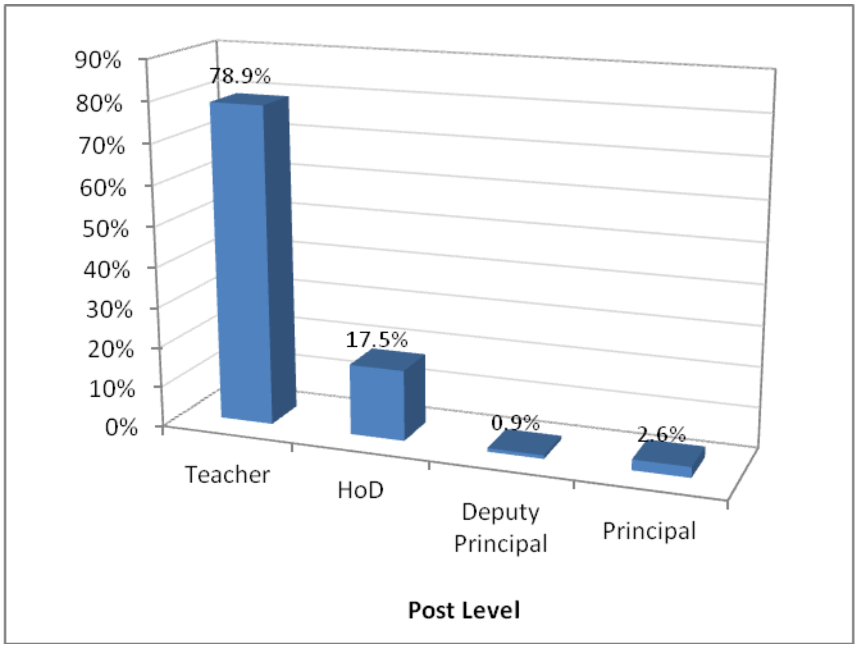

Figure 4.6: Post level of the teachers

This concludes findings on the biographical and background of the respondents and the next section will look at NCS training that took place from 2003 to 2008.

4.3.2 Training in the National Curriculum Statement (NCS) in general

General NCS training was provided in 2003 for the foundation phase (grades 1-3); in 2004 for the intermediate phase (grades 4-6); in 2005 for grade 7; and in 2006 for grades 8 and 9 by the DoE across all provinces. In 2008 master teachers were trained as an initiative of the Mathematics, Science and Technology (MST) directorate in the DoE. The intention of this training was to equip teachers for the implementation of the NCS. For each phase, training was done over a five day period. During the training of grades 7-9, more subject specific training was included. Due to the vast number of teachers to be trained, this was a once-off training provided by the provincial department and had to be followed up by the districts. The researcher started working at provincial level in 2001. During that time no specialist advisors were appointed in the districts. Appointments followed in 2003, but only one advisor per district was appointed. Some of the districts consist of 700 schools and with only one person to follow up on issues was impossible. The lack of human resources therefore hampered the implementation of subject specific NCS training.

Figure 4.7 (below) is in response to question 13.1 regarding who received general NCS training. 80.7% of the respondents indicated that they did receive training on general NCS issues, while 19.3% did not receive any training. This may be because of newly qualified teachers entering the system after 2006.

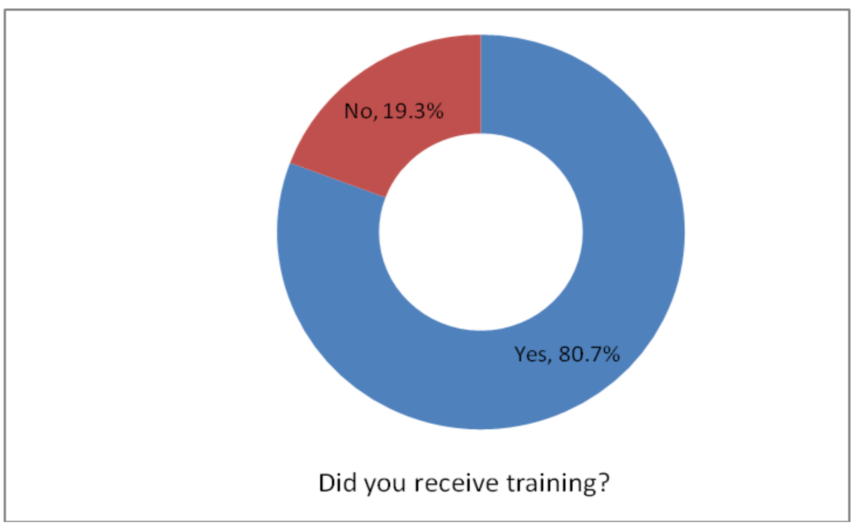

Figure 4.7: NCS training received

Figure 4.8 (below) shows that of the 80.7% of respondents that received training, 99.2% of the respondents received training from the Department of Education and 0.8% did not receive any training. Of this 99.2%, 76.8% received training during the roll-out programme of the NCS, while 22.5% received training from the special Mathematics, Science and Technology (MST) initiative which focused on TE in 2008. MST is a sub-directorate in the DoE which is involved with, and focuses on initiatives to improve the interest of learners in mathematics, science and technology and in doing so increases the number of learners pursuing further studies in these fields at tertiary level.

The low percentage in the foundation phase (4.7%) may be attributed to the fact that only 0.9% of the respondents were teaching in the foundation and intermediate phases while 99.1% teach senior and intermediate phase. A point of concern is the especially low percentage (10.9%) of training in grades 8 and 9. These two grades are in the high school where the main focus is on grade 12 and grade 8 and 9 are often neglected as indicated and explained later on in this chapter.

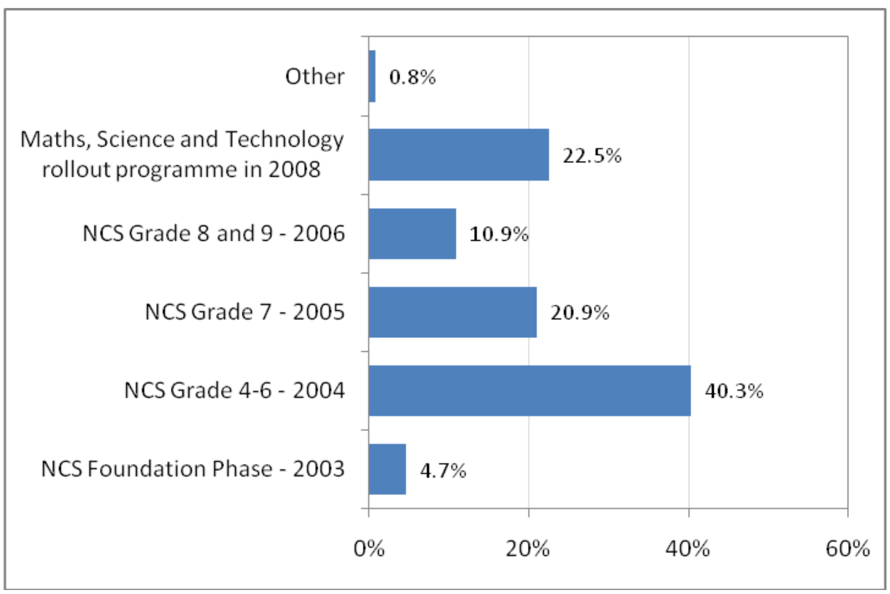

Figure 4.8: Where and when training was received

Further to the above finding, Figure 4.9 (below) and Table 4.4 (on page 101) indicate that the workshops run by the TASA contributed significantly towards the training of teachers in KwaZulu-Natal (42.2%). This training in the form of Saturday workshops accounted for training of 37.7% of teachers, and provincial conferences led to training of 4.5% of teachers.

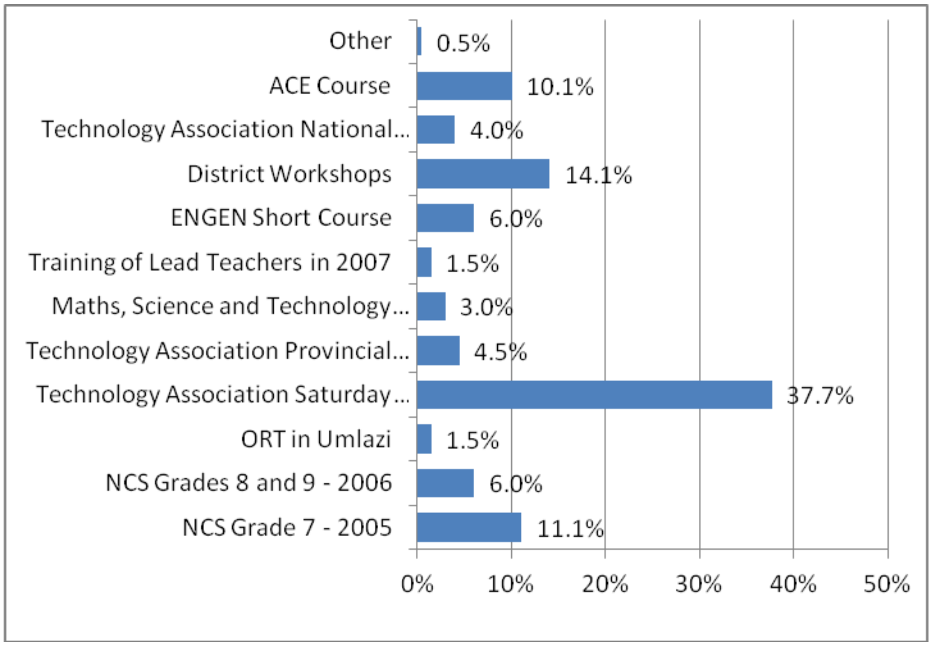

Figure 4.9: Where and when the teachers were trained in TE

Table 4.4 (on page 101) shows the proportion of teachers in each band of experience who attended the different workshops. All of the 38 teachers in the 2-4 year category of experience attended the TASA workshops on Saturdays, while 40% attended the district workshops, and 28% attended the ACE Course. 94.4% of the 22 respondents with 5-6 years experience attended the TASA Saturday workshops while 38.9% attended the ENGEN short course, 27.8% attended the district workshops and 22.2% the TASA National Conferences.

In the group with 10 years and more experience (22 teachers), 14 teachers received NCS training and 35.7% had done the ACE course while 14.3% did the ENGEN course and 57.1% attended district workshops.

	Years of experience										Total
	0-1 year		2-4 years		5-6 years		7-9 years		10 years & more		
	n	%	n	%	N	%	n	%	n	%	n
NCS Grade 7 - 2005	3	50.0%	4	16.0%	1	5.6%	8	57.1%	6	42.9%	22
NCS Grades 8 and 9 - 2006	1	16.7%	2	8.0%	2	11.1%	5	35.7%	2	14.3%	12
ORT in Umlazi	0	.0%	1	4.0%	1	5.6%	1	7.1%	0	.0%	3
TASA Saturday Workshops	6	100.0%	25	100.0%	17	94.4%	13	92.9%	14	100.0%	75
TASA Provincial Conferences	0	.0%	2	8.0%	3	16.7%	3	21.4%	1	7.1%	9
Maths, Science and Technology Rollout Programme in 2008	0	.0%	3	12.0%	1	5.6%	1	7.1%	1	7.1%	6
Training of Lead Teachers in 2007	0	.0%	0	.0%	2	11.1%	0	.0%	1	7.1%	3
ENGEN Short Course	0	.0%	2	8.0%	7	38.9%	1	7.1%	2	14.3%	12
District Workshops	2	33.3%	10	40.0%	5	27.8%	3	21.4%	8	57.1%	28
TASA National Conferences	0	.0%	1	4.0%	4	22.2%	2	14.3%	1	7.1%	8
ACE Course	0	.0%	7	28.0%	3	16.7%	5	35.7%	5	35.7%	20
Other	0	.0%	0	.0%	1	5.6%	0	.0%	0	.0%	1
Total	6		25		18		14		14		77

Table 4.4: Comparison between where and when teachers were trained in TE and years of experience

Question 13.2 questioned the effectiveness of the general NCS training for teachers in the classroom. Figure 4.10 (on page 102) shows that only 12.3% of the respondents indicated that the training they received equipped them ‘very well’ to implement the NCS in the classroom, and 54.4% indicated it equipped them ‘well’. This makes up a total of 66.7% of respondents feeling confident with implementing NCS in the classroom. This means that 33.3% of the teachers were not confident after the training. These figures do not augur well if effective implementation of the curriculum is to be achieved. The researcher notes that the approach to training from 2011 for the foundation phase needs to be carefully planned. According to the Review Committee (DoE, 2000), the training provided to teachers on C2005 and NCS, tended to focus on terminology rather than how and what to teach in an outcomes based framework (Ishmail, 2004:36).

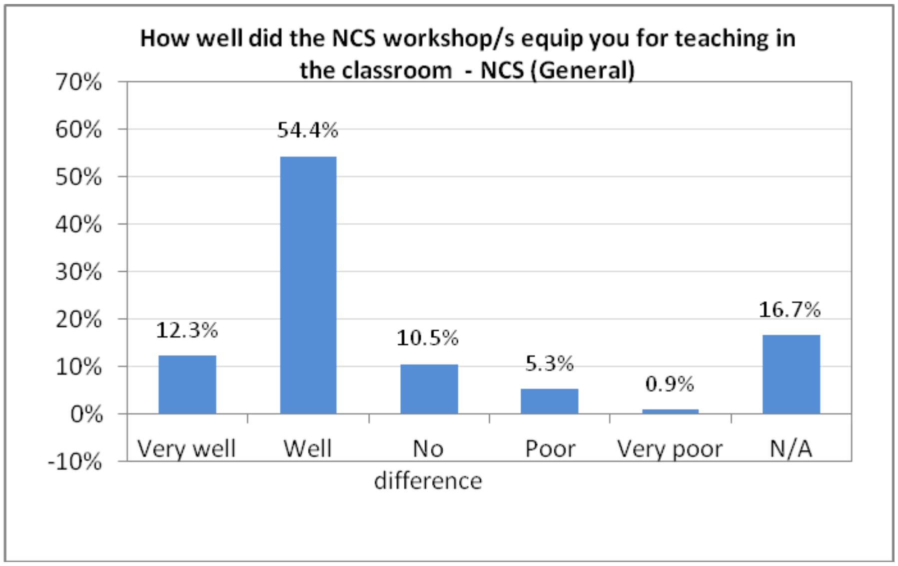

Figure 4.10: Effectiveness of the general NCS training

4.3.3 NCS training including TE

Question 14 dealt more specifically with TE training. Figure 4.11 (on page 103) indicates that 65.8% of the respondents received specific TE content and skills training while 34.3% did not. During the DoE training, the senior phase (grades 7-9) received specific TE training and the intermediate phase only received training on general issues regarding the NCS.

As stated earlier, the researcher is responsible for overseeing the implementation of TE in KwaZulu-Natal and could not find any written report on the number of teachers that were trained in TE between 2003 and 2006 when the NCS training took place. This is therefore an analysis of data from the researcher’s perspective.

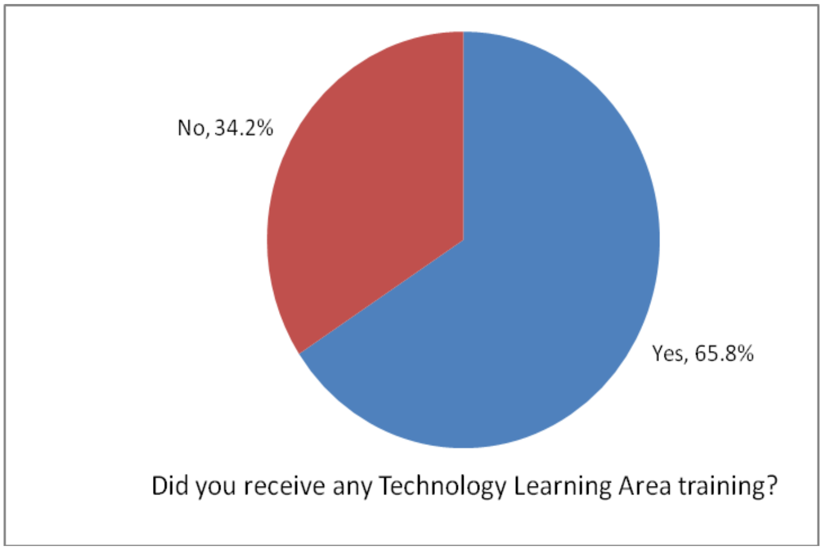

Figure 4.11: NCS training including TE

Figure 4.12 (on page 104) shows that 57.9% of the 65.8% (Figure 4.11, above) of the respondents who received TE training felt that the training equipped them ‘very well’ or ‘well’ for the implementation in the classroom while the remaining 42.1% of the respondents felt that the training had no effect. The conclusion that may be drawn from these statistics is that the implementation of TE in the classroom should be very good. The question that the researcher needs to address is whether the teachers know the content and methodology of TE, as the literature indicates that teachers find it very difficult to implement TE in the classroom without specialised training (Corkey *et al*., 2006:11-12) – this is done later in this chapter.

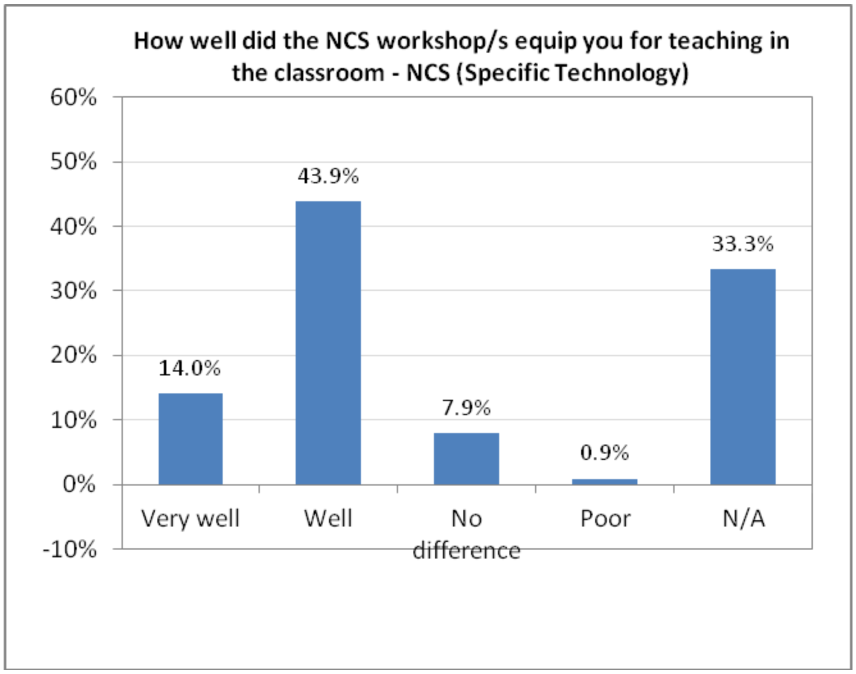

Figure 4.12: Effectiveness of training in TE

Table 4.5 (on page 105) indicates a significant relationship between years of experience and whether training was received at the 95% level ($p<0.05$). The majority of those teachers with five or more years experience received training, while a lower proportion of those with less than five years experience received training. Amongst those with 0-1 years of experience, 62.5% did not receive training. This may be an indication that teachers who received training feel confident in teaching TE and therefore keep on teaching the subject. This data also alluded to the discussion earlier in this chapter regarding the experience and qualifications of teachers in TE and the effective use of human resources such as qualified or trained teachers.

	Years of experience										Total	
	0-1 year		2-4 years		5-6 years		7-9 years		10 years & more			
	n	%	n	%	n	%	n	%	n	%	n	%
Yes	6	37.5%	24	63.2%	17	77.3%	14	87.5%	14	63.6%	75	65.8%
No	10	62.5%	14	36.8%	5	22.7%	2	12.5%	8	36.4%	39	34.2%
Total	16	100.0%	38	100.0%	22	100.0%	16	100.0%	22	100.0%	114	100.0%
Pearson Chi-Square=10.491,df=4,p=0.033												

Table 4.5: Comparison between years of experience and TE training received

Responses from attendees of the TASA workshops indicated that they found the practical work done during the workshops very helpful. One teacher said *"although I know the content and I have the necessary skills to teach TE, I find it valuable to attend, as I find new ways of teaching different aspects of TE in the classroom".* Others said that the content and skills covered in the workshops gave them the *"necessary knowledge"*, *"skills"* and *"confidence"* to *"do the practical work with the learners".* It therefore seems that the TASA as a non-government organization (NGO) is doing valuable work in supporting teachers with implementing TE.

4.3.4 Understanding of TE

In questions 15-19, the researcher wanted to establish how well teachers understood the content of the TE curriculum, specifically the design process. Question 15 asked the respondents how well they understood the learning outcomes and assessment standards of TE.

Figure 4.13 (on page 107) indicates that the majority of the teachers (66.7%) understand the learning outcomes 'very well' or 'well', while 27.2% understood it ‘fairly well’. Only 5.3% of the respondents indicated that they did not understand learning outcomes at all. Very similar results were indicated for assessment standards in Figure 4.14 (on page 107). The data indicates that 55.2% of the respondents understood the assessment standards of TE ‘very well’ and ‘well’. 7% of the respondents do not understand the assessment standards at all. Spady (2008:4) states that a learning outcome is a culminating demonstration of learning. He explains further that the learning outcome and assessment standards indicate the skills and and knowledge that need to be developed and is therefore more than just understanding, it is application of knowledge. Van Niekerk, Ankiewicz and De Swardt, (2005:2) posed the question: if the teachers don’t know what knowledge and skills are required in the learning outcome and assessment standards, how and what do they teach and what do they assess?

Assessment standards indicate the minimum standards the learners need to achieve each year. Spady (2008:4) clarifies the ‘demonstration of learning’ as learners doing something tangible, visible and observable. For TE this means that learners must demonstrate skills such as: designing, constructing, producing, investigating, etc. Although the learning outcomes stay the same in the different grades, the assessment standards progress from one grade to the next. This links to Vygotskys’ theory on ZPD who claims that after the learner internalises current knowledge, they may be exposed to the next level of understanding with the guidance of the teacher (Vygotsky, 1978:33). This is called ‘scaffolding’, meaning that learning is moving forward to develop the full potential of the learner (Lombard, 2008:1039). Vygotsky advocated that social learning precedes development. He stated that every function in a child’s cultural development appears twice: first on a social level, and later on a individual level; first between people and then inside a child (Vygotsky, 1978:33). The role of the teacher is therefore vital says Shulman (1986; 2004); and Mishra and Koehler (2006). They add that teachers need to have knowledge and understanding of the content and what the learner needs for their development.

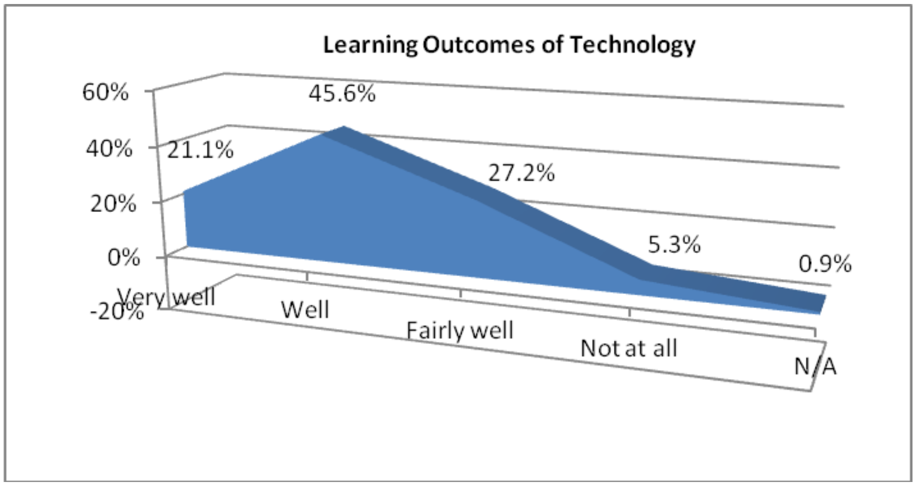

Figure 4.13: Understanding of learning outcomes

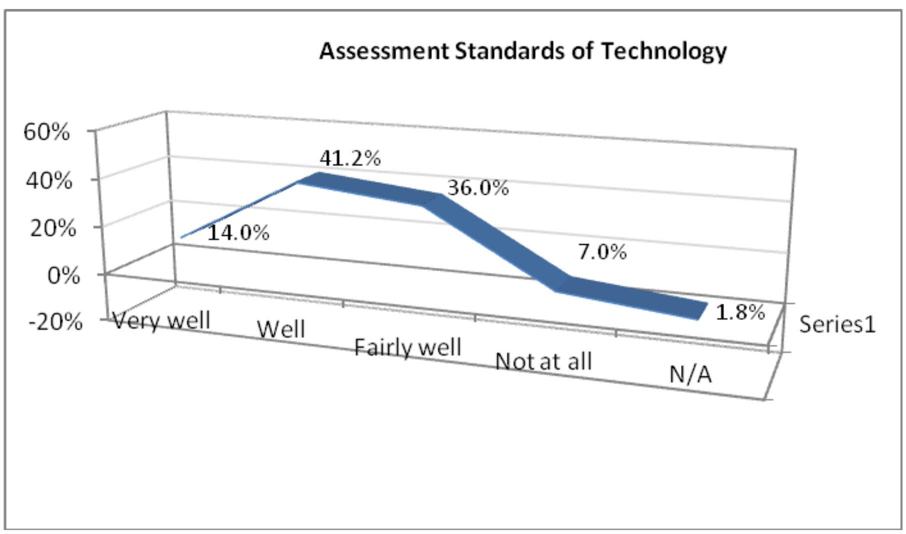

Figure 4.14: Understanding of assessment standards

Table 4.6 (on page 109) indicates that the primary school teachers understood the learning outcomes and assessment standards better than the high school teachers. This again indicates that the focus of the high schools is mainly on the grade 12's and not on the senior phase which is grades 8 and 9.

At the time of writing the researcher was visiting poor performing high schools, that is schools with less than a 60% pass rate in grade 12 in 2010, and some of the principals indicated that *"with the pressure for grade 12 to perform well, the grades 8 and 9 receive less attention than grade 12".* They also admitted that the less experienced teachers are teaching in grades 8 and 9.

For primary schools, 43.9% of the respondents indicated that they understood learning outcomes 'very well' or 'well', while in the senior phase only 22.8% understood the learning outcomes well. Regarding assessment standards, 35.1% primary school teachers understood it 'very well' or 'well', while 20.1% of high school teachers indicated their understanding of assessment standards were 'very well' or 'well'. These and the previous statistics indicate that teachers understand learning outcomes better than the assessment standards. This links directly with assessment that will be discussed in detail later in this chapter.

		Intermediate		Senior Phase		Both		Total	
		Count	%	Count	%	Count	%	Count	%
Q15a Learning Outcomes of Technology	Very well	10	8.8%	4	3.5%	10	8.8%	24	21.1%
	Well	20	17.5%	22	19.3%	10	8.8%	52	45.6%
	Fairly well	16	14.0%	10	8.8%	5	4.4%	31	27.2%
	Not at all	2	1.8%	3	2.6%	1	.9%	6	5.3%
	No response	1	.9%	0	.0%	0	.0%	1	.9%
	Total	49	43.0%	39	34.2%	26	22.8%	114	100.0%
Q15b Assessment Standards of Technology	Very well	8	7.0%	3	2.6%	5	4.4%	16	14.0%
	Well	15	13.2%	20	17.5%	12	10.5%	47	41.2%
	Fairly well	22	19.3%	12	10.5%	7	6.1%	41	36.0%
	Not at all	3	2.6%	4	3.5%	1	.9%	8	7.0%
	No response	1	.9%	0	.0%	1	.9%	2	1.8%
	Total	49	43.0%	39	34.2%	26	22.8%	114	100.0%

Table 4.6: Comparison between phase taught and understanding of learning outcomes and assessment standards

Question 15.1 asked which learning outcome the respondents deemed to be the most important. According to literature, the design process which is learning outcome 1, is the most important as it is the backbone of TE (Barlex, 2005; Corkery *et al.*, 2006; DoE: 2003). It is important for teachers to know learning outcome 1 along with the assessment standards as 50% of teaching time and mark distribution is allocated to learning outcome 1 (DoE, 2003:24).

According to Table 4.7 (on page 110) 61 (53.5%) respondents indicated that learning outcome 1 is the most important, while 14% felt that all the learning outcomes are important. 67.22% (41 of 61) of primary school teachers indicated that learning outcome 1 is the most important while this was the feeling of 32.79% of the high school teachers. This confirms the researchers' assumption that the high school teachers are less informed that the primary school teachers regarding the TE curriculum. As previously stated this may be because of the focus on grade 12 and neglect of the lower grades, thus justifying the need for well planned training.

		Intermediate		Senior Phase		Both		Total	
		Count	%	Count	%	Count	%	Count	%
Q15.1 Most important LO	Total	0	.0%	0	.0%	0	.0%	0	.0%
Q15.1.1	LO1	26	42.6%	20	32.8%	15	24.6%	61	100.0%
Q15.1.2	LO2	4	30.8%	4	30.8%	5	38.5%	13	100.0%
Q15.1.3	LO3	9	60.0%	3	20.0%	3	20.0%	15	100.0%
Q15.1.4	All	9	56.3%	4	25.0%	3	18.8%	16	100.0%

Table 4.7: Importance of the learning outcomes in the different phases

Respondents gave the following reasons for choosing learning outcome 1 as the most important outcome: *"the way in which the learners can apply the knowledge gained in technology"; "allows creative inquiry";* and *"you use learning outcome 1 in all the other outcomes".*

In general, very good reasons were given for their answers which indicate that the teachers understood the importance of learning outcome 1. The next part of the data analysis focuses on learning outcome 1, namely: the design process.

4.3.5 The design process

Question 16 addressed one of the research questions, namely: to determine whether teachers could identify the design process. The design process is seen as a higher order cognitive activity and a constructive, critical thinker will have the ability to monitor and evaluate the problem-solving process, make conclusions, reacts effectively to new tasks and situations and process information effectively, which involves ability to classify, compare, categorise, analyse, and evaluate (Lombard, 2008:1031).

The conclusion drawn from Figure 4.15 (on page 112) is that 66.7% of the teachers experienced the design process to be linear, 17.5% to be cyclical, 10% felt that one may start at any point, and 5.8% did not answer this question. The literature advises that the design process should not be seen as a linear process (Davis *et al.,* 2002:82; Leahy and Gaughran, 2007:52; Williams, 2000:382). Analysis of the data revealed that the majority of the teachers still do not understand the holistic approach of the design process and that training on the design process needs to be more in-depth. McCormick *et al*. (1994:7) believe that the personal understanding of the teacher regarding the design process in TE remains problematic as teachers do not always see the bigger picture of the design process and teach it according to their individual understanding and knowledge. This then influences how learners begin to undertake the design process. They state further that learners often experience the design process as individual tasks and find it difficult to see the relationship between the different tasks. It is therefore important for teachers to explain the link between aspects of the overall design process where a range of techniques are applied.

A reason for the teachers seeing the design process as a linear process may be the way in which the NCS policy document was written showing a linear approach of sequenced steps of investigate, design, make, evaluate and communicate without explaining that it is not necessary to follow these steps from one to the other, but rather that one needs to interact with the steps. Lewis (2006:266) suggests that it is better to talk about activities or targets rather than steps, as steps by nature indicate a linear process. This is an important finding as it indicates that the design process will have to be a key focus of the training on the CAPS document from 2012 to 2014. During the training the teachers will need to be capacitated in the words of Mishra and Koehler (2006:1020) with pedagogical and content knowledge (PCK) to enable them to guide the learners towards understanding the design process. They explain further that content and pedagogy must not be seen in isolation but should be blended into a understanding of how particular aspects of subject matter are organised, adapted and represented for instruction. Shulman (1986:9) argues that although knowledge of subject content is important, it is not enough for good teaching (*see also* Shulman, 2004). The teacher needs to know the subject pedagogy to deliver the content.

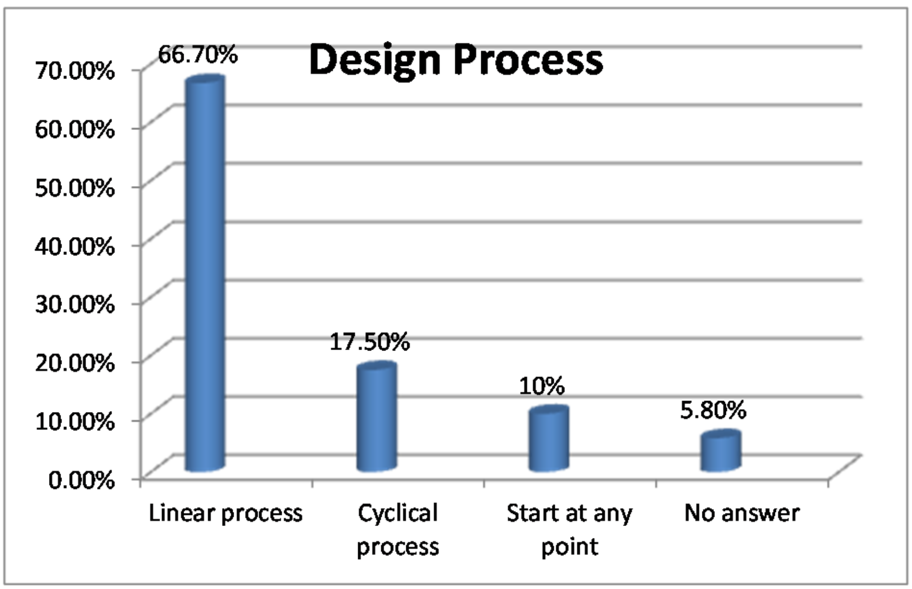

Figure 4.15: Model of the design process

Banks, Leach and Moon (1999:95) add another concept to PCK. They suggest that the context of the school also plays an important role in successful teaching. To be successful, they say, a teacher needs to develop pedagogical strategies on how content should be taught, that means transforming subject content into understandable ways for the learners, within the context in which the teacher is situated.

The purpose of including the design process in TE was to develop the ability and skill of the learners to be problem solvers, critical and creative thinkers (Norman, 2000:91). This is part of the constructivist approach to learning to ensure life-long learning by capacitating learners to be able to cope in the world of work (Brooks and Brooks, 1993:9). 91% of the respondents agreed that the design process benefits the learners in their development as can be seen in Figure 4.16 (below). Some reasons from the respondents for the inclusion of the design process were: *"the learner will be able to design her/his own product. This allows the learner to think deep"; "the design process allows for creative inquiry as well as problem solving thus allowing the young individual the ability to solve tomorrows problems today";* and *"learners learn to gain better understanding of the learning area through the design process thus benefitting them in their critical thinking and problem solving".*

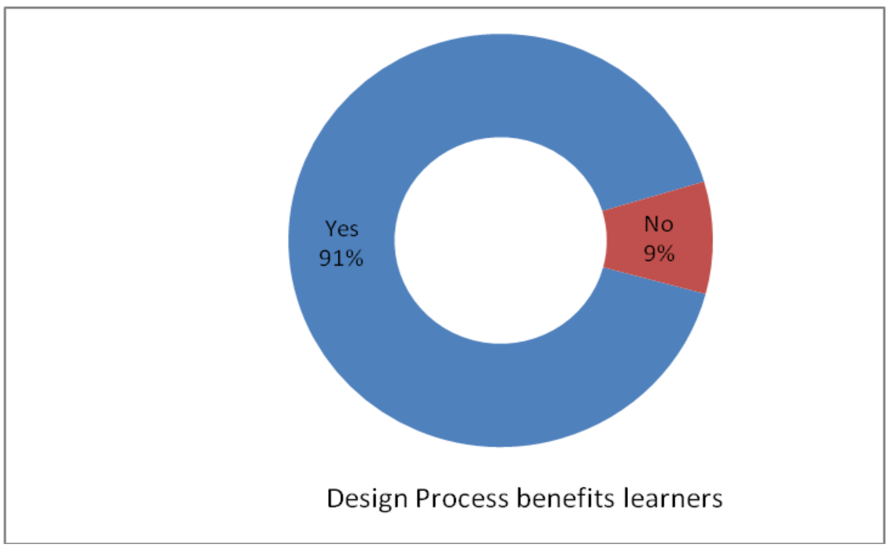

Figure 4.16: Benefit of the design process

A question linked with Figure 4.16 (on page 113) requested responses from the teachers regarding the development of learners as critical, creative, innovative problem solvers. This was one of the reasons for the NCS (DoE: 2002). Mahike (1993:6); and Potgieter (1999:85) support what the DoE set out to do by stating that the inclusion of TE worldwide was to teach learners to become critical, creative and problem solvers. Between 41.2% and 42.1% of respondents felt that the curriculum succeeded 'well' in the development of critical, creative and innovative thinkers, while between 22.2% and 33.3% responded with 'very well' indicating that more than 60% of respondents agree that the TE curriculum succeeds in this aspect. Figure 4.17 (below) shows a composite analysis of this question.

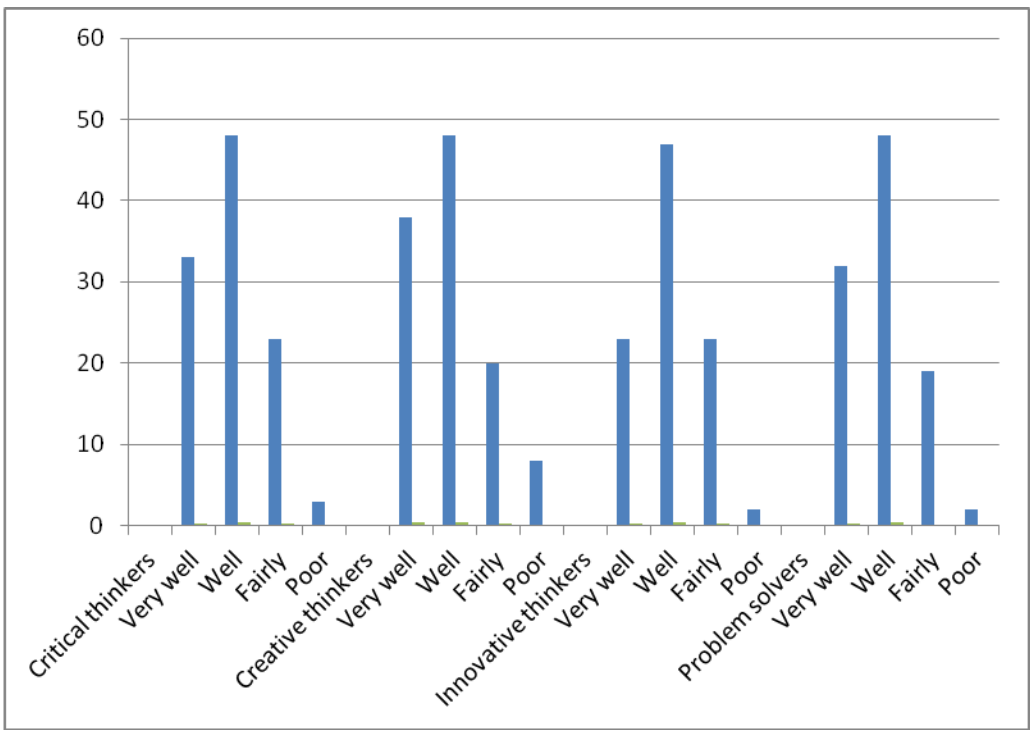

Figure 4.17: Development of critical, creative and innovative thinkers

The researcher gave a scenario of a problem to be solved through the design process in question 18. The scenario given read as follows:

> *Informal traders wish to cash in on the foreign trade that is about to hit our shores. The schools Technology department wants to be part of the activities by designing possible ideas of things they could make with wire or metal that could be sold to the tourists.*

This was to establish if the teachers could apply their theoretical knowledge of the design process in a practical way. The respondents had to explain what they would do in each part of the design process to solve the problem. An analytic rubric was used to categorise the responses into 'good', 'fair', 'poor', 'no response' and 'not sure' in order to identify and assess different components of the answer regarding the design process as given by the respondents. The data gathered for each step of the design process also established which steps the teachers found more difficult to implement. Although there are different models of the design process available in the literature (as discussed in chapter 2), the researcher used the model suggested in the NCS document (DoE, 2002:6-7) as this is what the teachers are used to.

Figures 4.18 to 4.22 (on pages 117-121) represent the responses regarding the stages of the design process namely: investigate; design; make; evaluate and communicate. On this practical implementation of the design process, only 7-14.9% of the respondents gave a 'good' response to the question, 24.6-40.4% gave a 'fair' response and 24.6-43% gave a 'poor' response. This is an indication that the teachers do not know how to practically implement the design process in the classroom because they do not understand the assessment standard (as previously stated). The assessment standards indicate what is expected from the learners in each grade (DoE, 2002). Therefore, although the teachers might know the different activities that need to be done during the design process, they do not understand what to do in each of the stages. As discussed under the design process, the teachers see the stages as different activities and not as solving a problem holistically (McCormick *et al*., 1994:7).

Each stage of the design process will be discussed from the premise of what literature views to be important.

The first stage of the design process is 'investigation'. For this stage the NCS (DoE, 2002:6) suggests that the learner needs to do research, gather data on existing products and compare, observe, interpret and process data that is gathered. Some of the answers given by teachers for the investigation stage were: *"gather information through books and questionnaires"; "investigate the types of materials you are going to use"; "look for information about the model you are going to make"; "investigate a symbolic curio";* and *"learners will investigate what is the new things built and made for 2010. They will also look at things that will attract tourists".* This question was answered fairly well and it seems that most of the teachers have a clear indication of this stage of the design process.

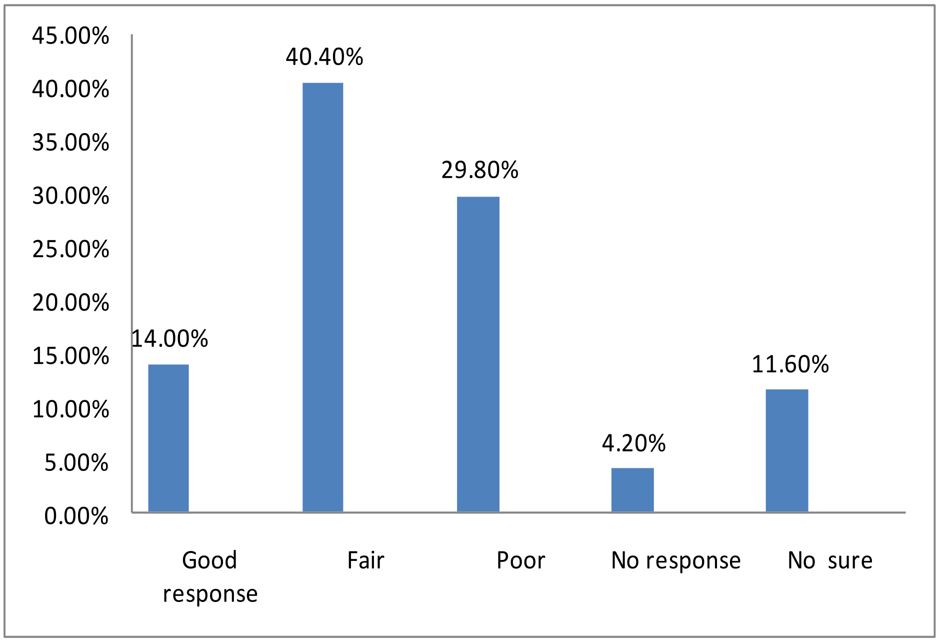

Figure 4.18: Investigating stage

According to the NCS (DoE, 2002:6) the learners need to design after the problem is fully understood. Design involves: writing of a design brief; generating possible solutions; drawing of these ideas which require graphic skills; selecting the best solution; and preparing a working drawing.

Answers given by the respondents regarding the design stage included: *"draw product according to criteria adding dimensions"; "make a drawing of the product they are going to make"; "write a design brief of what they are going to make and draw the product"; "they design the symbol for the Worlds Cup";* and *"make different designs and choose the best and then improve it".* Most of the respondents only mentioned one or two of the aspects that need to be followed during this stage.

During the design process, learners have to demonstrate competency in: writing a clear design brief; list specifications and constraints; generate different possible solutions; select a possible solution giving reasons for their choice; and develop the chosen idea using graphic or modeling techniques (DoE, 2002:36-38). The reason for teachers not mentioning all these requirements may indicate that the teachers do not know the assessment standards and skills associated with this stage of the design process as listed in the NCS.

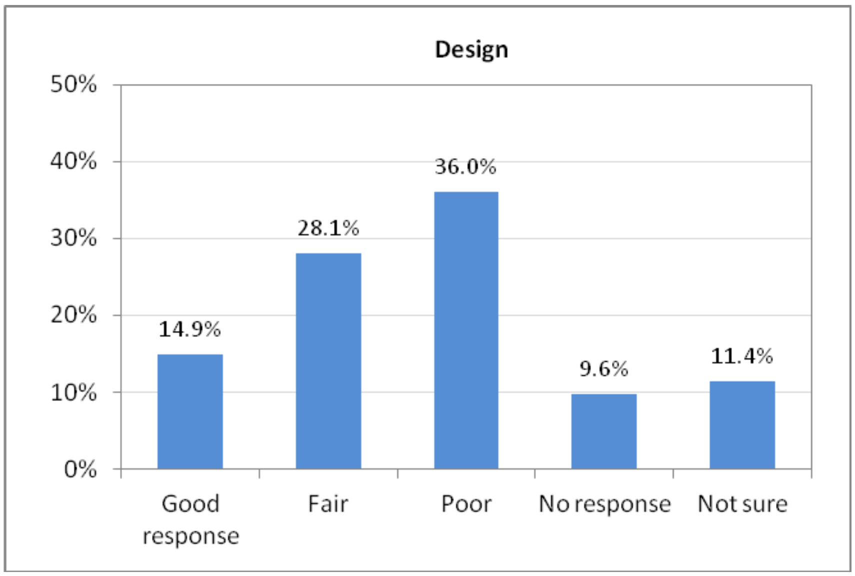

Figure 4.19: Designing stage

The explanation for the making stage in the NCS (DoE, 2002:7) states that it provides opportunities to the learner to use tools, equipment and materials to develop a solution to the identified problem. Skills such as cutting, joining, shaping, and measuring among others are developed and it should happen in a safe and healthy environment.

Some of the responses on the making stage of the design stage were: *"use materials from the environment and make the product according to the design";*

“they will make the model same as they have drawn it in their exercise book”; “put together according to the drawing”; “make looking at the drawing and specifications”; and *“collect materials and tools to be used and start making what has been chosen as a final design”.* Crucial skills associated with this stage were not mentioned by the teachers indicating that they just see it as a making process and not as development of skills. Mawson (2003:119); and Van Dyk and van Dyk (1998:51) urge teachers not to focus too much on the end product but to see the design process as a process of developing skills.

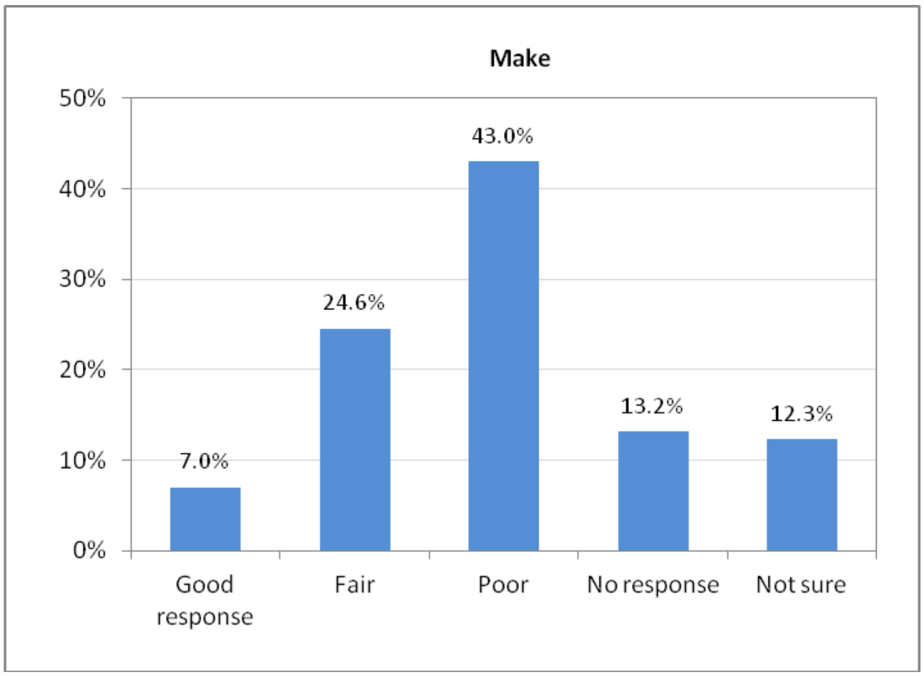

Figure 4.20: Making stage

The learner needs to evaluate actions, decisions and results throughout the design process (DoE, 2002:7). After the evaluation, learners need to suggest improvements to solution. They require the use of probing questions, fair testing, and analysis.

Regarding the evaluation stage, responds answered: *"evaluation is in the form of test or checking of some mistakes"; "test according to specifications"; "check whether product can be handled without harm"; "measure against needs"; "test the product for effectiveness";* and *"after that we test it if the measurements are correct and neatly done".* The responses were better than the previous stages. Although the respondents mentioned that testing and evaluation must take place against specifications, no one mentioned the need to suggest improvement to the product, which is a part of product development in a real world situation (Shigley, 1972:5).

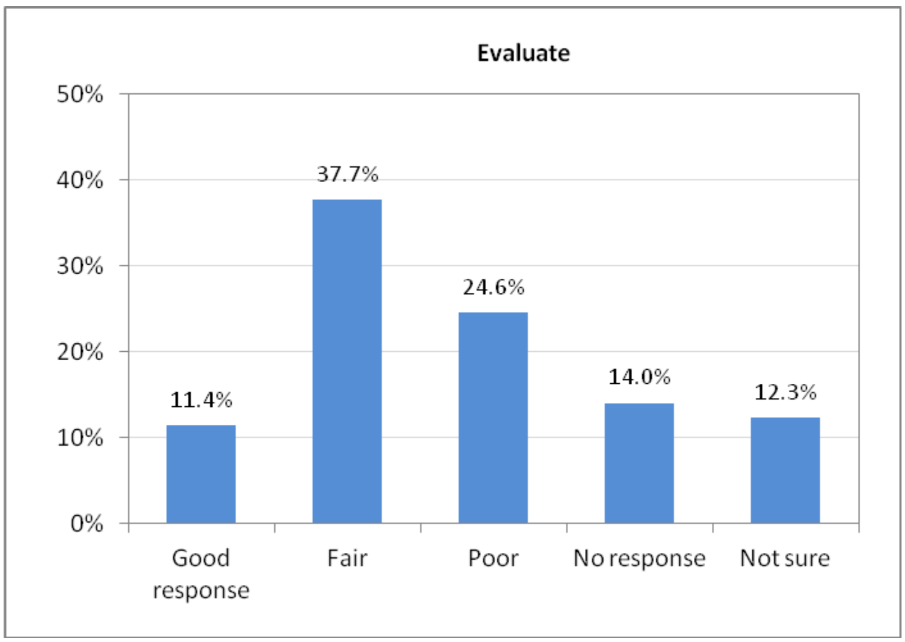

Figure 4.21: Evaluating stage

Communication is the last stage of the design process and is described in the NCS (DoE, 2002:7) as evidence of the process that was followed. All the stages of the project are recorded in a project portfolio. The communication can be done in oral, written, graphic or electronic form.

This stage was fairly well described with responses such as: *"learners do presentation"; "group presentation explaining why the product was made and the constraints (difficulties) they had during the making"; "they will tell other people how they worked with the model"; "what can be done to improve the model";* and *"discuss as a group or individual".* Teachers mentioned only the presentation of the end product and did not make any reference to the process followed to solve the problem.

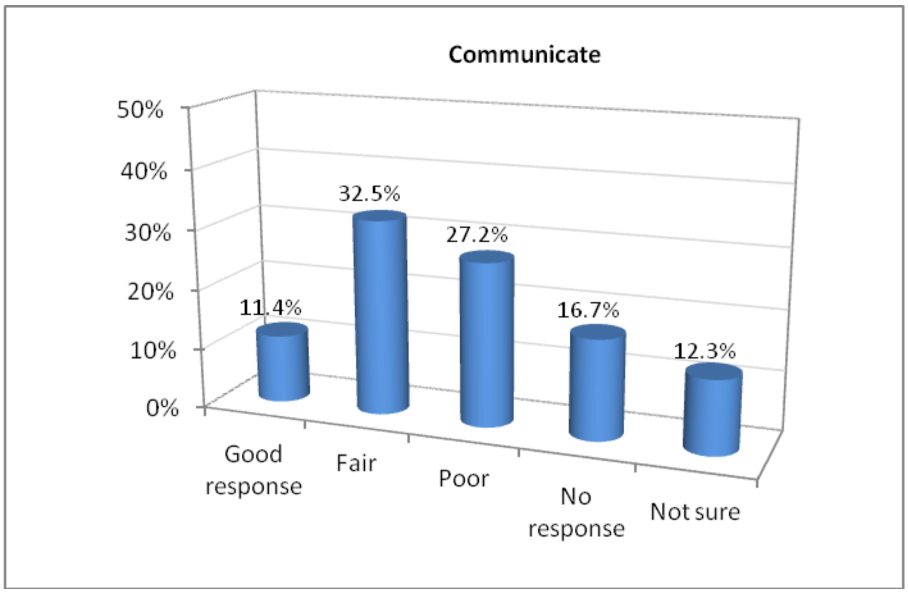

Figure 4.22: Communicating stage

When looking at the data presented on the stages of the design process, it is apparent that teachers do not see the bigger picture in using the design process to solve a problem, but they see it as individual stages not linking the one stage to the other. The successful use of the design process to solve a problem in TE requires both conceptual knowledge ("knowing that") and procedural knowledge ("knowing how"). Conceptual (knowledge and skills) and procedural knowledge (application in practice) can be distinguished in the TE curriculum and when teaching TE they cannot be separated (Van Niekerk, Ankiewicz and De Swardt, 2005:2). Shulman (1986:9) also highlighted two kinds of knowledge, he named the content knowledge ‘what to teach’ and pedagogical knowledge ‘how to teach’ (*see also* Mishra and Koehler, 2006:1018; Shulman, 2004). The teacher must build on the prior knowledge of the learners to construct new knowledge when solving a problem. Vysgotsky’s zone of proximal development (ZPD) has a direct influence on teaching and learning in the classroom. Vygotsky (1978:35) states that knowledge first has to be internalized before the child can work independently. The same principle may be applied when training teachers. This means that during the training of teachers on the design process, the facilitator must ensure guidance of the teachers to internalize pedagogical and content-knowledge to enable them to implement this knowledge in the constructivist TE classroom.

Although the researcher focused on learning outcome 1 (design process), it cannot be taught in isolation. Learning outcome 2 refers to the knowledge and skills to be developed during the design process, and learning outcome 3 deals with attitudes towards society and environment when solving a problem (DoE, 2002:9). A part of procedural (pedagogical) knowledge is to know how to achieve the learning outcomes. The policy document (DoE, 2003:6; Norman 2000:91) explains that the three learning outcomes should be taught in an integrated manner. Figure 4.23 (on page 123) shows that 73% of respondents indicated that they do teach in an integrated way while 27% teach learning outcomes in isolation.

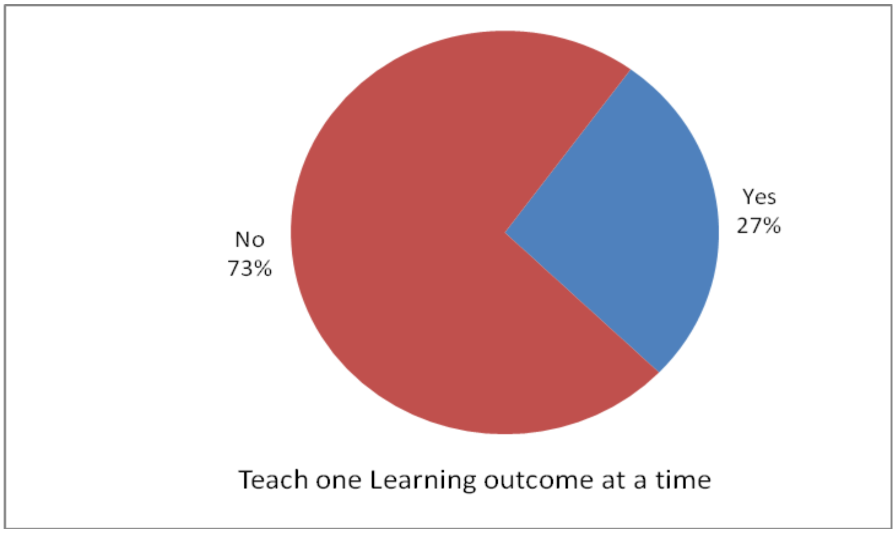

Figure 4.23: Sequence of learning outcomes

4.3.6 Assessment of TE

During the design process learners have to be continuously assessed (DoE, 2002). Neuman (2003:8) states that assessment may be done by the learner and teacher through reflecting, testing, modification, re-testing and re-evaluating as learner's progresses through the design cycle of the design process. He adds that if continuous assessment does not take place, the focus will wholly be on the end product and not on the process, and learners will not analyse the advantages and shortcomings of their product. This could result in learners not understanding the design process especially during the designing and making process.

In this study the researcher specifically focused on the assessment strategies that may be used to assess the design process. Different assessment strategies were indicated to the respondents so that they could say which they use 'always', 'sometimes', and 'not at all' or they could choose 'no response'.

Between 16.7% and 37.7% of respondents indicated ‘no response’ which is alarming as the researcher feels that this is an indication of the teachers’ lack of knowledge regarding assessment in TE (Figures 4.24-4.28, on pages 124-128).

Van Niekerk, Ankiewicz and De Swardt (2005:6) state that the inability of teachers to determine the learning outcomes relevant to a specific task often result in teachers only assessing the final product. The alternative to assessment of the end product is assessing the design process step by step. Assessing the learner step by step gives a clear picture of skills achieved and those not achieved, so that learners and parents will know where the shortcomings are. In Figure 4.24 (below) 26.3% of the respondents indicated that they always assess each step of the design process, while 49.1% do this sometimes, and 7.9% do not do this at all.

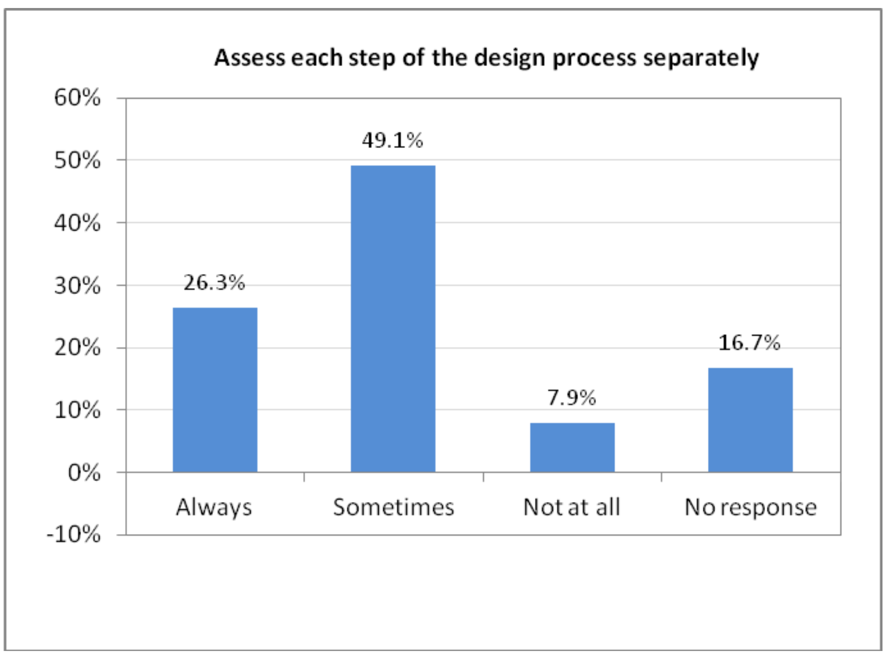

Figure 4.24: Assessing each step

The NCS document (DoE, 2002:45) specifies that a project portfolio should be used to assess the design process. Figure 4.25 (below) indicates that only 34.2% of the respondents fulfilled this requirement, while 40.4% ‘sometimes’ use a project portfolio and 10.5% not use it ‘at all’. 14.9% of the respondents did not answer this question. In a project portfolio the learners should record all the activities they engage in to solve the problem including all the drawings of the product which serve as evidence of the learners work. In other words, it is evidence of how well learners’ can apply their knowledge.

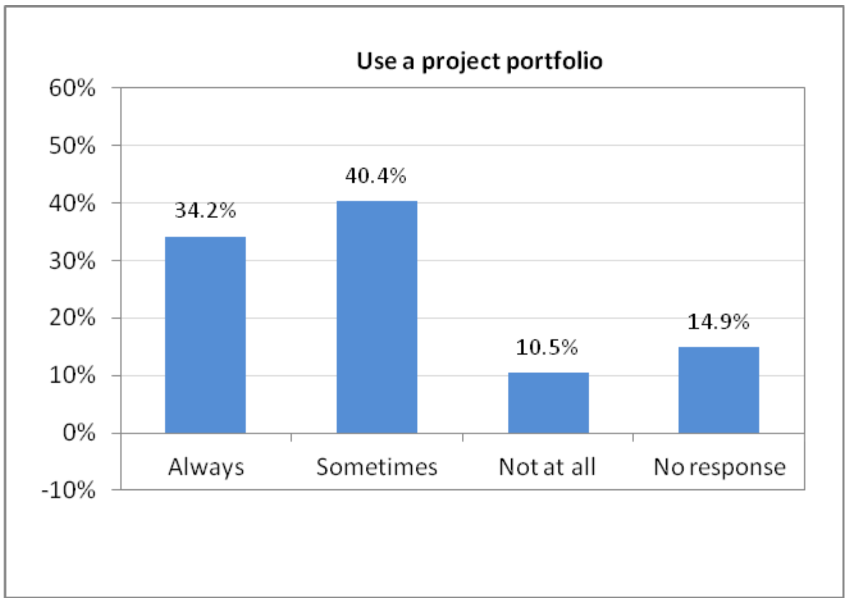

Figure 4.25: Assess using a project portfolio

The Assessment Policy (DoE, 2007:5) states that assessment should be mainly criterion referenced. Criterion referenced assessment refers to assessing a learner according to a specific set of criteria and not giving a general impression mark or assessing one learner against another (Van Niekerk, Ankiewicz and De Swardt, 2005:4). As Lipman (1985:40) says, a critical thinking constructivst teacher makes logical conclusions based on criteria sustained by proof and thus moves away from assumptions. Figure 4.26 (below) affirms that 46.5% of respondents ‘always’ use a set of criteria to assess their learners while 5.3% do not use criteria any at all. This confirms the difficulties teachers experience by turning away from the old way of assessment to assessing in an OBE way. In the past, assessment was done using the ‘pen-and-paper’ method where learners were given a numerical mark indicating a pass or fail. In the design process, application of knowledge is assessed against a specific set of criteria stated in the assessment standard of the learning outcome.

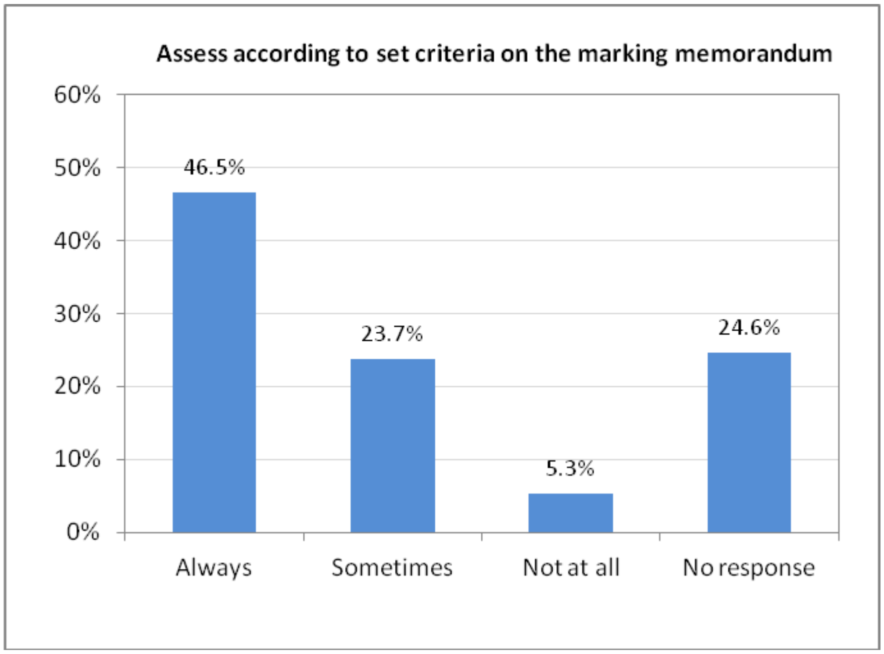

Figure 4.26: Assess according to a set of criteria

Figure 4.27 (on page 127) indicates that 16.7% of the respondents always give an impression mark and are therefore not using a set of criteria for learners' assessment. By giving an impression mark, the strenghts and weaknessess of the learner cannot be recognised and the teachers are not able to give constructive feedback to the learner (Neuman, 2003:8). This results in the learners not knowing how to improve their learning.

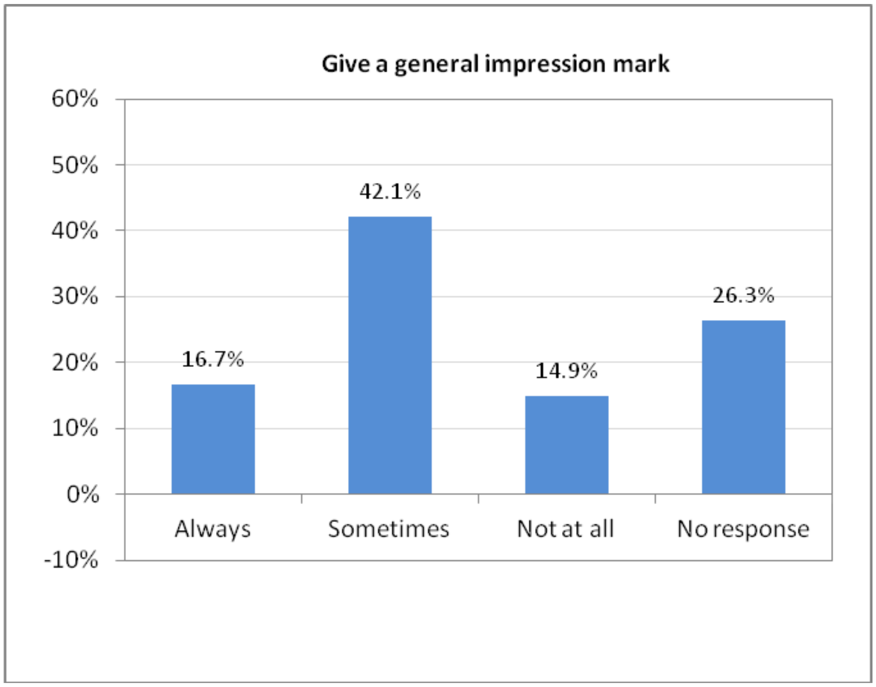

Figure 4.27: General impression mark

The main principles of assessment are validity, reliability, fairness, transparency and flexibility (DEC, 2003:28) Van Niekerk, Ankiewicz and De Swart (2005:4) state that meaningful and responsible assessment is more than just focusing on the end-product. To achieve this, assessment must be continuous, in other words throughout the whole process of learning. According to Moreland and Jones (2000:283); and Compton and Harwood (2003:4) teachers find assessment in TE difficult because they do not have the necessary knowledge of the subject. This results in teachers taking the easy way out and only assessing the end product instead of the process itself. This can also be seen in

Figure 4.28 (below) where 62.3% of respondents indicated that they ‘always’ or ‘sometimes’ base their assessment on the end product.

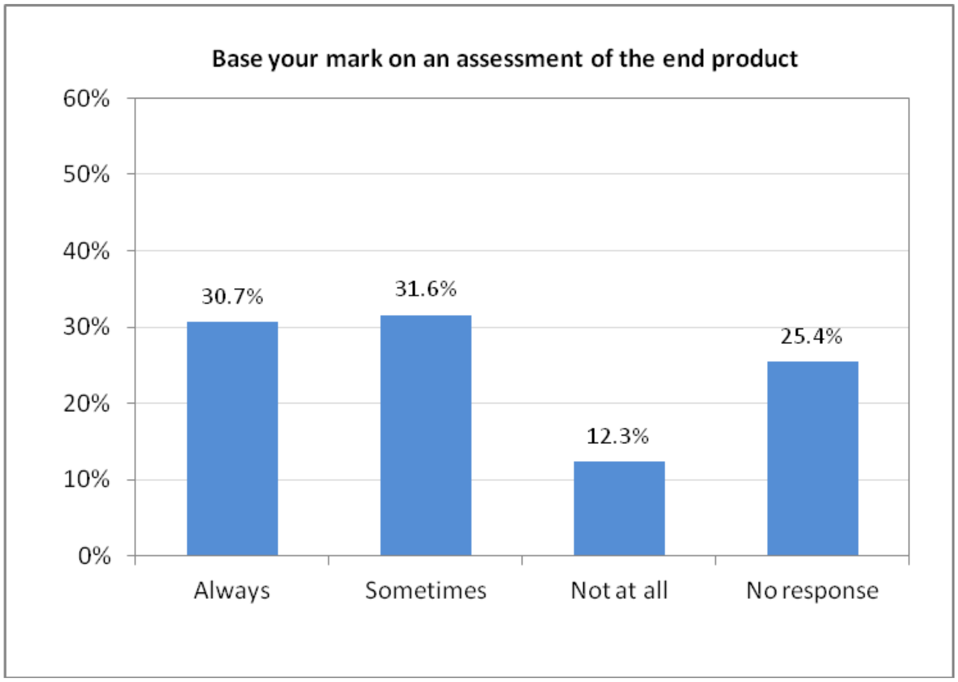

Figure 4.28: Assessing the end product

Teachers need assessment strategies and ‘tools’ for assessing learners in a fair, valid and reliable way. Assessment tools refer to the instruments used for assessment. The Department of Education states that assessment should be transparent and in order to achieve this, the learners need to know the criteria against which they are going to be assessed before starting with the task (DEC, 2003:28).

Question 21.2 gave a list of different instruments that may be used in assessment and the respondents had to indicate which of these instruments they ‘always’, ‘sometimes’ or ‘not at all’ use. The first assessment instrument was an analytic rubric. According to Mueller (2011:1) an analytic rubric refers to an instrument with multiple, separate scales and therefore provides a set of scores rather than just one. The set of criteria are analysed and each criteria is assessed on its own. An analytic rubric gives the learners feedback on which of skills were mastered and on which they must concentrate more on to be able to achieve the skill (Mueller, 2011:1). This type of rubric is more reliable and transparent than the holistic rubric and is usually used to assess more complex skills as well as introducing new skills. 24.6% of the respondents indicated that they always use an analytic rubric when assessing learners and 41.2% indicated that they use it sometimes. Only 7% indicated that they never use an analytic rubric while 27.2% did not respond to the question. This can be seen in Figure 4.29 (below). An analytic rubric is difficult to construct and requires intensive assessment. Although it is the best way to establish what learners can do, it is time consuming and that might be the reason for teachers not always using this assessment instrument.

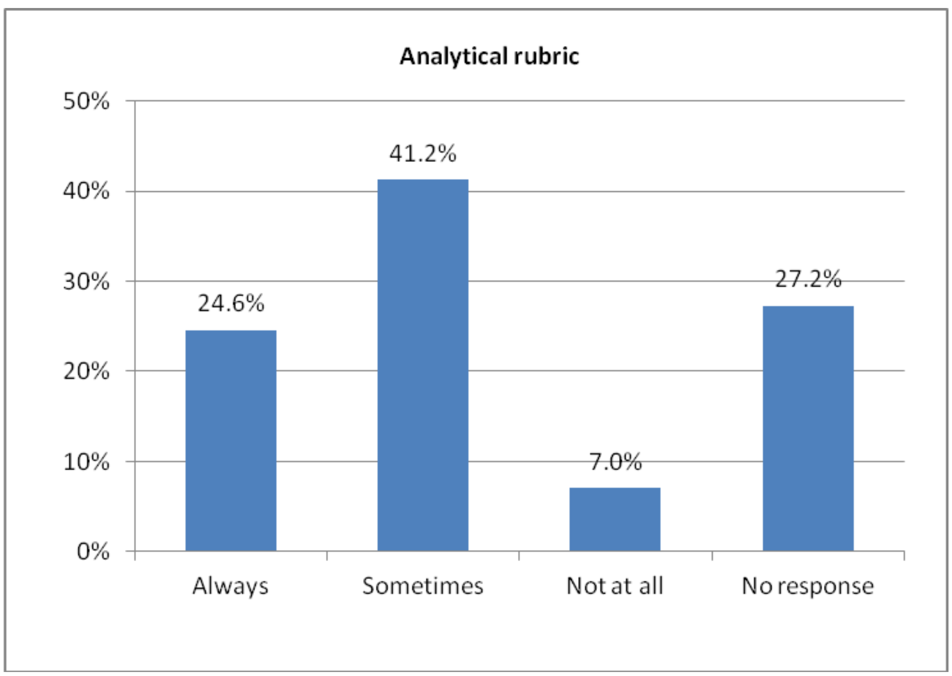

Figure 4.29: Analytic rubric

The second instrument mentioned in the questionnaire was the holistic rubric. The holistic rubric generally includes only a single scale (Mueller, 2011:1). He explains that criteria is grouped into a single level and therefore does not provide the learner with clear indications on whether the skills were achieved or not. This type of rubric is easier to create and can be used for different projects. In Figure 4.30 (below) the respondents indicated that 32.5% always use this instrument and 43% indicated that they use it sometimes. The holistic rubric is easier to construct and less time consuming to use. This might be the reason why more teachers use this instrument for assessing learners' work.

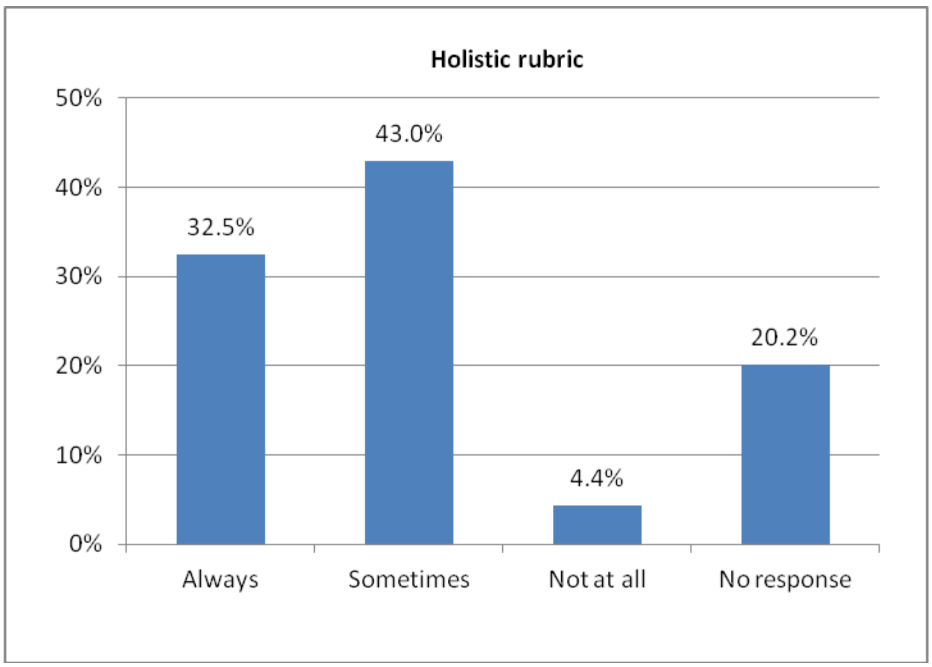

Figure 4.30: Holistic rubric

The third instrument mentioned in the questionnaire that the respondents could select was a checklist. A checklist is a more simplified instrument and can be used to indicate if learners completed the tasks given to them. No scale is attached to the checklist which makes it difficult to establish the level of achievement (Mueller, 2011:1). This is also the easiest method of assessment and the teacher can just tick whether a task was done or not. Figure 4.31 (below) indicates that 26.3% of the respondents 'always' use a checklist when assessing learners work. Only 37.7% 'sometimes' use the checklist and 5.3% indicated that they 'never' use a checklist to assess learners work. This instrument cannot be used to indicate the strengths and weaknesses of the learner and no constructive feedback can be given to the learner and parents. However, a checklist can be used very effectively by the learner to track their progress.

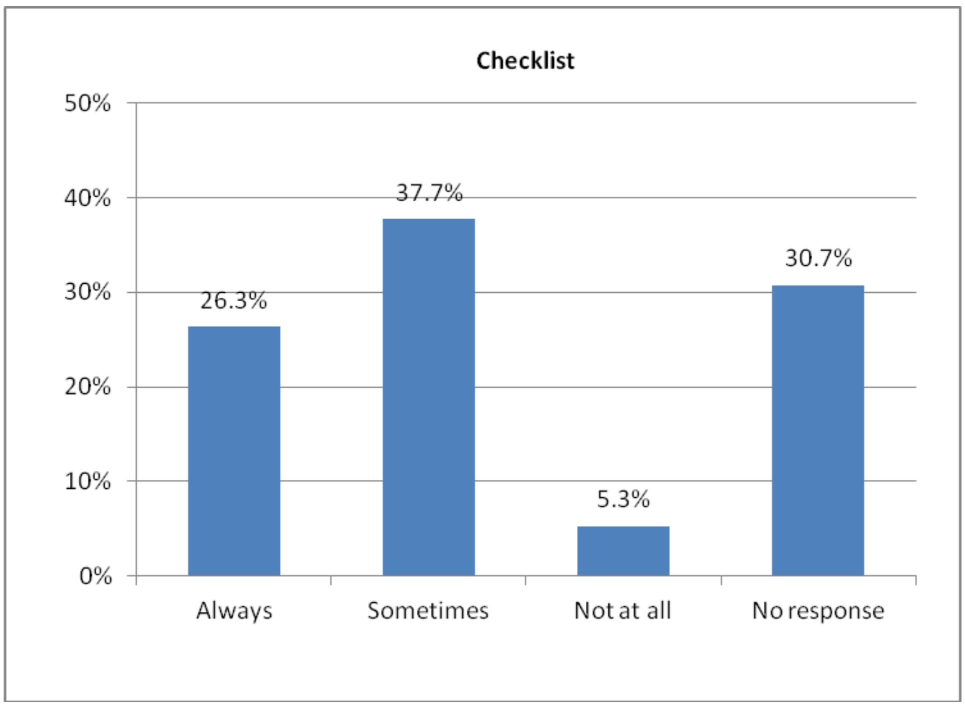

Figure 4.31: Checklist

The fourth way of assessing (indicated on the questionnaire) is to give a general impression mark. This is the easiest way to assess but this method should not be used as it is not valid, reliable, fair or transparent. No criteria is used and it does not give the learners feedback on what skills they still need to develop or on what level of development they are (Van Niekerk, Ankiewicz and De Swardt, 2005:6). It is therefore disturbing to see that 53.5% of respondent indicated that they ‘always’ or ‘sometimes’ use this method (*see* Figure 4.32, below). This together with the percentage of respondents, who opted not to answer the questions on assessment of the design process, could be an indication that the teachers do not know how to assess the design process in TE and opted for the easiest way by just giving a mark for the end product according to what the product looks like.

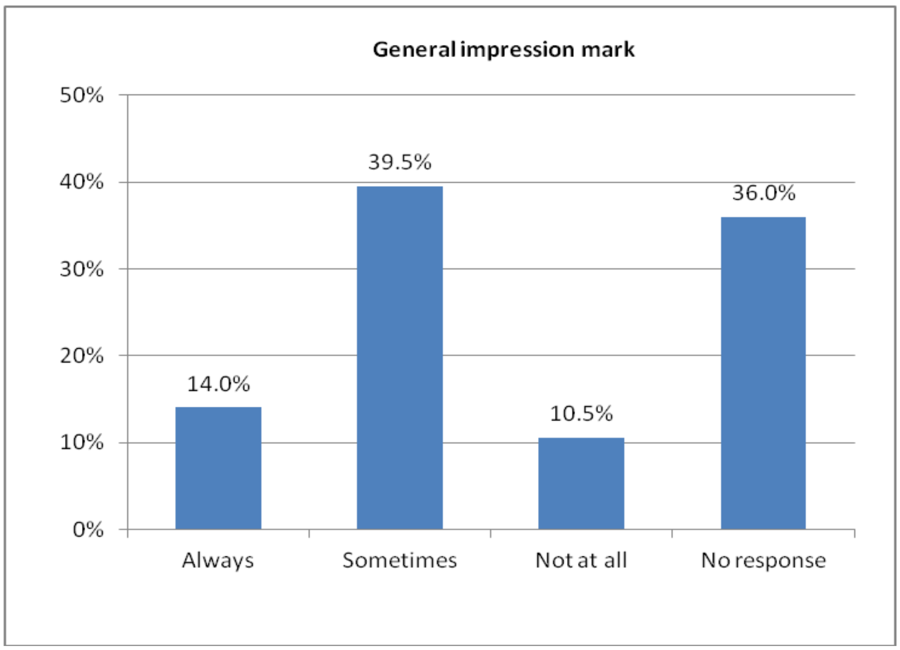

Figure 4.32: General impression mark

4.4 SUMMARY

The findings of this study indicate that teachers need in-depth training to implement the curriculum successfully. This conclusion is drawn from findings presented in this chapter which suggest that, teachers do not understand the design process and still perceive it as a linear process; although they know the activities involved in the design process, they are missing the interaction link between the activities; and while many lack content knowledge, most of the teachers lack the pedagogy of TE. Teachers find it difficult to select appropriate assessment forms and assessment strategies to assess technology in the classroom. The need for quality and needs-driven programme delivery by the DoE, higher education institutions and non-government organisations is evident from this study.

In this chapter, data collected from the questionnaires and semi-structured interviews were described and analysed. Firstly, data about biographical and background information were discussed to give the reader a profile of the respondents. Secondly, data on training of the NCS was discussed. The third part of the data analysis focused on TE, specifically on the design process. The researcher analysed and interpreted the data to be able to address the questions of this study. As teaching and learning cannot be separated from assessment, the last part of the data analysis looked at teachers' assessment of learners' work.

The next chapter presents the conclusions and recommendations of this study. Suggestions for further research arising from this study are indicated.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter a summary of the research study is first given. Secondly, conclusions arising out of the findings are discussed with regard to the research aims and objectives by referring to the literature study reflected in Chapter two and taking into consideration the descriptive research reported on in Chapter three. Thirdly, recommendations regarding the literature study and the design process model as a teaching strategy for TE teachers are highlighted followed by lessons learned and limitations of this study. The chapter concludes with directions for further research.

In June this year, the Minister of Basic Education in South Africa, Angie Motshekga reported that 4303 teachers in KZN are unqualified, which has resulted in learners performing poorly (Motshekga, 2011). This is an alarming number as these teachers influence the lives of 172,000 learners in their care. The Minister of Education in KwaZulu-Natal, Senzu Mchunu, reported that the Annual National Assessment results revealed a pass rate of 30% in grade 6 mathematics (Mchunu, 2011). This is not only due to unqualified teachers but also because teachers are poorly managed and not teaching effectively due to ineffective in-service and pre-service training (Centre of Development and Enterprise, 2011). Training of teachers is vital for the transformation of the education system. Mishra and Koehler (2006) and Shulman (1986) therefore cautioned against teacher education where subject matter or pedagogy dominated. They argue that having knowledge of subject matter and general pedagogical strategies, though necessary, is not sufficient for capturing the knowledge of good teachers.

McCormick, Murphy and Hennessy (1994:6) concur that teachers' personal understanding of concepts such as the design process in TE remain problematic as teachers do not always see the bigger picture and teach it according to their individual understanding and knowledge. This in turn influences the way learners learn and in the way they undertake tasks.

The primary aim of this study was to examine teachers' understanding and implementation of the design process as it relates to teaching TE in the intermediate and senior phases (Grades 4–9) of the General Education and Training Band in KwaZulu-Natal. In order to achieve this aim, the following research objectives were addressed: to determine teachers' perception of the design process in TE; to determine whether teachers can identify the design process; and to investigate the methods used by teachers' in the implementation of the design process in TE in their classroom. A secondary goal was to establish the success of NCS training during 2003 to 2008 to inform the researcher in terms of her portfolio in the DoE regarding the training of TE teachers during 2012 to 2014.

To achieve the above, this study was conducted within a constructivist framework using a mixed methods approach to gather data. The following section encapsulates how this study was conducted by providing a summary of the study.

5.2 SUMMARY OF THE STUDY

Chapter one provided a general overview of this study. Chapter two reviewed literature regarding the difference between TE and ET; international and national development of TE; changes in the South African curriculum with the inclusion of TE; and explanation of the NCS requirements in TE. The focus of this chapter was the findings in literature about TE terminology such as: design; design process; and different models used for the design process. The theoretical framework underpinning this study and the use of assessment in TE were explained.

Chapter three described the methodology of the study. The research design was discussed and gave insight in the techniques used for selecting the respondents and sampling methods which were questionnaire and a semi-structured interview. Purposeful sampling was employed to select respondents, namely TE teachers attending a TE workshop. The methodology was designed to ensure confidentiality, reliability and validity to ensure the credibility of the results of this study.

Chapter four focused on the descriptive investigation into the training of TE teachers and the way in which the design process may be used and applied as a strategy in the teaching of TE in KwaZulu-Natal schools. The data were categorised into six themes to present the findings of the questions that were posed to the TE teachers to elicit their opinion regarding TE. Theme one looked at the biographical and background information of the respondents, theme two examined the training during the NCS training, theme three focused on the TE NCS training, theme four focused on the understanding of the teachers regarding TE, and theme five examined the teachers understanding of the design process, and theme six discussed assessment in TE.

Conclusions based on the findings of this study are now presented in respect of the research aim and objectives.

5.3 ACHIEVEMENT OF THE OBJECTIVES

Primary objectives

5.3.1 Objective one: To determine teachers' perception of the design process in TE

According to the literature review (*see* 2.8) and Davis *et al.* (2002:82) the design process is often seen as a linear process. Lee and Todd (2004:9); Mawson (2003:119); and Moreland and Jones (2000:292) agree that the linear design process is used as it make the teaching and assessment in TE easier (Mawson, 2003:119). A design process model can be very helpful especially to non-specialist primary school teachers as it helps them with the implementation in the classroom in a simplistic way (Johnsey, 1997:204). It is evident from the data analysis regarding perceptions of the design process in TE that most (66.7%) of the teachers' experience the design process as a one way or linear process and that they teach the process accordingly. By so doing the teacher does not allow learners to be creative and critical when solving a problem and learners are more focused on the end product rather on than the process of solving the problem (Van Dyk and van Dyk, 1998:51).

Analysis of the different stages of the design process also revealed that teachers do not understand what needs to be done in each of these stages and therefore do not see the stages as important steps towards solving a problem. It would seem as if some teachers are not aware that the natural process of solving a problem is not a simplistic process as not all people solve problems in the same way. Learners are often encouraged to think in absolute terms of right and wrong, but the iterative nature of the process of designing lends itself to many right answers, some more 'right' than others depending on what one is trying to achieve (McCormick, 2004:23). It is therefore important for learners to study and practice the different parts of the design process to reinforce the link between problems and solutions (McCormick, 2004:23).

Dagan *et al.* (2003:41) summarised the different structures of the design process by identifying four types of models, namely: linear; cyclic; branching; and the forth model which was unnamed. As can be seen from the review of literature in this study, the linear model is not the best practice as learners need to interact with the design process in order to solve a specific problem (Leahy and Gaughran, 2007:52; Williams, 2000:382). The cyclic and branching models allow learners to interact with the iterative nature of the activities of the design process.

5.3.2 Objective two: To determine whether teachers can identify the design process

This study concluded that although teachers can identify the different stages in the design process, they do not see the design process holistically but focus more on the end product which indicates their lack of procedural and conceptual knowledge. This study also found that the teachers cannot identify all the different activities that need to be done in each stage of the process. The different activities in each stage are contained in the assessment standards of the learning outcome but because the teachers do not know the assessment standards, they do not know which skills and knowledge the learners need to achieve during the design process.

According to McCormick *et al*. (1994:7) when viewed as a problem solving process, the design process requires expertise in the context of its application. They state further that teaching general problem solving skills ignores the procedural and conceptual understanding of the design process as each design problem requires specific knowledge. Learners engaged in design need to understand both the "how's" (procedural) and the "whys" (conceptual) of the design issue at hand (Lewis, 1997:45). Both procedural and conceptual knowledge need to be present as one depends on the other. The design of the product (i.e. materials and structure) is determined by the learner's understanding of the proposed function of the product and is contingent upon the design problem at hand as the knowledge demands between each design problem differs (McCormick *et al*., 1994:7). They add that due to the imbalance of understanding between procedural and conceptual concepts, learners fail to experience the aspects of the design process holistically. The learners need to use their existing knowledge to develop new knowledge in a constructive way and in teaching TE these two types of knowledge cannot be separated (Van Niekerk, Ankiewicz and De Swardt, 2005:2).

5.3.3 Objective three: To investigate the methods used by teachers' in the implementation of the design process in their classroom

The findings of this study suggest that teachers use a structural approach and therefore teach the design process in a linear way. For learners to gain more skills in problem solving, teachers need to change from a structural approach to a functional approach. There should also be a balance between cognitive and practical activities, as problem solving in the real world needs both these skills.

Dagan *et al.* (2002:255) identify two main methodological approaches for teaching the problem solving process, namely: the structural (stage-by-stage) approach, and the functional approach. Learning in the structural approach to the design process takes place in a more ordered way. They add that different models (differing from each other mainly by the number of stages into which the process is divided) were developed all over the world as a tool for teaching the design process where learning takes place in a linear manner by gradually going from one step to the other. This they feel, might restrict the creativity of the learners. In the functional approach, learning takes place by studying the design functions rather than following the stages of problem identification and definition, investigation, decision making, planning, making and evaluation. Learners may use more than one of the design functions as this allows more flexibility and follows the cyclic and branching model. In the functional approach the learners use a way that best matches the problem, the situation, and their own personal style (Dagan *et al.,* 2002:255).

Most teachers use the project-based process but focus more on the end product than on skills gained during the process. In South Africa, according to the Department of Education (DoE, 2002), the approach to the teaching and learning of TE should be ‘project-based’ and ‘hands-on’. Project-based learning promotes technological literacy (Frank, 2005:12). Learners, who engage in project-based learning, engage in active learning and gain multidisciplinary knowledge which includes knowledge of investigation. This leads to valuable research skills, design, problem solving, and decision making activities. Learners can either work in groups or as individuals to come up with ideas and real-world solutions to problems. The project-based approach centres on the learners as they must organise their work and manage their own time. This approach increases self-confidence and motivation to study and therefore develops long-term learning skills (Hill and Smith, 1998:8; Norman and Schmidt, 2000:723). During the design process learners need to analyse their product as they become despondent if their product does not work and they do not know how to correct the mistakes. They must therefore be able to identify the advantages and shortcomings to be able to make changes and by so doing create a better solution.

In the constructivist classroom, the teacher acts as a facilitator helping the learner to become an active participant in their learning and to make meaningful connections between their prior knowledge, new knowledge and the process involved in learning (Van Wyk, 2007:3). The teaching of knowledge, skills, values and attitudes are the main focus of the NCS which will enable the learner to adjust to a rapidly changing technological world as well as for the world of work (DoE, 2002). The skills addressed in TE are primarily to help learners to become creative and critical problem solvers. The design process in TE forms the guideline to help in solving the problems given by the teacher.

According to Leahy and Gaughran (2007:390) the design process consists of both cognitive and practical activities and because teaching is a complex activity this needs to be taken into consideration when looking at the practical implementation of the design process. No two teachers teach in the same way, nor do all learners learn in the same way but the TE teacher can control the conditions under which successful learning can take place (Spady, 1994:9). Leahy and Gaughran (2007:390) suggest that a deeper understanding is required of what the design process is, how it works, and how learners and teachers can make it work for them. Learners, whose learning styles are compatible with the teaching style of a teacher, tend to retain information longer, apply it more effectively, and have a more positive attitude toward the subject (Felder, 1993:110; Seery, Gaughran and Waldmann, 2003:332). The teacher therefore needs to acknowledge each learner's preferential learning style, whether it is by reading, listening, hearing or doing, which will increase learning and understanding. It is therefore important for the TE teacher to use different teaching and assessment strategies and techniques in the classroom to accommodate learners to achieve a certain level of success (DoE, 2002).

Secondary objective

5.3.4 Training of teachers on the CAPS document

Findings in this study suggest that training during the implementation of the NCS was not successful as it did not fully prepare teachers for teaching TE in the classroom. It was also evident that teachers lack content and pedagogical knowledge.

Spady (2008:9) states that in conventional educational practice across the world 'content is king' which means that the education system is arranged around content the teacher wants the learner to remember and understand. With OBE the focus is less on content and more on competence, skills and application. Due to the unique nature of the NCS (and from 2012, CAPS) in the GET band and the OBE teaching approach, qualified teachers will have to be retrained. During the training programme, teachers will need to be equipped with pedagogical and content knowledge to be able to implement the CAPS in the classroom (Mishra and Koehler, 2006; Shulman, 1986). Banks, Leach and Moon (1999:95) add another dimension to content and pedagogical knowledge, namely context of the school. They state that a teacher's subject knowledge is transformed by his or her own pedagogy in practice and by the resources which form part of the school knowledge, context or the situation in which the teacher is situated. Teacher-training providers will thus have to adapt their training programmes to the demands (content, pedagogic and adaption to context of schools) if they want to train teachers who can practice successfully within the education dispensation.

Darling-Hammond (2006:80) states that successful teacher education programmes need to be planned very carefully. They explain that these programmes should conceptualise the knowledge base for teacher education by involving a set of ideas about 'what' teachers need to learn (content and preparation) and 'how' they need to learn, that is, the process of developing useful knowledge must be enacted in ways that respond to the complexity of the classroom. In their study Darling-Hammond (2006:80) identified eight characteristics of what they consider to be new conceptualisations of knowledge for teaching in a constructivist way. These are: understanding of learners and learning for making sound teaching decisions; understanding subject content and subject related pedagogy; understand the design of the curriculum; see learners, subject content and curriculum as existing in a social-cultural context; see assessment and feedback as an important process for learners and teachers; develop teachers as reflective decision makers; and see teaching as a collaborative activity conducted within a professional community that feeds on-going teacher learning (Darling-Hammond, 2006:81-82).

The above means that thorough training needs to be done which must go far beyond just a few days orientation programme (Prinsloo and Janks, 2003:36). During training, teachers must be engaged in similar active learning processes that learners experience in the classroom. Loughran (2006:42) agrees that during teacher training the teachers need to not only model or demonstrate a lesson but they need to be engaged in learning to value knowledge, skills and abilities which are found in good teaching.

5.4 RECOMMENDATIONS

From a constructivist perspective, the responsibility of the teacher is to create and maintain a collaborative problem solving environment for the learners where they are allowed to construct their own knowledge under the guidance of the teacher. The NCS curriculum for South African schools moves away from a teacher-centred to a learner-centred approach. To ensure that the learning outcomes set out in the NCS curriculum for TE are achieved, the TE teacher will have to consider different teaching strategies and methods. By using new strategies and methods, the teacher can ensure that effective teaching and learning takes place to develop technologically literate, knowledgeable and skilled learners who will become life-long learners. This can be achieved by training teachers to be fully prepared with content and pedagogical knowledge. Teachers need a change in mindset when teaching the design process. They need to be a more open-minded and creative, and should not teach all learners to solve a problem in the same way.

Recommendations regarding the primary and secondary objectives arising out of the findings of this study are made with reference to: teaching the design process in the classroom; teacher training; assessment in TE; and resources needed for the implementation of TE.

5.4.1 Teaching the design process in the classroom

In grades 4 and 5 in the intermediate phase, learners must understand what needs to be done in each activity of the design process. This will allow them to be more creative and critical in solving a problem from grade 6.

The cyclic or branching model must be used to solve problems. The design process must start with the problem context and end with reflecting (communication) on the artifact they developed to solve the problem. The learners must be allowed to be creative between the problem context and communication stages and use the activities in between these two points as they feel comfortable in doing. The important part is interaction between activities and that they must evaluate each activity to stay focused on the problem to be solved as illustrated in the CAPS document and shown in Figure 5.1 (below).

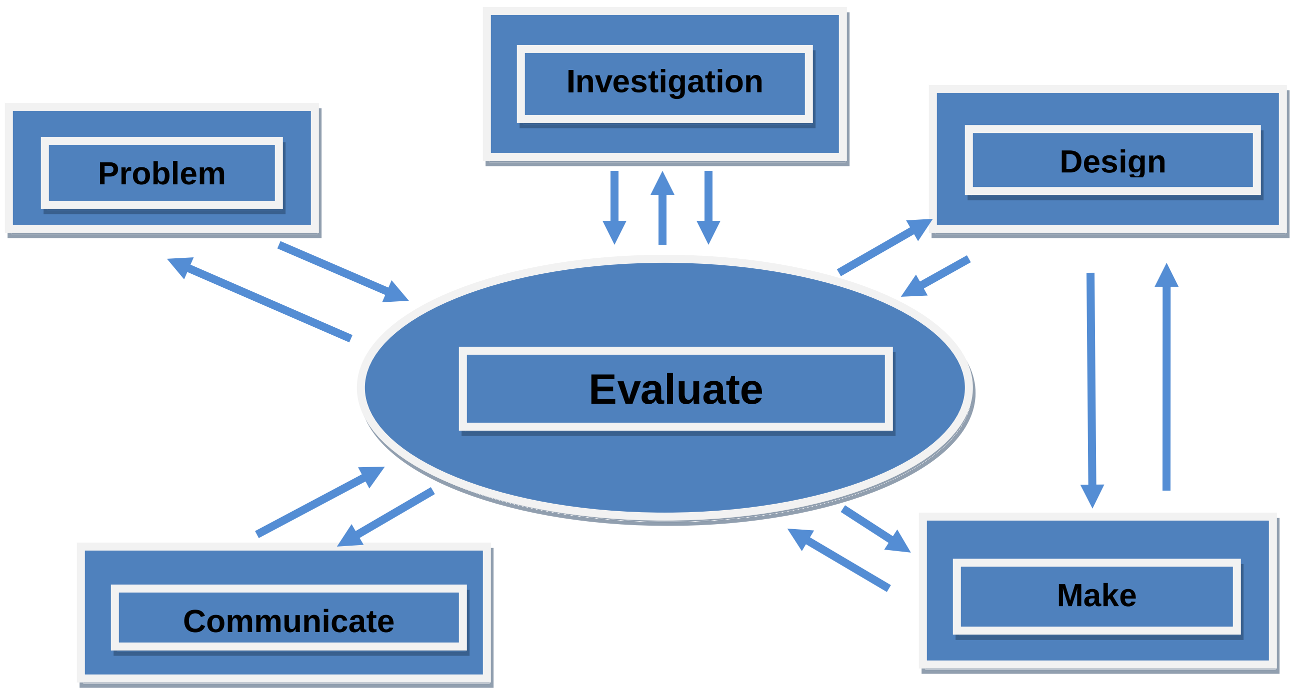

Figure 5.1: Design Process in CAPS document (DBE, 2010)

5.4.2 Teacher training

Higher education institutions (HEIs) should develop their courses or programmes not only around knowledge, but should focus strongly on methodology. The practical nature of TE and teaching in general is often portrayed by HEIs as a passive, knowledge orientated process. The training will have to include practical skills needed in making products to solve the problem as well as assessment. Teachers must become learners again and be subjected to what is expected from learners, only then can successful teaching be achieved.

The training must promote creative, critical and higher-order thinking skills. English must be the only medium of instruction during the training to improve the teachers' language ability to teach learners in the classroom as learners need to write their TE paper in English at the end of grade 9. As this study did not investigate medium of instruction in teaching TE, the advantages and disadvantages of teaching in English in a multilingual classroom are not discussed.

The DoE needs to provide in-depth training for teachers, that is, it must be more than just an orientation on the CAPS document. The researcher suggests that in order to train teachers effectively, they should to be taken out of the classroom for one week per term so that they can be trained on content and methodology needed for the next term. The researcher acknowledges that this may be problematic in schools as learners will be without teachers, but this problem may be overcome by prior planning. Work should be given to the learners to complete in the absence of their teacher. At the moment most teachers are not capacitated which leads to poor teaching in the classroom. The DoE must therefore prioritise proper training of TE teachers to ensure that teachers are equipped with the necessary skills. The DoE must budget carefully to ensure that in-depth training is provided to all TE teachers. They must also make sure that trained teachers continue to teach the subjects they were trained in so that expertise is maintained and learners benefit from specialized knowledge in TE.

5.4.3 Assessment

Teachers need to set assessment tasks that promote and stimulate learning. Assessment tasks must be set in such a way that it makes provision for learners with different learning styles and cognitive levels (Spady, 1994:9). When setting a problem solving task, the topic must be of such a nature that it captures the interest of the learners. The context of the problem must be set in a real world situation which will depend on the context of the school.

Following an assessment, prompt feedback must be given to learners in order to support current and future learning (Lombard, 2008:1040). Learners need to know where they went wrong and how to correct it to ensure that they do not make the same mistakes again. This will also enable them to build on their knowledge for future learning.

Analysis of the assessment results will enable teachers to reflect on their own teaching which will tell them if their teaching was successful or if they have to re-teach a concept.

5.4.4 Resources

Resources are integral to the success of any programme and may be divided into: human and physical resources (equipment and consumables).

5.4.4.1 Human resources

The DoE must ensure that only competent subject advisors are appointed as district officials. The subject advisors are there to support the teachers in the classroom and to mentor the inexperienced teachers; they therefore need to have the necessary skills and knowledge to do so. Given the current situation of an insufficient number of subject advisors, the DoE needs to appoint more subject advisors per district to ensure adequate support for teachers.

5.4.4.2 Physical resources

Funds must be available from national and provincial level to equip schools with the necessary tools, equipment and consumables to maximise learning. In the new CAPS document, 70% of the term mark in the senior phase is allocated to a practical assessment task. If schools are not resourced with equipment they will not be able to perform these practical assessment tasks. It goes without saying that security must also be provided to ensure safety of these physical resources.

5.5 LESSONS LEARNED

Informed by the findings of this study, the researcher gained valuable insight into teachers' understanding and implementation of TE in the classroom and teaching in general. Firstly, to achieve successful teaching in TE, the level of teacher training needs to be revised. As seen from the data analysis, teachers do not have the necessary skills, knowledge and pedagogical understanding to implement TE in the classroom.

Valuable lessons were also learned for the structuring of training programmes for teachers in TE. Findings of this study suggest that training of TE teachers must include skills, method, and content knowledge and must simulate real classroom situations so that they understand their learners' experience. As Shulman (2004) said, pedagogical content knowledge means knowing how to adapt learning content, teaching strategies and contextual resources to effective quality learning. Orientation only for the implementation of the CAPS document will not suffice; content and methodology will need to be included to help teachers with successful implementation in the classroom. The researcher will certainly draw on the findings of this study when structuring training for teachers from 2012.

The researcher gained insight into teachers' understanding and therefore their interpretation and implementation of relevant policy documents. There was no standardised implementation in the classroom because TE as a subject started before the teachers were trained in 1998 and teachers had to interpret the policy document on their own. Their perception of policy was different from that of the policymakers and differed even from one teacher to the next. As TE is a new subject and teachers are not adequately trained, this led to negative attitudes because teachers do not know how to teach the subject. The fact that very little research has been done on implementation of the design process in the South African context has also led to different interpretations and implementation of the design process from one school to the next.

5.6 SOME LIMITATIONS OF THE STUDY

While this study recommends that training for teachers be conducted in English in a bid to improve their communicative ability in the language, it also acknowledges that teachers and learners in the classrooms come from diverse language backgrounds. Many questions remain to be answered and need to be investigated further regarding the training of TE teachers in indigenous languages. The benefit of studying TE in their mother-tongue for learners is an area that requires much needed investigation.

For the purpose of this study, the sample was drawn from TE teachers who attended a TE workshop held by the TASA and the DoE on 5 June 2010. This was done because the researcher had access to this workshop and it was an ideal opportunity to have so many teachers teaching TE in the same place at one time. The researcher also wanted to ensure that the sample consisted of teachers implementing TE in their respective schools. The study was therefore limited in terms of the population and the geographical location (KwaZulu-Natal). Any significant results emerging from this study may therefore not reflect the situation at all schools regarding TE, but will undoubtedly prove useful in beginning to understand and address the needs of teachers regarding TE.

5.7 IMPLICATION FOR FURTHER STUDIES

Arising from the limitations, further research in this area should include TE teachers who do not attend the TE workshops held by the TASA or the DoE. It would also be useful to assess and compare the performance of learners of teachers that do attend these workshops against those who do not.

Because of the limited research in TE and specifically in the implementation of the design process in South Africa, further research in the following areas could benefit TE:

- development of effective models for training teachers in TE;
- didactics and assessment of implementation of the design process;
- the influence of the context of the school on the successful implementation of TE; and
- the influence of English as a medium of instruction in teaching TE in a diverse classroom.

5.8 A FINAL WORD

The biggest challenge facing South Africa is our high unemployment rate. Technology as a learning area if managed and promoted positively has the potential to contribute to the development of necessary technological skills thereby reducing the number of job vacancies and unemployed people (Rambrij, 2006:120). The Education Ministers of the African Union (Sawahel, 2006:18) state that Science and Technology are the most important tools available for addressing challenges in development and poverty eradication and participation in the global economy. TE has the potential to change the way learners think by enabling them to solve problem situations in everyday life. As TE is a compulsory subject in South African schools, we have the means to create a better future for our children by developing learners to be technologically literate, creative and critical problem solvers. This can only be done if teachers understand the design process as an integrated process towards solving a problem and not as isolated steps towards making a product. Learners must be allowed to solve problems creatively and they should not be forced into a sequential or linear process. It is therefore important for teachers to focus their attention and efforts on the desired result of education, results that are expressed in terms of individual learner learning (Killen, 2000:2) because as Spady (1994) says not all learners learn in the same way.

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APPENDIX A

QUESTIONNAIRE

14 April 2010

Dear Participant,

I am studying towards an M.-Tech- Degree in Language Practice at the Durban University of Technology. The title of my research is: Technology Education: Teachers' understanding of the design process and how it informs teaching practice in the General Education and Training Band in KwaZulu-Natal.

Kindly assist me by completing the attached questionnaire which will enable me to gather data for my research. The information you provide will be kept strictly confidential. Please be assured that you will remain completely anonymous in any reporting or write-up related to my research.

Please read and sign the attached Consent Form. Please return the Consent Form and completed questionnaire to Ria de Jager at the address below.

Thank you very much.

____

Ria de Jager
Student no. 20927232
46 Winchelsea Avenue
Bluff
4052

____

Prof. P Singh (PhD)
Research Supervisor

Questionnaire

Please answer all the questions. Extra paper is added at the back of the questionnaire if you want to write more than the space allows.

Please provide your biographical details below. Please be assured that only the researcher and research supervisor will know your identity. These details are required to enable follow-up interviews to be scheduled.

Biographical details:

1. Name and Surname:

   ____

2. School name:

   ____

3. District in which you teach: ____________________________

4. How would you like me to contact you? Please tick the appropriate block:

Cell phone		E-mail		Other	
Cell no.		**e-mail address**		**Telephone no.**	

5. What is your age? Please tick the appropriate block:

20 - 25 years		26 – 30 years		31 – 35 years	

36 – 40 years		41 – 45 years		Over 46 years	

Background information:

6. Please complete the following table regarding your qualification/s:

	Tertiary Education Qualifications e.g. B.Ed., STD	**Institution where qualification was received**	**Area of specialisation (E.g. Technology, Science, Mathematics, Language etc.)**
1			
2			
3			
4			

7. Are you employed by: (Please tick the correct block)

Department of Education		School Governing Body		Other	

7.1 If other, please explain:

____

8. Is your employment:

Permanent		Temporary	

9. How many years of experience do you have in teaching Technology? Please tick the appropriate block:

0-1 year		2-4 years		5-6 years		7-9 years		10 years and more	

10. In which **Phase/s** do/did you teach Technology? Please tick the appropriate block. You may tick more than one block:

Foundation Phase		Intermediate Phase		Senior Phase	

11. Which of the following **contexts** apply to your school? Please tick the appropriate block:

Rural		Township		City	
Independent		Ex Model C		Other	

11.1 If other, please explain:

____

12. In which post level are you at your school?

Teacher		HOD		Deputy principal		Principal		Other	

12.1 If **other**, please explain

____

National Curriculum Statement (NCS) – General

13. Did you receive any NCS training? ______________

13.1 Tick the block/s indicating when you attended your general NCS training. You may tick more than one block.

NCS Foundation Phase - 2003		NCS Grade 4-6 - 2004		NCS Grade 7 - 2005	
NCS Grade 8 and 9 - 2006		Maths, Science and Technology rollout programme in 2008		Other Please specify:	

13.2 How well did the NCS workshop/s equip you for teaching in the classroom? Please tick the appropriate block to indicate the effectiveness of the training on the scale below.

1 = Very well		2 = Well		3 = No difference		4 = Poor		5 = Very poor	

National Curriculum Statement (NCS) – Specific Technology

14. Did you receive any Technology Learning Area training ______________

14.1 If you answered yes in 14, tick the block/s indicating where and when you attended your NCS: Technology Learning Area training. You may tick more than one block.

NCS Grade 7 – 2005		NCS Grades 8 and 9 - 2006	
ORT in Umlazi		RNE training	
Technology Association Saturday Workshops		Technology Association Provincial Conferences	
Maths, Science and Technology Rollout Programme in 2008		Training of Lead Teachers in 2007	
ENGEN Short Course		District Workshops	
Technology Association National Conferences		International Conferences	
ACE Course		Other Please specify:	

14.2 How well did the NCS workshops equip you for teaching in the classroom? Please tick the appropriate block to indicate the effectiveness of the training on the scale below.

6 = Very well		7 = Well		8 = No difference		9 = Poor		10 = Very poor	

15 Please complete the table below regarding the General Education and Training Band (GET). How well do you understand the following aspects of the Technology Learning Area Policy document?

Aspects and policies	**Very well**	**Well**	**Fairly well**	**Not at all**	**Comments**
Learning Outcomes of Technology					
Assessment Standards of Technology					

15.1 Which Learning Outcome in the Technology curriculum would you say is the most important?

____

15.2 Please give reasons for your answer in 15.1: ____________________

____

____

____

16 Learning Outcome 1 in the Technology Learning Area addresses all the aspects of the Design Process also called the Technological Process. Teachers can implement this process in different ways. The following are different ways in which the process is generally implemented:

- A linear process – always starting at investigation, design, make, evaluate and ending with communication.
- A cyclical process – always interacting with the next or previous step
- A process which can start at any point of the Design Process

16.1 Which one of the above processes do you use in your classroom? ____

16.2 Please explain your preference in 16.1 above. ______________________

____

____

____

17 The Design Process was added when the new curriculum was designed.

17.1 Do you think the Design Process benefits learners?

Yes	OR	No

17.2 Please explain your answer in 17.1.

____

____

____

____

____

18 The steps of the design process are: investigation, design, making or manufacturing, evaluation and communication.

Please explain how you will use the project below to teach each of the steps in the Design Process in your classroom?

The Project:

Informal traders wish to cash in on the foreign trade that is about to hit our shores. The schools Technology department wants to be part of the activities by designing possible ideas of things they could make with wire or metal that could be sold to the tourists.

Task:

Design and make a symbolic curio for the world cup tourist trade.

Specifications:

The product must be:

- safe for children to use
- be made from wire or metal
- made from safe recyclable material

- be proudly South African
- symbolise the world cup

Constraints:

No part of the product should be more than 150mm wide.

Investigation:

Design:

Making or manufacturing:

Evaluation:

Communication:

19. When you are teaching Technology, do you:

19.1 Teach one Learning Outcome at a time:

Yes ☐ No ☐

OR

19.2 Integrate two or all three Learning Outcomes at the same time:

Yes ☐ No ☐

19.3 Please explain the why you teach the Learning Outcomes in the above way.

20. One of the reasons behind the development of the new curriculum was to develop critical, creative and innovative thinkers as well as problem solvers.

What is your opinion: Do you think that the design process in the present Technology curriculum succeeds in the intended aims to develop learners as indicated below? Please tick the appropriate block for your rating and explain your answer.

Development of:	**Very well**	**Well**	**Fairly**	**Poor**	**Very poor**	**Please give a reason for your answer.**
Critical thinkers						
Creative thinkers						
Innovative thinkers						
Problem solvers						

21 Please answer the following questions that pertain to assessment of the Design Process.

21.1 When assessing the design process, do you: (Please tick one or more of these responses)

Do you?	**Always**	**Some times**	**Not at all**	**Please explain your answer**
Assess each step of the design process separately?				

Use a project portfolio?				
Give a general impression mark?				
Base your mark on an assessment of the end product?				
Assess according to set criteria on the marking memorandum?				
Allocate the same weighting to all the steps?				
Use the complete design process as the summative assessment task for the term?				
Assess Learning Outcome 2 and 3 at the same time?				

21.2 How do you assess the design process? (Please tick one or more of these responses).

How do you assess?	Always	Sometimes	Not at all	Please explain
Analytical rubric – integrating all the Learning Outcomes				

Checklist				
Scoring rubric				
General impression mark				
Other: please explain				

Thank you very much for taking the time to complete the questionnaire

APPENDIX B

LETTER OF INFORMED CONSENT

LETTER OF CONSENT

Dear Participant

Thank you for agreeing to participate in this research study entitled: *Technology Education: Teachers' understanding and implementations of the design process in the GET band in KwaZulu-Natal.*

This study will investigate teachers' understandings and their implementation of the design process as it relates to teaching Technology Education in the Intermediate Phase (Grades 4 – 6) of the External Education and Training (GET) band in KwaZulu-Natal. It is hoped that the findings of this research will benefit the future training of teachers in Technology KwaZulu-Natal as well as in other provinces. It is also hoped that the findings of this study will give teachers, learners, parents and other educations specialist an insight into the perception of teachers' understandings and pedagogy of the design process as it relates to Technology Education in the General Education and Training (GET) Band.

The researcher undertakes to assure you of the following:

- to maintain your confidentiality
- to protect your rights and welfare, i.e. to ensure that no harm comes to you as a result of your participation in this research;
- to present information and transcripts used in this research in such a way as to maintain your dignity, and if in doubt to first consult with you; and
- to make available to you the final copy of this research publication

No manipulation or withholding of information is involved in this study. You are free to withdraw from this research process at any time, if the need should arise.

It is hoped that education at large will benefit from your understanding and implementation of the design process. Thank you for volunteering to add to a body of academic knowledge. Your participation in this study is appreciated.

Yours sincerely

____

M.L.E. de Jager
M.Tech: Language Practice
Student No: 20927232

I, __________________________ (participant's name), agree to participate in this study.

____________________________ ____________________

Participant's signature Date

APPENDIX C

PERMISSION BY THE DEPARTMENT OF EDUCATION

PROVINCE OF KWAZULU NATAL
ISIFUNDAZWE SAKWAZULU NATALI
PROVINSIE KWAZULU NATAL

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO
DEPARTEMENT VAN ONDERWYS

Tel.: 033 341 8611
Fax: 033 341 8612

Private Bag X9137
Pietermaritzburg
3200

228 Pietermaritz Street
Pietermaritzburg 3201

INHLOKOHHOVISI PIETERMARITZBURG HEAD OFFICE

Enquiries: Imibuzo: M. Francis Navrae:	Reference: Inkomba: 0201/06 Verwysing:	Date: Usuku: 31/10/2006 Datum:

RE: PERMISSION TO CONDUCT RESEARCH

TO WHOM IT MAY CONCERN:

This is to serve as notice that MLE De Jager has been granted permission to conduct research with the following terms and conditions:

- That as a researcher, he/she must present a copy of written permission from the Department to the Head of the Institution concerned before any research may be undertaken at a a departmental institution.
- She/he has been granted permission to conduct reasearch in schools, in the greater Durban area. It must be noted that the schools are not obligated to participate in the research if it is not a KZNDoE project.
- MLE De Jager has been granted permission to conduct his/her research during official contact times, as it is believed that their presence would not interrupt education programmes. Should education be interrupted, he/she must, therefore, conduct his/her research during non-official contact times.
- No school is expected to participate in the research during the fourth school term, as it is the critical period for schools to focus on their exams.

[redacted]

for SUPERINTENDENT GENERAL
KwaZulu Natal Department of Education