THE ROLE OF TECHNOLOGY TEACHERS' KNOWLEDGE IN PROMOTING GRADE 7 LEARNERS' HIGHER ORDER THINKING SKILLS IN JOHANNESBURG WEST DISTRICT OF GAUTENG PROVINCE

BY

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I declare that **THE ROLE OF TECHNOLOGY TEACHERS' KNOWLEDGE IN PROMOTING GRADE 7 LEARNERS' HIGHER ORDER THINKING SKILLS IN JOHANNESBURG WEST DISTRICT OF GAUTENG PROVINCE** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE DATE

(MR R MALULEKE)

ABSTRACT

The aim of this study was to investigate the role of Technology teachers' knowledge in promoting learners' higher order thinking skills. This aim was addressed by conducting the relevant literature survey and an empirical investigation. Four schools were selected in the Johannesburg West District. Here, twelve Grade 7 Technology teachers, three from each school, were interviewed and observations conducted. The data was analysed and findings presented ultimately. The findings reveal that Technology teachers who possess a greater depth of technological content knowledge, pedagogical knowledge and assessment knowledge are more effective in as far as promoting learners' higher order thinking. On the other hand, Technology teachers who possess a shallow technological content knowledge, pedagogical knowledge and assessment knowledge struggle to promote learners' higher order thinking. The main conclusions drawn from this study are that Technology teachers' knowledge can play a role in learners' acquisition of higher order thinking skills. Therefore, Technology teachers should acquire a sound technological knowledge in order to be able to promote learners' acquisition of higher order thinking skills.

Key terms: Technology Education, Thinking skills, Creative thinking, Critical thinking, Higher order thinking, Teacher knowledge, Pedagogical knowledge, Assessment knowledge, Content knowledge, Conceptual knowledge, Procedural knowledge.

DEDICATION

This study is dedicated to my late father, Freddy Risenga Maluleke, for instilling within me a culture of hard work. I am a responsible and dedicated man because of his teachings. I pray that the Almighty God will assist me to cherish the mantle I received from my father and enable me to pass it to my children.

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*The true worth of a researcher lies in pursuing what he did not seek in his experiment as well as what he sought (**Claude Bernard, 1813-1878).***

*We only think when we are confronted with problems (**John Dewy, 1859-1952).***

*Man is an invention of recent date (**Michael Foucault, 1926-1984).***

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CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Since the inception of a democratic government in South Africa, the country has been trying to find effective ways of promoting higher order thinking in teaching and learning to produce critical and creative thinking skills in learners. According to Hoadley and Jansen (2010:239), the Department of Education has been struggling to construct a curriculum that can enhance a higher level of skills and knowledge. Gauteng Department of Education (2010:8) however points out that Mathematics, Science and Technology Education in South Africa have been in an ongoing state of crisis since the introduction of Bantu Education in 1953. City Press (2011:30) further asserts that our learners do not perform well in our country because teachers do not set high enough standards and do not teach the technological strands in depth.

According to Jones and Moreland (2004:122), Technology Education is concerned with developing student technological literacy through exploration and solving of complex and interrelated technological problems that involve multiple conceptual, procedural, societal and technical variables. Therefore, Technology Education can be an effective vehicle for promoting and teaching learners' higher order thinking in order to develop their critical and creative thinking skills.

There are however many factors that can influence the teaching and learning of higher order thinking skills. Some of the factors are subject knowledge, curriculum knowledge and assessment knowledge. Borko and Putnam as cited by Ertmer and Ottenbreit-Leftwich (2009:3) state that teachers' thinking is directly influenced by their knowledge and their thinking in turn determines their actions in the classroom. According to Evans (2007:424), content knowledge that a teacher brings to the classroom has a major influence on learning.

The development of teachers' Technology knowledge may help to improve the performance of learners in Technology. Ankiewicz, De Swardt and Engelbrecht (2005:1) state that in Technology there is a distinction between conceptual and procedural knowledge. Ankiewicz et al. (2005:1) further state that conceptual knowledge is knowledge of a physical nature and functional nature, while procedural knowledge is demonstrated when a task is performed. According to Ankiewicz et al. (2005:1), conceptual knowledge and procedural knowledge cannot be separated in the teaching and learning of Technology. Therefore, Technology teachers should possess conceptual and procedural knowledge in order to be effective in their teaching and those teachers who do not possess these skills will not be able to teach Technology in depth.

Technology is one of the new learning areas introduced as part of Curriculum 2005. It can play a significant role in equipping learners to become productive future citizens. In the senior phase Technology is still retained as one of the learning areas in the new Curriculum Assessment Policy Statement (CAPS). It is retained because it can play a significant role in promoting higher order thinking skills. According to Hofmyr (2010:10), the Outcomes Based Education (OBE) as a framework for education and training in South Africa has not changed in the Revised National Curriculum Statement (RNCS). The core values of OBE are still embedded in the new CAPS.

According to Van Niekerk, Ankiewicz and De Swardt (2005:3), all the changes in the national and provincial policies caused a shift away from the traditional ways of evaluation to assessment. According to Hofmyr (2010:17), the new CAPS curriculum is user-friendly, but its success depends heavily on the competence of teachers. Hofmyr (2010:17) continues to state that teachers' subject knowledge can play an influential role in implementing CAPS. Technology teachers should consequently acquire content knowledge in order to be able to implement the new curriculum effectively in order to assist their learners to acquire technological concepts and processes. The repercussions of not acquiring this knowledge may lead Technology teachers to continue to use traditional methods of teaching and assessing learners.

According to Gelven and Stewart (2001:4), employers and teachers are generally in agreement that learners need to increase their problem solving and critical thinking skills. They believe that students must be taught to acquire higher order thinking skills. Scott and Koch (2010:18) point out that technological problem solving involves higher order thinking and that it is a critical survival skill in today's progressive work environment. The authors further state that government, business, vocational and Technology Education leaders have increasingly called for more emphasis in the classroom on higher order thinking skills (Scott and Koch, 2010:18).

One of the major aims of transformation in the South African education system following the 1994 elections was the development of learners' cognitive processes. According to Department of Basic Education (2011:3), the National Curriculum Statement Grade R-12 is based on the principles that expect high knowledge and high skills to be achieved at each grade. Technology Education can play a pivotal role in assisting learners to acquire higher order thinking skills. Gauteng Department of Education (2010:9) claims that Gauteng continues to strive for a major improvement in the quality of Technology teaching and learning, and achievement in its schools in order to ensure the development of the higher order thinking skills.

1.2 RESEARCH PROBLEM

In terms of the exploration of the problem presented in the Introduction, the following research problem can be stated:

What is the role that Technology teachers' knowledge can contribute to teaching and learning of Technology in Grade 7 in Johannesburg West District (D12)? From this main question the following sub-questions emerge:

- What role does the Technology teachers' subject matter knowledge play in Grade 7 learners' acquisition of higher order thinking skills?

- What role does the Technology teachers' pedagogical knowledge play in Grade 7 learners' acquisition of higher order thinking skills?
- What role does the Technology teachers' assessment knowledge play in Grade 7 learners' acquisition of higher order thinking skills?

1.3 AIMS OF THE STUDY

The purpose of this study is to investigate the role of Technology teachers' knowledge in promoting learners' higher order thinking skills when solving technological problems. The secondary aims are as follows:

- To establish the role that the Technology teachers' subject matter knowledge play in Grade 7 learners' acquisition of higher order thinking skills.
- To explore the role that the Technology teachers' pedagogical knowledge play in Grade 7 learners' acquisition of higher order thinking skills.
- To explore the role that the Technology teachers' assessment knowledge play in Grade 7 learners' acquisition of higher order thinking skills.

1.4 IMPORTANCE OF THE STUDY

Technology Education can play a major role in promoting the aspirations of the democratic government. One of the aspirations of the South African government is to produce creative and critical thinkers in order to have a prosperous country and therefore a good curriculum should be future oriented. All countries seek better ways of planning their curriculum in a way that can make learners marketable in the future. The South African curriculum is geared to help learners to acquire the higher order thinking skills that are highly needed in modern societies. According to De Swardt (1998:4), higher order thinking skills are integrated in modern curricula as they are the basis of growth in modern economies. The Department of Education (2004:6) states that the RNCS is aimed at developing high level of knowledge and skills for all South African learners. This study is relevant as it seeks to investigate how learners can be assisted to acquire high order thinking skills, in line with the aspirations of our democratic government.

According to the Financial Mail (2009:38), the South African new school curriculum is modern, more relevant and better than any curriculum South Africa ever had before. Financial Mail (2009:38) further claims that many educational experts believe that the new South African curriculum is relevant even though many people blame the curriculum for the deterioration of educational standards. This implies that teachers lack adequate knowledge that can enable them to implement the National Curriculum Statement (NCS) effectively. Although the RNCS is good for the country, most of the teachers unfortunately cannot comprehend and implement it successfully. The Financial Mail (2009:38) further substantiates this view by stating that there is not a lot of wrong with the curriculum itself, but that there is a lot wrong with the quality of how it is delivered in the classroom. This study seeks to investigate the role of Technology teachers' knowledge in higher order thinking skills in Technology and seeks to verify if the Technology teachers' knowledge can have an impact on learners acquiring higher order thinking skills.

1.5 RESEARCH METHODOLOGY

1.5.1 Literature review

In this study the researcher will consult different primary and secondary sources that address the research problem. Literature about the contribution of Technology teachers' knowledge in acquisition of higher order thinking skills includes primary sources such as theses, dissertations, conference reports and secondary sources, including books and educational journals. The findings from literature will be used to make recommendations that will assist Technology teachers in teaching learners to acquire higher order thinking skills.

1.5.2 Research design

According to McMillan and Schumacher (2010:20), a research design is a plan that describes the procedures for conducting the study and research plan includes when; from whom; and under what conditions the data will be collected. For this study, the researcher is going to apply a qualitative approach to collect data. According to Gall,

Gall and Borg (2005:15), a qualitative researcher applies a holistic observation approach to the total context within which a social action occurs. Here, the study will entail observing teachers and learners in their classes to investigate the roles of Technology teachers' knowledge in enhancing the acquisition of higher order thinking skills. The research group will be Grade 7 Technology teachers and learners from the Johannesburg West District, because the learners should have acquired all the expected basic knowledge and skills at primary school level. The Grade 7 learners are also in the first grade in the senior phase and the highest grade in the primary level. Therefore, the sample, in line with the study's research problem, will be drawn from this population of Grade 7 Technology teachers.

Strauss and Myburg (2005:71) describe a population as a collection of members to be investigated and a sample as the small group that is observed. Teachers will be sampled by using the purposeful sampling strategy. The choice of this sampling strategy is supported by Gall et al. (2005:310) who state that the goal of purposeful sampling is to select individuals for a case study who are likely to be information-rich with respect to the researcher's purpose.

According to Welman, Kruger and Mitchelle (2010:69), researchers rely on their experience, ingenuity and previous research findings to deliberately obtain units of analysis in such a manner that the sample they obtain may be regarded as being representative of the relevant population. The researcher will use a sample of four schools from Johannesburg West District (D12) due to the limited resources and time. Leedy and Ormrod (2005:206) state that purposive sampling is appropriate where people are chosen for a specific purpose. Here, Technology teachers were chosen for the sample of this study because they have firsthand experience of teaching and learning of Technology. The participants will be selected according to the study's purpose and resources. Patton in Nayagar (2002:27) states that the participants who are regarded as information-rich cases are those from which the researcher can learn more about issues central to the purpose of the research. The learners will only be observed as learning takes place.

1.5.3 Data collection method

According to McMillan and Schumacher (2010:8), research methods are methods used to collect and analyse data. In this study, the researcher will use individual qualitative interviews and observations to collect data.

Best and Kahn (1998:255), state that a researcher can conduct interviews to gather information about the individuals' experiences and knowledge. This study will use semi-structured interviews in order to determine the Technology teachers' knowledge and to encourage the participants to talk about what is important to them rather than discussing the researcher's view. According to Welman et al. (2010:166), in a semi-structured interview, the researcher has a list of themes and questions to be covered in the form of an interview guide. The researcher will use the interview guide approach in this study where topics and issues to be covered are specified in advance, in an outlined form (Best and Kahn, 1998:256). The interviewer decides sequence and wording of questions in the course of the interview. The interview guide approach will be very relevant as some teachers may need questions to be rephrased. As this study investigates the role that Technology teachers' knowledge can play in acquiring higher order thinking skills, the open-ended question is the most relevant type of interview. The participants will answer questions that will enable the researcher to determine levels of Technology teachers' knowledge.

The researcher will also use the observation technique to collect data. He will observe Technology teachers and learners in practice. Johnson and Christensen (2008:212) state that when the qualitative observation technique is used the researcher is the data collection instrument, because they decide what is important and what should be recorded. The researcher will observe the Technology teachers when they are teaching their learners to generate initial ideas for solving a technological problem, when they draw three labeled freehand sketches of the initial ideas and possible solutions for solving a technological problem. In addition, the researcher will observe the learners if the domain-specific basic knowledge and domain-specific design knowledge can help them in solving technological problems. Lastly, there will be an observation of the Technology teachers' application of different educational theories in accommodating different learners according to the multiple intelligences of the individual learners. The researcher will take notes and use observation checklists to record the information as the learning unfolds.

1.5.4 Data analysis

The qualitative data analysis will be applied to this study. Data collected through semi-structured interviews and observation will be analysed by using inductive analysis. McMillan and Schuman (2010:367) describe inductive analysis as "the process which qualitative researchers can synthesise and make meaning from data, starting with specific data and ending with categories and patterns". The researcher will use line by line coding where the responses will be coded and the codes that are similar will be grouped together to form different categories of data. The categories will be formed by using the recursive process and similar categories will be grouped together to form patterns. The researcher will provide detailed information on the data collection and analysis procedures in Chapters Three and Four of this mini dissertation.

1.5.5 Reliability and validity

The researcher will use different data collection techniques to ensure validity. McMillan and Schumacher (2010:330) point out that to ensure validity in qualitative research, the researchers can use a combination of possible strategies. This study will apply the following strategies: member checking; participant language and verbatim account; prolonged and persistent fieldwork; and mechanically recorded data to ensure that the instruments that are used can be accurate and reliable. The instruments that will be used must measure what they intend to measure. The instruments that the researcher will use must give similar data if repetition of the study is conducted. In order to ensure reliability and validity, the data will be collected mechanically so that it does not allow any distortion of the real data. Here, an audio tape recorder will be used to record the responses of the participants. The interviews will however only be recorded if the participants give their permission to do so. The interview questions will initially be piloted. The researcher will use a pilot sample of three Technology teachers to check the questions for ambiguity. Therefore, if required, the questions will be rephrased to ensure clarity in meaning.

1.6 ETHICAL CONSIDERATIONS

Permission was sought from the principals to conduct research in their respective schools (see Appendix C: Principals' consent letter for interview and observation). The permission letters were sent in advance to participants (see Appendix D: Teachers' consent letter for interview and observation). The researcher ensured that the participants' responses remain confidential. Here, researcher disclosed the reason for conducting this study and informed the participants about their rights before the study commenced. For example, the participants must know that they have a right to withdraw at any time should they wish to do so. Lastly, the participants' permission was requested for the audio tape recording of their responses.

1.7 CLARIFICATION OF KEY CONCEPTS

Here, several key concepts that apply to this study are defined. They are, namely, Technology Education, conceptual knowledge, thinking skill, higher order thinking skills, procedural knowledge and teacher knowledge.

1.7.1. Technology Education

Black (1998:1) states that Technology is a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems or environments. Black further elaborates, that knowledge, skills and resources are combined to help solve practical problems. According to Pudi (2011:37), Technology Education can be defined as a comprehensive experience-based educational programme that allows learners to investigate and experience the means by which people meet their needs and wants, solve problems and extend their capabilities. Technology Education is the means for teaching Technology.

1.7.2 Conceptual knowledge

According to Ankiewicz, De Swardt and De Vries (2006:120), conceptual knowledge relates to the links between knowledge items to such an extent that learners can identify these links. It consists of classifications, categories, principles, generalisations, theories, models and structures. The learners' conceptual knowledge can help them in choosing suitable materials that can be used to design a new product, which can solve a new problem.

1.7.3 Thinking skill

According to Gredo (1997:11), a skill is a specialised ability that culminates from training or practice. Therefore, a skill is a practical ability to doing something or succeeding in a task. According to Ankiewicz, De Swardt and Stark (2000:102), thinking skills are the mental operations that are used in combination to achieve a particular goal. The modern learners should learn to think as we live in an ever-changing world.

1.7.4 Higher order thinking skills

Gredo (1997:6) states that higher order thinking skills include critical, logical, reflective, meta-cognitive and creative thinking. According to Gredo (1997:11), higher order thinking skills occur when a person takes new information and uses the information stored in their memory to interrelate, rearrange and extend this information in order to solve a problem. This study seeks to establish how higher order thinking skills that can be acquired during the teaching and learning of Technology. Higher order thinking skills are essential for all Technology learners.

1.7.5 Procedural knowledge

Ankiewicz et al. (2006:120) state that procedural knowledge is frequently referred to as tacit, personal or implicit knowledge. Procedural knowledge is very important in Technology as it is knowledge of how to do things. The learner's procedural knowledge can help them in designing a new product, which can solve a new problem effectively.

1.7.6 Teacher knowledge

According to Rohaan, Taconis and Jochems (2010:17), teacher knowledge includes knowledge of subject, teaching methods, classroom management strategies and acknowledging how to teach specific content to specific learners within a specific context. This study seeks to establish if the teachers' knowledge can have an impact in acquiring higher order thinking skills.

1.8 LIMITATIONS OF THE STUDY

This study may be constrained by language due to the multiculturalism and multilingualism in the Johannesburg West District, Soweto. If learners do not have a firm understanding of English, which is used as medium of instruction, they may be reluctant to respond in this language. In this study the researcher will request the participant teachers to give learners latitude to respond in their own language if they opt to do so. The researcher will also try to clarify each question for all the research teachers who are the key research participants.

Gauteng Department of Education is only paying for the researcher's tuition fees and prescribed textbooks. This will restrict the researcher to rely on his own resources for data collection. Therefore, the financial constraint is one of his restrictions that will limit this research to only four schools.

1.9 CHAPTER DIVISION

This mini dissertation comprises of five chapters:

Chapter One: Orientation of the study

This chapter explores the research problem, provides the rationale for the study and specifically states the research problem. In this chapter, the researcher contextualised the study by giving reasons for the choice of the research methods. There is also validation given for the research area of conceptual knowledge and higher order thinking skills in learning.

Chapter Two: The role of Technology teachers' knowledge in promoting higher order thinking skills. The researcher contextualises the study by referring to relevant literature in accordance with the research question guiding the study.

Chapter Three: Research methodology

This chapter focuses on the research methodology for this empirical investigation. Here, research design and methodology that will be applied is further explained along with the effective methods to collect and analyse data. The researcher's application of methods to ensure validity and reliability of the study is also discussed.

Chapter Four: Analysis and interpretation of findings

This chapter will present the analysed and interpreted data.

Chapter Five: Research objectives, main findings, limitations and recommendations

In the final chapter of the study, the main findings will be summarised. The researcher will also discuss the limitations followed by the study's recommendations for further research and practice.

CHAPTER TWO

THE ROLE OF TECHNOLOGY TEACHERS' KNOWLEDGE IN PROMOTING HIGHER ORDER THINKING SKILLS

2.1 INTRODUCTION

This literature review provided an overview of the relationship between Technology teachers' knowledge and higher order thinking skills. It described how the existing theories can influence the acquisition of higher order thinking skills when teachers are teaching Technology in their schools. Included in this review is the role that Technology teachers' knowledge can play in promoting the acquisition of higher order thinking skills, together with pedagogical, content, assessment and technological knowledge, which is divided into conceptual and procedural knowledge. The review concluded with a discussion of the two higher order thinking skills, which are creative and critical thinking skills.

2.2 THEORETICAL FRAMEWORK

This study is informed by the socio-cultural theory and Bloom's Taxonomy. According to Woolfolk (2010:42), a major representative for socio-cultural theory was a Russian psychologist, Vygotsky. Socio-cultural theory advocates cooperative learning. According to Woolfolk (2010:42), the socio-cultural theory emphasises the development of cooperative dialogue between learners and more knowledgeable teachers. Cooperative learning assists both the teacher and the learner. While the Technology teachers can use this approach to promote higher order thinking skills, it also assists learners to acquire higher order thinking skills as learners are afforded an opportunity to help one another. In addition, Technology teachers who are competent in teaching Technology are able to supervise their learners as they cooperate in their groups in order to achieve the higher order thinking skills.

According to Fox-Turnbull (2007:8), technological activities are embedded in the made-world, which is influenced by social, cultural, environmental, economic and political influences. Fox-Turnbull (2007:8) elaborates further that when learners are given the opportunity to solve technological problems through the use of activities and practice, their knowledge and understanding of practices are likely to be stronger. Competent Technology teachers who understand that Technology is about minds-on and hands-on activities will always complement the minds-on activities with hands-on activities. Woolfolk (2010:42) draws on cooperative learning by stating that human activities take place in cultural settings and cannot be understood apart from the settings. Formal learning can occur in a cultural setting like a school or classroom. Higher order thinking skills can be achieved when learners interact with teachers and with one another. These social interactions are more than simple influences on cognitive development, as they actually create cognitive structures and thinking processes.

Constructivism can play a crucial role when learners acquire higher order thinking skills. Karagiorgi and Symeou (2005:18) state that according to constructivists, knowledge is being constructed by individuals. Thus, constructivist learning affords learners an opportunity to construct knowledge. According to Karagiori and Symeou (2005:19), the centre of instruction in accordance with constructivist theory is the learner. According to Kanselaar (2002:1), constructivism implies that learners are encouraged to construct their knowledge instead of copying it from an authority like a book or teacher. Meaningful understanding occurs when students develop effective ways to resolve problematic situations. Technology teachers who advocate constructivist theory can help their learners to attain a sound understanding and retain higher order thinking skills due to learners' involvement in constructing knowledge.

According to Kanselaar (2002:1), the central idea of constructivism is that human knowledge is constructed, that learners build new knowledge upon the foundation of previous learning. Murphy (1997:1) further states that constructivist teachers are able to use their knowledge to create real-world environments that employ the context in which learning is relevant. Competent Technology teachers are therefore able to create a thriving environment for the acquisition of higher order thinking skills. Murphy (1997:1) states that constructivist teachers must play a role of a coach and focus on realistic approaches to solving real problems. According to Kanselaar (2002:3), the constructivist teachers must also be able to accommodate multiple representations of reality and emphasise knowledge construction, as opposed to knowledge reproduction.

The Technology teachers must teach their learners that there are multiple realities and encourage them to use their higher order thinking skills to solve technological problems. According to Lunenburg (2011:7), constructivist teachers allow wait time after posing questions as some learners require more time to think about the posed questions. These teachers, who give their learners time to ruminate the posed questions, automatically inculcate higher order thinking skills. Notably, constructivist teachers encourage and accept learners' autonomy and initiative (Lunenburg, 2011:5). The Technology learners can be afforded an opportunity to formulate questions and answer them in order to inculcate higher order thinking skills like creative and critical thinking skills. Teachers who possess a sound knowledge of constructivist theory are therefore able to encourage the learners to take responsibility of their own learning (Lunenberg, 2011:6). This approach allows learners to drive lessons, shift instructional strategies and alter content. These teachers capitalise on the teachable moments throughout the school year.

An additional aspect of constructivist teaching is encouraging learners to engage in dialogue with the teacher and with one another (Lunenberg, 2011:6). These learners will be able to take bold steps in constructing new knowledge and participate in dialogue that will consequently inculcate creative and critical thinking skills. According to Fox-Turnbull (2007:10), a constructivist approach includes modeling and scaffolding that are integral to effective teaching and learning. Technology teachers may therefore use modeling and scaffolding to help their learners to acquire new technological skills. According to Hennessy, cited in Fox-Turnbull (2007:10), scaffolding is the process whereby teachers guide learners through an activity in a manner that gradually increases the confidence and competence of learners in solving technological problems.

Fox-Turnbull (2007:10) explains further that the expert teacher begins by modeling the effective strategies and techniques and may make explicit their tacit knowledge. The knowledgeable or competent Technology teacher is able to formulate a scenario and identify a problem in order to help learners to identify their own problems in other scenarios.

According to Starko (2010:13), contemporary theory acknowledges human learning to be more complex, which can be achieved by applying constructive processes. According to De Swardt, Ankiewicz and Engelbrecht (2005:3), instruction and learning are very complex processes that are influenced by many different variables such as learner's attitude, abilities, teacher's competencies and context. Learning is an activity which leads to the acquisition of knowledge, skills and values. Technology learners can construct knowledge when they interact with one another. Technology teachers can use constructive approach if they want to promote effective learning. According to Starko (2010:13), constructivism process implies that learners build their own knowledge.

In line with the constructivist approach, Technology learners must not depend completely on their teachers to provide them with technological knowledge. According to De Swardt et al. (2005:8), Technology teachers have to help learners construct their own knowledge, rather than simply supply information that they are expected to memorise. The Technology teachers who possess a vast knowledge of Technology are able to guide their learners to generate new ideas that can solve the identified problems. Higher order thinking skills can thrive when learners are allowed to think for themselves. According to Starko (2010:13), processes associated with this vision of learning are organising information, linking new information to prior knowledge and using meta-cognitive strategies to plan the accomplishment of goals.

Vygotsky, cited by Frank, Lavy and Elata (2003:274), states that learners construct knowledge or understanding as a result of thinking and doing within a social context. Learners can acquire higher order thinking skills when they are involved in solving real problems in their Technology classes. According to Frank et al. (2003:274), social construction suggests that learners learn concepts and construct meaning about ideas through their interaction with other learners, with their world and through interpretations of that world by actively constructing meaning. Teachers must always try to give learners activities that they can relate to from the point of view of what they know. For example, learners can be given a project to make school bags that they need to carry their school books. Therefore, the competent Technology teacher is able to give their learners a project that requires them to practice using their higher order thinking skills.

Starko (2010:13) states that in order to maintain the attention necessary to build in-depth understanding, learners must be engaged in activities that they perceive as interesting and relevant. Technology teachers must choose the topics which are interesting to learners so that they can participate actively, as Rately (cited by Starko, 2010:13) advises:

We always have the ability to remodel our brains. To change the wiring in one skill, you must engage in some activity but that is unfamiliar, novel to you but related to that skill, because simply repeating the same activity only maintains already established connections. To bolster his creative circuitry, Albert Einstein played the violin. Winston Churchill painted landscapes.

According to Woolfolk (2010:43), both Piaget and Vygotsky emphasised the importance of social interactions in cognitive development, even though their views were different. Piaget believed that interaction encouraged development by creating disequilibrium and that cognitive conflict motivated change. Therefore, Piaget believed that the most helpful interactions were those between peers, because peers are on an equal basis and can challenge each other’s thinking. He further believed that learners can learn better if they are given an opportunity to teach each other. Vygotsky, on the other hand, suggested that children’s cognitive development is fostered by interactions with people who are more capable and advanced in their thinking, like parents and teachers.

In accordance with Vygotsky's view that learners can learn better under the supervision of teachers, higher order thinking skills can be acquired under the guidance of competent teachers. Learners can brainstorm different ideas which they may use to solve a technological problem that they are grappling with. Fox-Turnbull (2007:11) points out that the use of a template is particularly useful when applying the scaffolding strategy within Technology Education. This can be used as a guide or a pattern that guides the user towards the achievement of consistent outcomes. According to Woolfolk (2010:43), Vygotsky assumed that:

Every function in a child's cultural development appears twice, first on the social level and later on the individual level; first between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relations between human individuals.

Vygotsky, cited by Woolfolk (2010:43), states that learners can start to learn by interacting with other people and then learning can start to take place mentally. Vygotsky believes that at any given point in the learning process there are certain problems that a child is on the verge of being able to solve. The child just needs some structure, clues, reminders and help with remembering details or steps and encouragement to keep trying. Some problems however, are beyond a child's capability even if every step is explained clearly.

These problems that are beyond a child's capability must be taught in the zone of proximal development in order for learners to comprehend. The zone of proximal development is the area between the child's current development level as determined by independent problem solving and the level of development that the child could achieve through adult guidance or in collaboration with more capable peers. It is a dynamic and changing space where the learner and teacher interact. According to Woolfolk (2010:43), this is the area called 'magic middle', where instruction can succeed. This area is somewhere between what the learners already know and what they are not ready to learn.

The zone of proximal development's scaffolding from the teacher or a peer can support learning. The Technology teachers must not teach things that can be boring or are very difficult to their learners, as this can discourage learners from acquiring higher order thinking skills. However, in order for Technology teachers to help their learners to acquire higher order thinking skills, they must teach them in their zone of proximal development.

According to Forrester (2008:102), Bloom's Taxonomy divides the way people learn into three educational objectives or overlapping domains of affective, psychomotor and cognitive. Krathwohl (2002:218) states that the taxonomy of educational objectives is a scheme for classifying educational goals, objectives and standards. The teachers' knowledge of cognitive domains, which deals with knowledge, can play a pivotal role in teaching and learning of Technology. These teachers must know the objectives for each lesson in advance before they present it to their learners. They must know the levels of Bloom's cognitive domain which they want to attain in their teaching. According to Mayer (2002:227), teachers should understand Bloom's Taxonomy in order to be able to teach and assess the degree to which students have learned some subject matter content and assess higher order thinking skills.

King, Godson and Rohani (1998:40) state that situations, skills and outcomes are the components that challenge the thinker to engage in higher order thinking. Therefore, Technology teachers should be able to create situations that will enhance higher order thinking skills in their learners. King et al. (1998:37) argue that situations like challenges, ambiguities, confusions, doubt, puzzles, questions, doubt, obstacles, dilemmas and uncertainties can compel learners to use their higher order thinking skills.

According to Moore and Stanley (2010:1), in order for teachers to be able to instill in their learners the ability to think at a higher level, they need to be able to understand, teach and apply creative thinking skills themselves. Therefore, Technology teachers must be able apply higher order thinking skills when they are teaching Technology.

Moore and Stanley (2010:2) point out that the bottom line is that it actually requires applying higher order thinking, in order to teach higher order thinking skills. Teachers who have not acquired higher order thinking skills are not able to instill higher order thinking skills in their learners. According to Moore and Stanley (2010:2), the better you understand the lower levels of thinking, the easier it will be to achieve the higher levels of Bloom's Taxonomy. According to Chapman (2009:5), each of the three domains of Bloom's Taxonomy is based on the premise that the categories are ordered in degree of difficulty. A learner who has acquired lower levels like knowledge, understanding and application can easily proceed to higher levels such as application, synthesis and evaluation. The Technology teachers who possess the knowledge of Bloom's Taxonomy are able to assist their learners to proceed gradually from lower levels to higher levels.

Moore and Stanley (2010:5) argue that synthesis in the Bloom's Taxonomy allows learners to create new knowledge and information as they interact with new material or information. Technology teachers must always create situations which will enable their learners to create new ideas for solving technological problems. According to Moore and Stanley (2010:5), evaluation in the Bloom's Taxonomy is demonstrated when a learner is asked to present and defend opinions by making judgments that is based on set criteria. Technology teachers who possess Technology knowledge are able to give their learners opportunities to create criteria which will be used for evaluation. Technology learners must be given opportunities to assess new ideas that are intended to solve technological problems in order to promote the acquisition of higher order thinking skills.

2.3 TEACHERS' KNOWLEDGE

2.3.1 The importance of a teacher's knowledge

As referred to earlier in this review, Technology teachers' knowledge can play a pivotal role in promoting higher order thinking skills. Beyer (1987:68) asserts that subject matter is one of the dimensions in which thinking and the teaching of thinking are taught. Borko & Putman as cited by Ertmer & Ottenbreit-Leftwich (2009:3), state that teachers' thinking is directly influenced by their knowledge and their thinking in turn determines their actions in the classroom. According to Rohaan (2009:15), the cognitive and affective domain of teachers' knowledge is assumed to be important determiners of high quality Technology Education. Teachers' knowledge may play a crucial role in promoting acquisition of higher order thinking skills. Rohaan (2009:100) states that the general aim of their study was to investigate the primary school teachers' knowledge and Technology Education. Their study investigated the impact of teachers' knowledge in Technology Education on learners when they were involved in technological activities. Rohaan (2009:25) states that teacher knowledge is an umbrella term that covers a large variety of cognitions, beliefs, skills and knowledge domains.

According to Shulman in Ertmer and Ottenbreit-Leftwich (2009:3), teacher knowledge includes subject, teaching methods and classroom management strategies together with knowledge of how to teach specific content to specific learners. Teachers' knowledge comprises of knowledge and insight that underlies teachers' actions in practice, which also include tacit knowledge (Rohaan, 2009:26). Rohaan (2009:26) suggests that a teacher should be able to combine subject matter knowledge and pedagogical knowledge for effective coaching of learners. Technology teachers should therefore acquire thorough knowledge of content and pedagogy in order to be effective in their teaching. Jones and Moreland (2004:124) assert that teachers cannot provide experiences and activities that guide learners' progress towards understanding ideas if they themselves do not know what the ideas are. According to Van Niekerk et al. (2005:2), the content of Technology Education must include conceptual knowledge ("knowing that") of technological artifacts as well as procedural knowledge ("knowing how") on design and making of such artifacts.

Rohaan (2009:41) states that pedagogical content knowledge is a crucial part of the knowledge base for teaching. Teachers' pedagogical and content knowledge can promote effective teaching and learning of Technology. According to Rohaan (2009:41), studies in the field of primary Technology Education show that this domain of teachers' knowledge is related to learners' increased learning, motivation and interest. Their study used a multiple choice test to measure teachers' pedagogical content knowledge in primary Technology Education. For the measurement of primary school teachers' pedagogical content knowledge of Technology Education, a version of the Teaching of Technology Test was used. Path analysis was followed to analyse the results. According to Rohaan (2009:93), it was found that the effects of teachers' knowledge on learners' concept and attitude were small. The findings revealed that there is weak relationship between teachers and pupil variables. It also found that primary school teachers often seem to lack the ability and confidence to develop and stimulate their learners' curiosity for Technology.

Technology teachers should be able to develop appropriate pedagogy for each lesson. According to Barlex (2007:152), technological pedagogy consists of three types of learning activities which are resource task, capability task and case study. According to Barlex (2012:3), case studies are true stories about design and technology in the world outside of school through which learners learn how businesses design and manufacture goods, as well as how those goods are marketed and sold. Gerring in Rauscher (2009:7) defines the case study as an intensive study of a single unit for the purpose of understanding a larger class of similar units. Case studies can help Technology learners when they are involved in investigation stage of technological process. According to The Southern African Development Community (2001:35), these investigations aim to link learning in schools with technological experience in the wider community. The investigations include visits to local businesses and industries such as learners visiting a local supermarket to see different kinds of packaging products. The case studies can also assist Technology learners when they are engaging at a design brief stage. The learners will be able to use their higher order thinking skills to give a broad indication of what should be designed in order to solve an existing problem.

According to Barlex in Rauscher (2009:7), resource tasks are used to teach learners the knowledge, understanding and skills that are likely to be required in designing and making products for assignments. Barlex (2012:2) asserts that resource tasks are short practical activities to make learners think and help them learn the knowledge and skill needed to design and make a product. Resource tasks are short, often practical activities that teach specific skills, knowledge and understanding which is likely to be useful in tackling a design and making a product. According to Ankiewicz and De Swardt (2001:43), resource tasks are usually performed under the guidance of the teacher in order to ensure that prior to performing on their own, learners have factual knowledge, basic skills and attitude. Technology teachers can teach learners about the conceptual knowledge like the properties of material and procedural knowledge, like how to use tools. They can therefore demonstrate to their learners the correct way of using tools and help learners to acquire skills to make a product, while giving them an opportunity to practice under their supervision. These practice skills include cutting skills, joining and weaving skills.

The South African Development Community (2001:35) points out that the resource tasks can develop the knowledge and the skills that learners need to engage in the design problems posed by the capability tasks. The resource tasks can help learners when they are in the idea generating stage, assist them to identify the advantages and disadvantages of different materials and prompt them to think critically as they judge the generated ideas according to the knowledge that they have acquired about different materials. Capability tasks are longer, open designing and making product activities. Barlex (2012:3) indicates that capability tasks are about designing and making products that work, while building on the learning experience of resource tasks and case studies. According to Van Niekerk et al. (2005:4), in Technology Education too much emphasis is placed on capability tasks because Technology Education is regarded as designing, making and testing. Technology teachers can observe the learners when they perform the capability tasks. According to The Southern African Development Community (2001:19), when learners are in the making stage they must be able to work accurately and apply the necessary skills and techniques to ensure quality workmanship. The Technology learners can apply a range of knowledge, skills and experiences acquired through case study and resource tasks to design a product which can solve the identified problem.

According to Barlex (2007:154), through careful combination of these types of learning activities a teacher can construct a learning experience that is broad and balanced, while covering the required programme of study and meet the requirements of continuity and progression. Technology teachers who possess sound knowledge know exactly what can be done in order to stimulate higher order thinking when they are involved with each of the three technological tasks.

2.3.2 Effects of teachers' knowledge on learners' concepts and attitude

Rohaan, Taconis and Jochems (2009:346) explored teacher knowledge in Technology Education and its effects on learners' concepts and attitude. According to Rahaan et al. (2009:346), high quality Technology Education means that high quality Technology Education teachers are required. Teachers' attitudes and self-efficacy may play a significant role in acquiring higher order thinking skills. Rohaan et al. (2009:387) state that the main purpose of their study was to investigate teachers' knowledge of Technology in primary schools and to analyse its impact on learners' concept and attitude towards Technology. This study investigated factors that primary school teachers need to know in order to be high quality Technology teachers. The study sought to establish the cognitions and beliefs that underlie teachers' behaviour during Technology activities. Rohaan et al. (2009:346) state that teachers' knowledge guides a teacher's behaviour in the classroom. This implies that teachers' knowledge could play a crucial role in what they do within their classrooms.

According to Rohaan et al. (2009: 357), it was found that primary school teachers have basic levels of subject matter knowledge and pedagogical content knowledge of Technology Education. Rohaan et al. (2010: 22) state that Technology teachers hamper creativity in their pupils if they themselves lack confidence about their understanding of creativity in Technology Education. It was determined that their self-efficacy in teaching Technology and attitude towards Technology are moderately positive. From the path analysis of teacher knowledge domains, the authors concluded that subject matter knowledge is an important factor for pedagogical content knowledge, as well as self-efficacy. According to Rohaan et al. (2010:21), teachers' attitude towards Technology and confidence in teaching Technology are other important aspects with respect to learners' attitude towards Technology Education. Rohaan et al. (2010:21) state that enhanced knowledge is related to enhanced confidence of learners and this confidence can motivate them to apply higher order thinking skills.

2.3.3 Content knowledge

Ginns, Norton, Robbie and Davis (2007:199) suggest that teachers should possess a personal knowledge and understanding of the content, as well as processes of design and technology, and possess related content knowledge and pedagogical knowledge. Pedagogical content knowledge can influence the performance of Technology teachers. Jimoyiannis (2010:599) describes content as the subject matter that is to be learned. According to Phillips, De Miranda and Shin (2009:48), content knowledge refers to one's understanding of the subject matter, while pedagogical knowledge refers to a person's understanding of teaching and learning processes. Cox (2008:15) further elaborates that a person with content knowledge also understands the structures of their subject matter and that this partition of the framework would refer to tasks like knowing how to write a five paragraph essay and reciting the periodic table of elements.

Barlex and Rutland (2008:239) state that subject knowledge is about how things work, look, are made, knowledge about the market, design strategies, modeling and presentation techniques, health and safety knowledge. Cox (2008:7) concedes that subject matter knowledge includes an understanding of the major facts and concepts in a discipline as well as substantive and syntactic structures of that field. Here, substantive structures include the major paradigms that influence the organisation of the discipline as well as its methods and topics of inquiry (Cox, 2008:7). Fogarty and McTighe (1993:161) point out that seasoned teachers know their content well and understand child development, which can help them to assist their learners to acquire higher order thinking skills. Technology teachers should therefore acquire content knowledge in order to teach Technology effectively.

According to Mawson (2003:123), learners' understanding of the nature and properties of materials also needs to be fostered. Schlichter (1991:9) states that thinking does not occur in a vacuum, therefore there must be something like content to think about. Technology teachers should always have content that can be used to teach higher order thinking skills. Mawson (2003:123) states that learners are often asked to develop solutions without knowledge of available materials and their properties. Higher order thinking skills should therefore be supported by content knowledge.

Compton (2004:10) states that teachers must know technological strands that are taught in Technology Education. According to Compton (2007:15), there are three new strands in the New Zealand Technology curriculum which are Technological practice, Nature of Technology and Technological knowledge. According to Gauteng Department of Education and Gauteng Institute for Curriculum Development (1999:xiii), there are eight strands in South African Technology curriculum – Technological Process, Systems and Control, Materials and Processing, Structures, Energy, Communication, Critical Consumer and Technology and Society. Pudi (2007:139) states:

In contrast to the content or objectives mode of education, outcomes-based education is based on learner outcomes. The learner solves problems and completes tasks by using knowledge at his or her disposal or including prior knowledge. This mode of education has the advantage of giving the learner an opportunity to create new knowledge.

Hunter (1993:106) concedes that teachers must first plant the seeds of information and understanding before hoping to encourage any form of creative activity. According to Swartz and Perkins in Fogarty and McTighe (1993:161), teachers are beginning to realise that their subject matter content is not the focus, but the vehicle that carries the skills of critical and creative critical thinking. Technology teachers should regard subject knowledge, but they must always remember that the subject knowledge can play a significant role in promoting the acquisition of higher order thinking skills. De Vries (2002:2) states four artifact related knowledge in this regard:

- Physical nature knowledge: It relates to the physical properties of the artifact. This type of knowledge incorporates science understandings which can be operationalised. It is the knowledge of technological laws. Technology teachers must acquire knowledge of the properties of materials.

- Functional nature knowledge: It relates to the function an artifact can fulfill. This means that Technology teachers must know what to do to ensure the function of artifact. Technology teachers must also acquire knowledge of structural rules. They must teach their learners to know how things can come together and give reasons for each and every action which is taken. The learners must be equipped to be able to provide reasons why they feel that a certain product will be suitable for consumers.
- Means ends knowledge: It is the knowledge of the relationships between physical and functional knowledge. It is evaluative knowledge as it provides knowledge of whether the material or a product is fit for its intended function.
- Action knowledge: It is the knowledge of how to perform certain actions which can lead to desired outcomes. Action knowledge is also called strategic or technical knowledge.

2.4 TECHNOLOGY KNOWLEDGE

2.4.1 Features of technology knowledge

Ku (2007:3) explains that technological knowledge can be divided into two types which are procedural and conceptual knowledge. Procedural knowledge relates to the activity, whilst conceptual knowledge relates to the body of content (Williams, 2000:1). The content of Technology must include conceptual knowledge of artifacts and procedural knowledge, namely, the design and making of such artifacts (Van Niekerk et al., 2005:2). McCormick (1997:143) asserts that the inter-relationship between procedural and conceptual knowledge is important in problem solving. According to De Swardt, et al. (2005:2), Ku (2007:3) and Ankiewicz et al. (2005:2), Technology teachers are expected to possess technological knowledge and to have ability to control technological process which is procedural knowledge. When learners acquire high level skills they must be able to use their factual and conceptual knowledge and move from personal experience to a more sophisticated understanding (Tapper, 2009:9).

2.4.2 Conceptual knowledge

Conceptual knowledge can play a pivotal role in the teaching and learning of Technology. According Pesonen (2004:2), conceptual knowledge denotes knowledge of concepts and rules. McCormick (1997:143) states that conceptual knowledge is concerned with relationships among items of knowledge, how it relates to the body of content and relationships among the concepts in the knowledge. McCormick (1997:143) concludes that learners are known to have a conceptual knowledge when they are able to identify these relationships among the concepts. “The goal for teaching Technology should be to produce students with a more conceptual understanding of Technology and its place in society, who can grasp and evaluate new bits of Technology that they might never have seen before” (ITEA in Ku, 2007:2).

It can be surmised from this assertion, that conceptual knowledge plays a pivotal role in the learning of Technology in terms of promoting the acquisition of higher order thinking skills. According to Ku (2007:2), much of the learning done in Technology Education classroom is learning in which students build their own knowledge from their experiences from doing and thinking. Technology learners can use their knowledge of different shapes when they make a certain structure to solve a technological problem. Ku (2007:3) states, with regard to this view, many cognitive psychologists and science teachers have shown that all real understanding of science concepts occurs when learners fully participate in the development of their own knowledge. Thus, learners can acquire conceptual knowledge in Technology when they fully participate in the development of their own knowledge.

2.4.3 Procedural knowledge

Procedural knowledge is a significant term used in Technology and is “know how to do it” knowledge (McCormick, 1997:143). According to King, et al. (1998:12), procedural knowledge is not really a higher order thinking skill; however, it is needed for promoting such a skill. Crowl, Kaminsky and Podell (cited in King et al., 1998:12) support the idea that procedural knowledge may be a requisite for higher order thinking skill. According to Pesonen (2004:3), procedural knowledge often calls for automated and unconscious steps. Pesonen (2004:3) adds that procedural knowledge may also be demonstrated in a reflective mode of thinking when the learners skillfully combine two rules without exactly knowing why they work. According to Haapasalo (2003:6), children often choose the right thing to do without being able to mention the reasons for it. According to Williams (2000:1), procedural knowledge is developed through the creation of a process when a solution to a particular need or brief is sought. Compton (2004:4) states that procedural knowledge is often equated with tacit knowledge, but she argues that not all tacit knowledge is procedural and that not all procedural knowledge is tacit. Technological knowledge presents certain effects that need to be taken into account in a classroom situation if learners' higher order thinking is to be nurtured.

2.4.4 Effects of technological knowledge

Mawson (2007:253) explored the factors of learning in Technology. Though the study was conducted on children in their early years at school, it can assist in this study to understand the effects of technological knowledge. The main aim of the study was to establish the technological knowledge, understanding, capabilities of children and the factors which encourage or hinder learning in Technology. Mawson (2007:258) states that personal disposition toward risk-taking in Technology is an important feature of children's technological practice. According to Mawson (2007:262), a second major factor which can influence children learning Technology is the way in which individual teachers teach the unit. Interviews were conducted to explore the children's initial knowledge and understanding of Technology in terms of their experiences, use of electronic technologies and understanding of the use and operation of every day technology.

There were also some simple construction and problem solving exercises in this interview to give an indication of their level of technological capability. The parents of 13 learners were also interviewed. The semi-structured interviews examined the parents' perceptions of their children's early childhood education experience; cooperative and leadership behaviours; preferred learning styles; problem solving ability; competence and experience with electronic equipment, tools and utensils; levels of curiosity; attitude towards Technology Education; and the parents' own understanding of Technology.

The findings of the study revealed two categories of factors which can affect learning in Technology, which are personal and systematic factors. Personal factors are academic ability, personal disposition to risk taking, home experiences and gender, school planning process, teacher constructs of Technology and the requirements of the compulsory Technology curriculum. Systematic factors are the school context and the wide educational context. The data indicated that personal disposition toward risk-taking is a significant factor in achievement in Technology.

2.5 PEDAGOGICAL KNOWLEDGE

According to Jimoyiannis (2010:599), pedagogy describes the collected practice, processes, strategies, procedures and methods of teaching and learning. Pedagogical knowledge is knowledge of teaching and learning methods, assessment methods, assessment techniques and types of assessment, which can help teachers to plan their daily lessons. According to Barbara and Wendy (2010:2), pedagogy is a word that describes the art of teaching and a strong pedagogy necessitates the study of teaching methods which includes the study of specific ways in which teaching goals may be achieved. According to Fogarty and McTighe (1993:161), seasoned teachers want to know how to teach learners to think and how to develop the skills they will need as they encounter life's challenges.

Jimoyians (2010:599) asserts that pedagogy also includes knowledge about instruction, assessment and student learning. Cox (2008:15) adds that pedagogical knowledge refers to basic, generalizable teaching strategies. According to Cox (2008:7), general pedagogical knowledge includes general skills, beliefs and knowledge related to teaching. According to Johnson (1992:1), through well-developed curricula Technology Education programmes are able to reinforce academic content, enhance higher order thinking skills and promote active involvement with Technology. Modern curricula must be well developed to promote higher order thinking skills.

Technology Education can play a crucial role in promoting higher order thinking skills by using problem solving activities. The Technology teachers can give their learners the problem solving activities which will afford them an opportunity to use higher order thinking skills. According to Williams (2000:2), there is a range of activities which the learners are engaged when they are interacting with Technology. The activities which can help learners to acquire higher order thinking skills are evaluation, communication, modeling, generating ideas, research and investigation, producing and documenting.

According to Williams (2000:2), the two most common processes are design and problem solving. According to Johnson (1992:1), there is little doubt that development of intellectual processes is critical in this age of advancing technology. The modern curricula must be geared towards promoting higher order thinking skills. Johnson (1992:2) states that contemporary curriculum needs to emphasize understanding rather than rote memorisation and heighten higher level of cognitive skills in addition to physical and basic skills. Teachers must acquire a vast knowledge of teaching strategies so that they can be able to choose the best strategy which can enhance higher order thinking skills.

According to Ku (2007:21), constructivist learning is based on the principle that students discover their own truth through activities and the role of the teacher is to facilitate this discovery. Morine-Dershimer and Kent (in Cox, 2008:15) state that pedagogical knowledge is a combination of many components, include classroom management and organisation; instructional models and strategies; and classroom communication and discourse. On the other hand De Swardt et al. (2005:3) state that many researchers agree that there is no single instructional strategy that is effective for all learners all the time. Technology teachers must therefore avoid relying on one teaching method when they are teaching their learners to acquire higher order thinking skills.

Hunter (1993:106) concedes that teachers must incorporate into their classroom practices various forms of thinking instruction. According to Hunter (1993), teachers should challenge and stretch young minds in order to help them achieve their potential. Technology teachers can promote higher order thinking by using different teaching and learning methods. For purposes of this study, various types of learning, namely, inquiry, discovery project based, cooperative and contextual learning were all found to be relevant to this study in terms of their potential to promote higher order thinking in the learning process.

2.5.1 Inquiry learning and teaching method

According to Ankiewicz and De Swardt (2001:25), inquiry learning is based on the premise that intellectual strategies used by scientists to solve problems which are unknown can be taught to learners. According to Frank et al. (2003:275), this teaching method is derived from Dewey, who suggested applying the principles of scientific research to teaching. Dewey claimed that by employing this approach we encourage our learners to create knowledge rather than being merely passive recipients of content. Barbara and Wendy (2010:2) point out that active learning can make a course more enjoyable for both teachers and learners and most importantly can cause learners to think at a higher level. Technology teachers can use the inquiry learning method in order to arouse the interest of their learners. According to Frank et al. (2003:275), in inquiry based learning, the learners are involved after their interest has been aroused and they have been encouraged to find solutions, answers, explanations or make decisions connected with the researched subject. Inquiry learning is concerned with the solving of problems, but it does not demand that a solution be found.

Prince and Felder (2007:14) point out that in inquiry-based learning, also known as guided learning, learners are presented with a challenge and are expected to accomplish the desired learning outcome in the process of responding to that challenge. Barbara and Wendy (2010:2) state that in order for active learning to thrive, teachers must give up the belief that learners will be unable to learn the subject at hand unless teachers cover it. Technology teachers must understand that in order to promote effective acquisition of higher order thinking skills they must not transmit knowledge to their learners. Barbara and Wendy (2010:2) further elaborate that while learners may gain some exposure to material through pre-class readings and overview lectures, true understanding of the material takes place when they are actively involved with and reflect on the meaning of what they are doing. This type of learning allows teachers to ask learners questions which they must answer. The learners are also expected to observe certain data and interpret it. According to Ankiewicz and De Swardt (2001:26), inquiry teaching is a process of answering questions and solving problems. Teachers use inquiry learning to teach their learners how to investigate problems.

2.5.2 Discovery learning

Hammer (1997:4) argues that discovery learning has taken on a range of meanings, but most often it refers to a form of curriculum in which learners are exposed to particular questions and experiences in such a way that they discover for themselves the intended concepts. Hammer (1997:4) points out that the learners' inquiry should be guided by the teacher and the material, because no one expects them to arrive on their own at ideas it took scientists centuries to develop. According to Prince and Felder (2007:15), in discovery learning, learners are confronted with a challenge and left to work out the solution on their own. The teacher or instructor may provide feedback on the response to learners' efforts, but offers little or no direction before or during those efforts. Lack of structure and guidance provided by the instructor and the trial and error consequently required of students are the defining features of discovery learning (Prince& Felder, 2007:15).

Discovery learning takes place in problem solving situations where the learner draws on their own experience and prior knowledge. It is a method of instruction through which learners interact with their environment by exploring and manipulating objects, wrestling with questions and controversies or performing experiments. It is based on the premise that when learners are afforded an opportunity to discover for themselves they will acquire information which can be easily retrieved.

2.5.3 Project-based learning

According to Prince and Felder (2007:16), project-based learning involves assignments that call for learners to produce something such as a process or product design; a computer code or simulation; or the design of experiment and the analysis; and interpretation of the data. In the project-based learning learners mainly apply previously acquired knowledge and final product is the central focus of the assignment. They ask questions, make predictions, design investigations, collect and analyze data, use technology, make products and share ideas (Frank et al., 2003:275). Project-based learning can play a major role in the learning of Technology as it can help learners to demonstrate holistically what they have learned, and to store knowledge, skills and values that they have acquired into their long-term memories.

2.5.4 Cooperative learning

Cooperative learning can be defined as a structured form of group work where learners pursue common goals while being assessed individually (Prince, 2004:1). Prince (2004:5) points out that cooperative learning is based on the premise that cooperation is more effective than competition among learners for producing positive learning outcomes. According to Klimoviene, Urboniene and Barzdziukiene (2006:82), cooperative learning is a valuable tool for developing critical thinking for it creates the most desirable classroom environment where learners experience psychological safety, intellectual freedom and respect for one another as persons of worth. The authors further state that, cooperative learning can be applied because it is an effective method to be used with any problem solving task (2009:80). According to Fogarty and McTighe (1993:167), teachers who employ cooperative learning methods promote thinking because these collaborative experiences engage learners in an interactive approach to processing information. Fogarty and McTighe (1993:162) add that thinking skills can be enhanced by the incorporation of cooperative learning. Technology teachers should give their learners plenty of opportunities to brainstorm ideas, to express divergent points of view, to implement and to evaluate the solutions at the same time helping them become better listeners, speakers, readers and writers.

Prince (2004:1) states that collaborative learning can refer to any instructional method in which students work together in small groups toward a common goal. Collaborative learning can be viewed as encompassing all group based instructional methods which include cooperative learning. Cooperative learning promotes interpersonal relationships, improves social support and fosters self-esteem. It provides a natural environment in which to promote effective teamwork and interpersonal skills. According to Klimoviene et al. (2006:82), a teacher should perform the role of consultant, offering the learners a strong support to seek imaginative, constructive and ethical solutions to problems. Klimoviene et al. (2006:80) suggest that learners should be given a scenario and asked to find a plausible solution. Feedback should be provided to the learners on a group basis when learners are selecting materials, discussing issues and preparing drafts. According to Johnson and Johnson (cited in Fogarty and McTighe, 1993:167), cooperative learning promotes greater retention of subject matter, improves attitude towards learning and increases opportunities for higher order processing information. Fogarty and McTighe (1993:162) concede that cooperative learning provides powerful interactive and organisational mind tools for helping learners think more effectively about the content.

2.5.5 Contextual learning

According to Chubinski (1996:23), a rich learning environment filled with authentic problems and real situations is critical for developing intellectual skills. Chubinski (1996:23) further explains that learning within a rich context also helps to address the problem by learning in an environment that reflects the way knowledge will be used in real life. Beyer (cited by Schlichter, 1991:7) concedes that skills taught in the context of subject matter rather than in isolation are more likely to be transferred to other situations where they can be useful. According to Chubinski (1996:23), if education is to facilitate learning that is useful outside the classroom, it must take place in contexts that resemble the situations in which knowledge and skills will be used.

Contextual learning theory states that learning occurs only when learners process new information or knowledge in such a way that it makes sense to them in their own frames of reference, their own inner worlds of memory, experience and response (Barak and Williams, 2007:334). Here, concepts are internalised through the process of discovering, reinforcing and relating to real life situations. Barak and Williams (2007:334) further suggest that learners must discover meaningful relationships between abstract ideas and practical applications.

Teachers must be aware that the technological activity can be conducted in a variety of ways (Ginns et al., 2007:199). Ginns et al. (2007:199) suggest that teachers should be cognisant of the thinking learners engage in when problem solving in Technology occurs if they are to capitalise on critical incidents where learners may refer directly or indirectly to the content and processes of Technology. Many teachers in countries that have been implementing Technology Education experienced a variety of difficulties (Ginns et al., 2007:200) due to their limited understanding of the phenomenon of Technology. They possess a limited understanding of Technology concepts and processes, and a limited knowledge of specific tools and practice skills. In addition, these teachers have a low level of confidence in their ability to teach Technology due to a lack of personal experience within the area.

These difficulties teachers experience impacts on learners' motivation to learn Technology. Beyer (1987:73) states that learners' motivation to learn a new skill or strategy is sharply enhanced when instruction in how to execute that skill or strategy is provided at a time it is needed to accomplish an assigned task. If the task assigned involves decision making, instruction in how to generate alternatives is most appropriate.

2.6 TEACHERS' KNOWLEDGE OF ASSESSMENT

A meaningful assessment in Technology Education requires the teacher to assess more than just the end product to avoid concentrating simply on a final or summative assessment (Van Niekerk, Ankiewicz & De Swardt, 2010:192). The main aim of the authors' research was to develop a process-based assessment framework to support the Technology teachers with assessment activities, which incorporates the technological process and provides opportunities for the assessment of aspects of the thinking processes as part of technological process. Van Niekerk et al. (2010:191) state that Technology is a new and unfamiliar learning area for many teachers. This led to their action research focused on the initial ideas of the technological process as well as creative and critical thinking processes. They used observation and semi-structured interviews to collect data. The researchers were the primary instrument in the collection of data as they functioned as participative observers, facilitated and monitored the project.

Audio recordings were made of all the semi-structured interviews, which were then transcribed and analysed. Analysis of the semi-structured interviews, follow-up semi-structured interviews and observations led to analysing, categorising and tabulating of the data. The main finding of their study was that Technology teachers must not only rely on summative assessment in order to obtain a true reflection of learners' performance in Technology.

As a result there is a number of assessment types considered that can enhance higher order thinking in learners – on-going formative assessment, work projects, performance assessment, and portfolio assessment. Knowledgeable teachers use on-going formative assessment opportunities to give learners quality feedback (Fox-Turnbull, 2006:75). They empower learners to make design and process decisions that increase their likelihood of producing successful solutions (Fox-Turnbull, 2006:75). Thus, the teacher's feedback is a key element to effective formative interactions (Jones & Moreland, 2004:25). So, learners benefit from feedback that identifies both the strength and weakness of their work, which enables them to take control of their learning (Jones & Moreland, 2004:25). According to Fox-Turnbull (2006:75), learners' practice can be altered by teacher intervention through formative assessment opportunities by using higher level questions to extend and challenge their thinking.

Project assessment is taken over a period of time and often involves the collection and analysis of data (Ankiewicz & De Swardt, 2001:103). During the project assessment Technology teachers evaluate the higher order thinking skills which were used when the product was made. Performance assessment occurs when the learner performs or demonstrates live in front of an assessor (Ankiewicz & De Swardt, 2001:102). These authors point out that during performance assessment learners are engaged in activities that require the demonstration of specific skills or the development of specific products. During performance assessment Technology teachers assess learners' competence as learners present their projects live in the classroom. Technology learners are expected to use their critical reasoning skills to defend their ideas for producing the project being presented. Portfolio assessment occurs when Technology teachers assess a design portfolio (Ankiewicz & De Swardt, 2001:103). A design portfolio is a file that contains samples of learners' work such as homework, papers, teacher's ratings of the work performed and other significant materials gathered by the learner. Technology teachers can use a rubric to assess a design portfolio. In a portfolio assessment Technology teachers judge competence which is completed over a period of time. Assessment can be used to support the learner's individual progression.

Technology teachers therefore need to be well conversant with different assessment methods, techniques and forms. Butt (2010:1) believes that the impact of different assessment practices on learning can be positive, negative or benign. Black and William (1998:2) assert that it is through assessment that we can find out whether learners have learned what they have been taught so that we can make appropriate adjustments to our teaching. It can assist teachers in determining if the learners are competent in the targeted skills. Van Niekerk et al. (2005:6) confirm that Technology teachers must assess their learners to check what they are able to do at the end of each learning experience. They must also assess what learners are able to demonstrate regarding the initial idea generation, as well as how their creativity and critical thinking within context of Technology have been applied. Therefore, being clear about the purpose of an assessment is an essential (Bell and Cowie, 2001:538).

2.7 HIGHER ORDER THINKING SKILLS

Here, a closer examination of higher order thinking skills assists in understanding creative and critical thinking skills for purposes of classroom engagements with learners.

2.7.1 Features of higher order thinking skills

Higher order thinking skills is essential for Technology learners. Gredo (1997:6) states that higher order thinking skills include critical, logical, reflective, meta-cognitive and creative thinking. This discussion will concentrate on creative and critical thinking skills as higher order thinking skills which are highly sought in Technology. According to Williams (2000:1), the development of thinking skills occurs through procedural knowledge. Gredo (1997:11) adds that higher order thinking skills occur when a person takes new information and uses the information stored in a memory to interrelate, rearrange and extend this information in order to solve a problem. This study seeks to establish how higher order thinking skills can be acquired during the teaching and learning of Technology with teachers' knowledge playing a role.

According to Beyer (1987:75), introduction of any thinking operation may be initiated whenever a teacher senses a need for learners to be able to execute it in a better manner than they seem to be able to do. Teachers must identify a thinking skill which needs to be developed and can then introduce learners to the major attributes or components of the new thinking skill. As an example, a teacher can identify creative thinking skill as a main thinking skill to be acquired by learners. Beyer (1987:4) states that bodies of knowledge are important, but they often become outdated. On the other hand thinking skills never become outdated and they enable us to acquire knowledge and to reason with it, regardless of time, place or the kinds of knowledge to which they are applied. It is very important that learners in this information age are well equipped with higher order thinking skills. The higher order thinking skills will help them to deal with new challenges in the future.

2.7.2 Stages of teaching thinking skills

According to Beyer (1987:75), an instructional framework for teaching thinking can be divided into various stages. These are discussed next.

2.7.2.1 Guided practice

Beyer (1987:76) states that once a thinking skill has been introduced, students will be given lessons in which they will practice executing it with instructive guidance. According to Jacobs, Vakalisa and Gawe (2011:50), teachers can use modeling to demonstrate how to solve problems. Teachers can provide their learners with concrete examples by demonstrating to their learners how to measure and cut material for constructing a technological product. Technology learners will then be afforded opportunities to practice to execute a new thinking skill by using the same kind of subject matter and the same media used in their introduction to the new skill. The learners should always be given adequate time to practice to execute new thinking skills in order to retain it. They will practice the new skills with the considerable teacher or peer provided guidance. The thinking skills can therefore be incorporated into lessons that aim to meet important subject-matter learning objectives.

2.7.2.2 Independent application

According to Beyer (1987:77), as learners demonstrate an ability to execute the thinking operation being practiced without assistance or guidance, they are provided with repeated opportunities to use it on their own. According to Fox-Turnbull 2007:32), when learners are given an opportunity to solve a technological problem through use of an activity and practical application that is authentic to a specific culture of technological practice, their knowledge and understanding of practice and issues are likely to be stronger. The practice of thinking operations should continue to use the same kind of data, subject matter or media which the operation was originally introduced and practiced. According to Beyer (1987:77), there are many techniques like teacher, text or workbook questions which may be used to initiate a thinking skill or strategy. These techniques can help learners to practice using thinking skills independent of their teachers or peers. Class discussions, debates and writing journals or paragraphs or short essays are ways for learners to apply designated thinking operations (Beyer 1987:77).

2.7.2.3 Transfer and elaboration

Beyer (1987:78) points out that during this stage of learning teachers show their learners how to apply a previously introduced skill or strategy in new, unfamiliar settings. According to Fox-Turnbull (2007:33), if Technology learners are to understand technological process they must be actively engaged in practice that reflects the culture of real technological practice. Transferring a thinking operation consists of helping learners learn how to execute a newly learned skill or strategy in settings other than that in which it was introduced. According to Beyer (1987:78), lessons that launch such transfer are in effect reintroductions of the thinking operation, but in a new subject matter or with new kinds of data or media. In these reintroductions learners review what they already know about the operation being learned and then receive instruction on how to execute it in a new setting. The main focus is still on the thinking operation, rather than on attaining any subject-matter goal.

2.7.2.4 Guided practice

Beyer (1987:79) states that once a thinking skill has been initially transferred with instruction to a new context, it must be practiced again with teacher guidance within that new context a number of times until learners demonstrate appropriate proficiency in applying it. According to Fox-Turnbull (2007:34), the forms of these supportive interventions vary, but all aim to assist the learner gain goals that would be beyond their capability without the support. As learners become proficient in applying it within the new context, guidance can be reduced.

2.7.2.5 Autonomous use

According to Fox-Turnbull (2007:34), with gradual withdrawal of the scaffold, the learner becomes progressively independent. At this stage the Technology teachers can start to remove their assistance so that learners can execute their skills on their own. Beyer (1987:79) argues that being able to use a thinking operation or strategy to generate knowledge on one's own and using one's own initiative is the major goal.

During this stage learners are provided with repeated opportunities to execute the learned skills precisely. Learners will be given opportunities to respond to given questions, engaging in discussions, debates, writing, completing research or action projects and so on. According to Ramirez and Ganaden (2008:24), the top two cognitive processes which are considered as higher order thinking skills are critical and creative thinking. The final part of this chapter discusses creative and critical thinking skills, which are the key components of higher order thinking skills.

2.8 CREATIVE THINKING SKILLS

Torrance, as cited by Ramirez and Ganaden (2008:25), define creativity as the process of sensing gaps or disturbing, missing elements, forming ideas or hypothesis concerning them, testing hypothesis and communicating the results. According to King et al. (1998:13), although some references do not explicitly include creativity as higher order thinking, it cannot be unmeshed from the process. Gredo (1997:4) explains that teaching for essential skills helps learners acquire information about a subject and teaching for higher order thinking purports to lead to the development of creative and critical thinking skills. Creative refers to the generation of ideas. According to Starko (2010:5), a creative result is a result that is both original and appropriate. A creative person is a person who fairly routinely produces creative results. According to King et al. (1998:13), the very act of generating solutions to problems requires the creative process of going beyond previously learned concepts and rules. Technology learners must therefore think attentively when they are solving technological problems.

Starko (2010:6) argues that the novelty and originality may be the characteristics which are most immediately associated with creativity. In order for an idea to be regarded as creative idea it must be new. According to Starko (2010:6), the second aspect of creativity is appropriateness. A creative idea must be suitable to solve a problem that has been identified. Technology teachers must teach their learners to be able to solve the existing problem appropriately. One important factor in determining appropriateness is the cultural context in which creativity is based. Creativity varies from culture to culture and across time as cultures differs in their conceptions of the nature of creativity. Starko (2010:7) believes that an idea or product is appropriate if it meets some goal or criterion. A creative product must be able to meet the criteria that have been set when they are judged or assessed.

Creativity is purposeful and involves an effort to make something work, to make something better, more meaningful, or more beautiful. According to Starko (2010:8), in most adult creativity, criteria for assessment are set by the said culture and the discipline. The criteria which are used to judge learners are therefore set by teachers.

Starko (2010:10) divides creativity in terms of creativity with a big C, "Creativity" and the creativity with a little c, "creativity". Creativity with big C represents innovations of disciplines and creativity with "little c" represents innovations of everyday life. Starko (2010:10) suggests that the kind of creativity which should be enhanced in young learners is creativity with "little c". Baer and Garrett (2010:6) argue that teaching for creativity and teaching specific content knowledge need not to be in opposition. The teaching of content knowledge must not oppose the teaching of higher order thinking skills. According to Baer and Garrett (2010:6), creative thinking actually requires significant content knowledge and thinking creatively about a topic. It helps to deepen one's knowledge of that topic. Baer and Garrett (2010:7) state that teaching detailed content knowledge and teaching for creativity often work synergistically. The content knowledge can therefore enhance the creativity of learners.

Teaching for creativity helps meet content standard goals and teaching detailed content knowledge can reinforce and enhance student creativity (Baer & Garrett, 2010:7). Content knowledge can promote acquisition of higher order thinking skills because creativity, content knowledge and skills are not orthogonal variables (Baer & Garrett, 2010:7). Baer and Garrett (2010:8) state that creativity depends on domain knowledge and skills. In order for creativity to thrive, learners must acquire domain knowledge. According Baer and Garrett (2010:9), mistakes in everyday critical thinking are more often the result of incorrect factual knowledge, than a lack of general problem solving skills. Baer and Garrett (2010:9) conclude that content knowledge is essential to serious thinking that teaching content-free thinking skills is not possible, and that higher-level thinking skills require the automatisation of lower-level skills.

In order for teachers to improve learner's thinking in a given domain, learners must acquire an understanding of an abundant amount of factual content about that domain, as well as a variety of domain-specific cognitive skills. Teachers must teach their learners content knowledge in order to improve their thinking. According to Baer and Garrett (2010:10), more creativity will often lead to more content knowledge and more content knowledge will generally lead to creativity.

2.8.1 The creative process

According to Jacobs et al. (2011:87), the sixth level in Bloom's Taxonomy is referred to as creating. Creating means to bring something that does not exist into existence. Jacobs et al. (2011:87) state that creating is the highest thinking skill in Bloom's Taxonomy. Webster, Compbell and Jane (2006:221) indicate that in the recent years the thinking curriculum has drawn much attention to the teaching methods that incorporate higher order thinking and student-centred learning. Here, interdependence and self-motivation are promoted and encouraged. The main aim of this study focused on how teachers fostered creativity as they implemented the Technology task. According to Webster et al. (2006: 233), this study sought to establish if there is a correlation between the duration of the incubation of ideas and the degree of creativity. The teachers who were involved in this study were provided with an opportunity to focus on enhancing creativity in Technology Education and to explore the notion of the incubation period of creative problem solving.

This study was conducted in three primary schools. Informal semi-structured interviews with teachers were conducted after the children had produced their recycling devices. These interviews were audio-taped and the tapes were transcribed. The transcripts were analysed for any discussion relating to teachers' awareness of the four phases of creativity problem solving: preparation, incubation, illumination and insight. The conducted interviews revealed that the majority of learners rarely changed ideas substantially after the incubation period. The key finding of this study is in relation to the importance of this incubation period of a Technology process. The teachers in the study identified a correlation between the duration of the incubation of ideas and the degree of creativity exhibited by students.

The learners who are given time for incubation can generate more ideas than those who are not given time. Nordstrom (2008:2) states that there are four stages of creative process which are preparation, incubation, illumination and verification. According Nordsdrom (2008:2), preparation means preparation in two senses.

The first sense involves the need to develop over time basic skills and expertise that one must have to function creatively in the particular domain. Teachers who possess a sound knowledge of Technology can help their learners to acquire the technological knowledge, which can help them to function creatively when they are involved in Technological activities. According to Nordsdrom (2008:2), second sense involves defining the problem, gathering information and actively trying to think, feel or see your way to a solution.

Technology teachers who possess a sound knowledge of Technology can help their learners to define the problem, collect information and try to find a solution. Spooner (2004:5) explains that preparation involves observing a need or deficiency, as well as clarifying the precise problem followed by a period of reading, discussing, exploring and formulating many possible solutions while critically analysing these solutions for advantages and disadvantages.

According to Nordstrom (2008:3), incubation involves taking time out from the problem. Technology teachers who possess a sound knowledge of Technology can afford their learners waiting time to incubate the problem. The Technology learners can be taught to meditate the problem. According to Spooner (2004:5), incubation involves a period of pre-conscious, off-conscious or unconscious mental activity.

Illumination is a stage where a flash of insight occurs (Nordstrom, 2008:3). Spooner (2004:5) adds that illumination entails a flash of insight that is characterised by a sudden change in perception, a new idea or transformation that produces a solution. Teachers who possess a vast knowledge of Technology are able to help their learners to record all the emerging new ideas which can solve the existing problem.

According to Nordstrom (2008:3), the last stage of the process is verification which involves either intellectually fleshing out the illumination in detail or testing its practicality. According to Spooner (2004:5), verification consists of selecting a solution and testing it. During the verification process, Technology teachers who possess a vast knowledge of Technology, can advise their learners to verify the generated ideas if they can indeed solve the problem.

2.8.2 Teaching techniques that can enhance creativity

According to Baer and Garrett (2010:10), the most widely used teaching techniques for improving student creativity are brainstorming activities. Teachers may follow certain rules of brainstorming to improve learners' creativity.

2.8.2.1 Defer judgment

According to Baer and Garrett (2010:10), the goal of brainstorming is to come up with unusual and original ideas. Teachers should avoid judging the ideas of learners when they begin to generate new ideas. Judging learners on the onset may demoralise them to continue to seek new ideas that can possibly solve the identified problem. Technology teachers must therefore refrain completely from criticising their learners in the early stages of generating new ideas. The positive judgment and negative judgment of learners' ideas may come at a later stage of the process. According to Marrapodi (2003:8), instant judgment is the enemy of creativity. Technology teachers must allow many ideas to emerge without screening them. Marrapodi (2003:8) adds that there is a need for a quantity of ideas for a good one to emerge. Technology learners must therefore be afforded an opportunity to generate many ideas without any instant judgment.

2.8.2.2 Avoid ownership of ideas

Baer and Garrett (2010:10) believe that when people feel that an idea is theirs, egos sometimes get in the way of creative thinking. Technology teachers must always advise their learners to refrain from defending their new ideas for personal reasons or for self-centered reasons. If they defend their new ideas they will end up defending even the ideas which are not appropriate to solve the identified problem(s). Ownership of ideas may impede creative thinking as people have a tendency to defend their ideas irrespective of faults.

2.8.2.3 Feel free to hitchhike on other ideas

According to Baldwin (2010:8), learners combine ideas, images or words to produce new creations. Technology learners can combine the ideas of other people with their new ideas to make a new product to solve the technological problem. Baer and Garrett (2010:10) state that learners may borrow elements from ideas already on the table or to make slight modifications of ideas already suggested. Technology teachers may advise their learners about others' ideas. The learners can apply these ideas and use the knowledge of the existing ideas to come up with new ones.

2.8.2.4 Wild ideas are encouraged

Baer and Garrett (2010:10) argue that impossible, totally unworkable ideas may lead someone to think of other, more possible, more workable ideas. According to Baldwin (2010:8), teachers should advise their learners to think about things from different points of view. When Technology learners brainstorm about different ways to solve the identified problem they must be allowed to generate different ideas, put all their ideas on the table, and bring the ideas which may be suitable to solve the identified problem. Those ideas may be refined or discarded at a later stage.

2.8.3 Keys for developing creativity habit

According Sternberg (2010:402), there are twelve keys for developing the creativity habit in learners. The discussion of these key points follows.

2.8.3.1 Redefine problems

According to Sternberg (2010:403), teachers and parents can promote creative performance by encouraging learners to define and redefine their own problems and projects. Adults can encourage creative thinking by having learners choose their own topic for their presentation. Learners' choice of their own topic must be approved by teachers. Sternberg (2010:403) states that the teachers' approval ensures that the topic is relevant to the lesson and has a chance of leading to a successful project. Technology teachers must thoroughly check projects which are chosen by their learners before approving or disapproving.

In addition, they may allow learners to choose their own methods of solving problems and provide the opportunity to reselect if their prior methods were a mistake. According to Sternberg (2010:403), teachers and parents should remember that an important part of creativity is the analytical component which is learning to recognise a mistake and give students the chance and the opportunity to redefine their choices. The Technology learners must therefore be encouraged to do self-evaluation. They must be afforded an opportunity to analytically judge their own ideas without defense and bias. Strong (2006:5) states that creative people have both depth in some area of specialisation and breadth in understanding of other areas. According to Strong (2006:5), without the depth of knowledge in the narrow field, the ability to use insight may not be valuable in advancing knowledge or creating something worthwhile.

2.8.3.2 Question and analyse assumptions

According to Sternberg (2010:403), creative people question assumptions and eventually lead others to do the same. Technology learners must be traditional and rebellious. According to Strong (2006:6), creative learners must favour careful work of others which can lead to new discoveries. Morris (2006:4) states that creative learners question and challenge existing ideas and that these learners are curious, question and challenge existing ideas. In essence, they question the status quo. Questioning assumptions is part of the analytical thinking involved in creativity.

2.8.3.3 Do not assume that creative ideas sell themselves

According to Sternberg (2010:404), creative ideas are usually viewed with suspicion and distrust because people are comfortable with the way they already think and because they have a vested interest in their existing way of thinking. Strong (2006:6) points out, that creative learners are however objective and passionate. Technology learners must be able to support their ideas. According to Strong (2006), creative learners must feel deeply about the importance of their work and often derive strength from it. Sternberg (2010:404) states that learners need to learn how to persuade other people of the value of their ideas. Technology learners must learn to give reasons why they feel new ideas will be beneficial for humankind. The good ideas which can help so many people may be suppressed by those in authority if the learners are unable to elaborate the value of their ideas.

2.8.3.4 Encourage idea generation

According to Morris (2006:4), creative learners explore ideas and options. Morris (2006:4) adds that creative learners play with ideas, try alternative and fresh approaches, keep an open mind and modify their ideas to achieve creative results. Technology learners must be motivated and eager to explore different ideas. Sternberg (2010:405) suggests that adults and learners should collaborate to identify and encourage any creative aspects of ideas that are presented. Teachers should not criticise ideas that do not seem to have much value. According to Sternberg (2010:405), teachers should suggest new approaches, preferably ones that incorporate at least some aspects of the previous ideas that seemed not to have much value. The main aim must be to help learners to learn to generate new ideas. Learners must be afforded an opportunity to generate as many ideas as they can, in order to inculcate higher order thinking skills.

2.8.3.5 Recognise that knowledge is a doubled-edge sword and act accordingly

According to Sternberg (2010:405), a person cannot be creative without knowledge. Bartel (2008:10) further states that creativity flourishes when we are intimately acquainted with our content. Most creative work can happen if learners are open to their immediate surroundings. People with a greater knowledge-base can be creative in ways that those who are still learning about the basics of the field cannot. Technology learners must acquire factual knowledge to be able to solve technological problems effectively.

2.8.3.6 Encourage students to identify and surmount obstacles

Sternberg (2010:405) writes that people who defy the crowd, people who think creatively almost inevitably encounter resistance. According to Strong (2006:7), creative learners must be prepared for pain and pleasure. Strong (2006:7) adds that creative learners may suffer both pain and receive great enjoyment from their work. Technology teachers must however prepare their learners to deal with challenges that may emerge. According to Sternberg (2010:405), creative thinkers should have fortitude to persevere and to go against the crowd. They must not be prepared to be led against the option of the majority, as sometimes the majority may be wrong. Teachers can prepare their learners for resistance by telling them about the well-known figures in society who faced obstacles while trying to be creative. Sternberg (2010:406) suggests that the students should be praised when they attempt to surmount an obstacle. If a learner provides valid reasons to support their ideas which were not supported by majority of other learners, the teacher must praise that learner.

2.8.3.7 Encourage sensible risk-taking

According to Marrapodi (2003:10), learners must embrace and manage appropriate risk taking. They must take calculated and appropriate risks to advance ideas. Sternberg (2010:406) states that when creative people defy the crowd by buying low and selling high, they take risks in much the same way as the people who invest. Some of these investments may not produce the expected results. Technology teachers must equip their learners to understand that some of their efforts may also not produce the expected results. According to Sternberg (2010:406), creative people take sensible risks and produce ideas that others ultimately respect as trend-setting. In taking sensible risks, creative people sometimes make mistakes and fail. Learners must be encouraged to understand failure as the first step in learning.

2.8.3.8 Encourage tolerance of ambiguity

Sternberg (2010:407) states that creative thinkers need to tolerate ambiguity and uncertainty until they get the idea just right. According to Adams (2006:38), incongruities within the logic process between expectation and results or between assumptions and realities can create opportunities for innovation. Technology teachers must teach their learners to tolerate ideas which puzzle them about how they can solve existing problems. According to Sternberg (2010:407), a creative idea tends to come in bits and pieces and develops over time. The ideas which are ambiguous can be developed and refined. The period in which the idea is developing tends to be uncomfortable and therefore creative thinkers must tolerate ambiguity and not jump to quick solutions. Sternberg (2010:407) suggests that students need to be taught that uncertainty and discomfort are part of living a creative life. Learners must tolerate a chaotic situation in learning and try to find a solution.

2.8.3.9 Help students build self-efficacy

According to Strong (2006:6), creative people are remarkably humble and proud at the same time. Technology teachers must encourage their learners to be proud with what they can do. They must believe in themselves that they have potential to create. According to Sternberg (2010:407), it is extremely important that creative people believe in the value of what they are doing as creative work does not always receive a warm reception.

Teachers must also help learners to believe in their own ability. If learners are encouraged to believe in their own ability to succeed they are likely to find the success that otherwise would elude them. Sternberg (2010:407) states that the main limitation on what learners can do is what they think they can do. All leaners have the capacity to be creators and experience the joy associated with making something new. The primary limitation for learners in generating new ideas is what they think they can do. If they think they have potential, their performance will also improve.

2.8.3.10 Help learners find what they love to do

According to Strong (2006:6), creative learners are objective and passionate. They feel deeply about the importance of their work and derive strength from it. Sternberg (2010:408) suggests that teachers must help leaners find what excites them to unleash their learners' best creative performances. If learners are allowed to do what is thrilling to them they will always try to get good results. According to Sternberg (2010:408), people who truly excel creatively in a pursuit, whether vocational or non-vocational, almost always genuinely love what they do. Here, Technology teachers can give learners a project to create prototypes, as learners love to solve a technological problem which is identified.

2.8.3.11 Teach learners the importance of delaying gratification

According to Strong (2006:6), creative learners must be well-disciplined. Strong (2006:6) explains that discipline is associated with focus and hard work. According to Sternberg (2010:408), part of being creative means being able to work on a project or task for a long time without immediate rewards. Learners must learn that rewards are not always immediate and that there are benefits to delaying gratification. They must be taught that some rewards for creative ideas are not obtained immediately.

2.8.3.12 Create environment that fosters creativity

Sternberg (2010:409) states that there are many ways teachers can use to provide an environment that fosters creativity. The most powerful way for teachers to develop creativity in learners is to role model creativity. According to Cotton (1991:9), a positive classroom climate is characterised by high expectations, a teacher's warmth and encouragement. According to Sternberg (2010:409), teachers can stimulate creativity by helping learners to cross-fertilize their thinking by thinking across subjects and disciplines. Teaching learners to cross-fertilize draws on their skills, interests and abilities regardless of their subject. There must be integration of other learning areas in teaching Technology since Technology is evident in all of them. Therefore, teachers must teach their learners to draw from skills, knowledge and values of other learning areas when they solve technological problems.

2.8.4 Favourable conditions for creative thinking

Craft, Jeffrey and Leibling (2004:39) believe that teachers can create an environment in which creativity can thrive. As a result there are four conditions for creative learning which are particularly relevant in the school's learning content or material. These are discussed briefly in the following sub-sections.

2.8.4.1 The need to be challenged

James, Lederman and Vagt-Traore (2004:13) write that a challenge is the stretch between being able to do something with great ease and being unable to achieve an objective. Somewhere in the gap is an ideal learner's state in which a learner has just enough knowledge, ability or skills to make considerable progress in pursuing the goal and yet not feel overwhelmed by the task. James et al. (2004:6) further states that a challenge tests one's abilities to resolve a problem and in its very nature is motivating and interesting. On the other hand, Craft et al. (2004:31) state that learners need to be challenged by having goals set for them and by helping them set their own goals. Technology teachers should create a supportive environment for learners who fail to reach the set goals. On the other hand, they should be able to create a chaotic environment that can provoke learners to think creatively.

2.8.4.2 The elimination of negative stress

According to James et al. (2004:7), when people have autonomy over how they reach their goal, they will be more creative. Technology teachers should avoid exercising dominant control over learners when they are involved in a technological activity. Instead, they can provide their learners with minimal guidance, affording learners autonomy during the learning process.

2.8.4.3 Feedback

Craft et al. (2004:39) state that without skilled feedback teachers will not learn to distinguish what was quite good from what was stunningly brilliant. Without skilled feedback, teachers will not know which approach works better and they will not acquire the habit of internal feedback reflection. With quality feedback we acquire self-knowledge, deepen our self-esteem and continue to be motivated to learn. According to Morris (2006:4), creative learners reflect critically on ideas, actions and outcomes. They review progress, invite and use feedback, criticise constructively and make perceptive observations.

2.8.4.4 The capacity to live with uncertainty

Strong (2006:6) states that creative learners are smart and certain, highly intelligent but also at times are doubtful of their understanding. Thus, teachers who are seeking to encourage creativity cannot expect to have all the answers (Craft et al., 2004:39). However, they can offer robust and workable alternative structures and processes to learners that can be developed and personalised. Technology teachers must ask their learners open-ended questions which allow them to come up with different answers.

2.9 CRITICAL THINKING

2.9.1 Critical thinking skills

Critical thinking consists of the analysis and evaluation of information and ideas leading to a belief that one is capable of explaining and justifying rationally (Montgomery, 2009:214). The term critical, is derived from the Greek word 'kritike', which means to sift (Ankiewicz, 2000:104). To be a critical thinker means to be able to sift right from wrong, meaningful from meaningless, or acceptable from unacceptable. Critical thinking is the intellectually disciplined process of actively and skillfully conceptualising, applying, analysing, synthesising and evaluating information gathered from or generated by observation, experience, reflection, reasoning or communication as a guide to belief and action. It is based on universal values of clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth and fairness. Critical thinking is mainly evaluative, selective and analytical.

According to McGuire (2010:26), critical thinking cognitive skills include interpretation, analysis, evaluation, inference, explanation and self-regulation. Facione (1990:2) states that critical thinking is purposeful and self-regulatory judgment, which results in interpretation, analysis, evaluation and inference as well as explanation of the evidential, conceptual, methodological, criteriological and contextual considerations upon which that judgment is based. The following sub-section will discuss the six core critical thinking skills in detail.

2.9.2 The six core critical thinking skills

2.9.2.1 Interpretation

According to Facione (1990:4), learners who possess interpretation skill can comprehend and express the meaning of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures or criteria. Interpretation includes the sub-skills of categorisation, decoding significance and clarifying meaning.

Purvis (2009:45) explains that interpretation incorporates the ability to understand and identify problems. Technology teachers who are knowledgeable in Technology are able to help their learners to acquire interpretive skills. According to Ankiewicz et al. (2000:129), Technology learners should be able to describe the problem, need or want in short but descriptive one or two sentences. Technology teachers who possess a sound knowledge of Technology can guide their learners to write a statement which explains how they are intending to solve the problem.

2.9.2.2 Analysis

According to Facione (1990:4), learners who possess analysis skill are able to identify the intended and actual inferential relationships among statements, questions, concepts, descriptions intended to express beliefs, judgments, experiences, reasons, information or opinions. Analysis includes the sub-skills of examining ideas, detecting arguments and analysing arguments into their component elements. According to Ricketts and Rudd (2004:23), a learner competent in analysis can effectively identify the relationship between statements, questions, concepts and judgments. According to Purvis (2009:45), analytical skills incorporate the ability to examine, organise, classify, categorise, differentiate and prioritize variables. Technology teachers who possess analytical skills are able to teach their learners to sift information that they have collected during the research stage. The Technology learners can be taught to examine information about different materials.

2.9.2.3 Evaluation

According to Facione (1990:4), learners who possess evaluation skills are able to assess the credibility of statements which are accounts or descriptions of a person's perception, experience, situation, judgment, belief or opinion. The Technology learners who possess the evaluation skill are able to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representations. Evaluation includes the sub-skills of assessing claims and assessing arguments. Technology teachers can help their learners to practice their evaluation skill by affording them an opportunity to evaluate the products that they have made. When learners are evaluating their products they will be acquiring a critical skill that is part of higher order thinking skills.

2.9.2.4 Inference

According to Facione (1990:4), the learners who possess inference skill are able to identify and secure elements needed to draw reasonable conclusions and hypotheses. Purvis (2009:45) adds that the inference skill incorporates the ability to formulate hypotheses and draw conclusion based on the evidence. Technology learners who possess the inference skill are able to choose the best initial idea from the three generated initial ideas. Technology teachers who are knowledgeable can help their learners to be able to give reasonable advantages for choosing a certain initial idea and reasonable disadvantages for not choosing the other two initial ideas. Facione (1990:4) states that learners who possess the inference skill are able to consider relevant information and to bring out the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions and questions other forms of representation. Inference includes the sub-skills of querying evidence, conjecturing alternatives and drawing conclusions.

2.9.2.5 Explanation

According to Facione (1990:4), learners who possess the explanation skill are able to state the results of their reasoning, to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological and contextual considerations upon which their results were based and to present their reasoning in the form of cogent arguments. Explanation includes the sub-skills of stating results, justifying procedures and presenting arguments. According to Purvis (2009:45), explanation incorporates the ability to explain assumptions that lead to the conclusions reached. Knowledgeable Technology teachers are able to help their learners to refine their ideas when they are involved in the development stage of the technological process.

2.9.2.6 Self-regulation

According to Facione (1990:4), learners who possess the self-regulation skill are able to monitor their own cognitive activities. According to Purvis (2009:45), self-regulation incorporates the ability for self-examination and self-correction. Technology teachers who possess a sound knowledge of Technology can afford their learners an opportunity to examine and correct themselves when they are involved in each stage of the technological process.

Technology teachers who possess a sound knowledge of the six core critical skills are also able to help their learners to acquire them when they are teaching different stages of technological process. They are able to incorporate the six core critical skills when they are teaching learners about the stages of technological process. The impediment of critical thinking skills can however thwart teachers' efforts to help learners to become effective critical thinkers. Technology teachers must be conversant with the impediments of critical thinking skills, so that they can be able to eliminate them from their learners. The following sub-heading discusses in detail the different factors which can impede learners to think critically when they are involved in technological activities.

2.9.3 Deeper, more pervasive impediments to critical thinking

2.9.3.1 Egocentrism

According to Pinder (2012:1), bending ideas to fit one's beliefs can be a barrier to critical thinking. Nosich (2005:24) states that each person is at the centre of their own thinking. We live in the middle of our own feelings, pains and pleasure, the things we want, the things we are afraid of, the experiences that have shaped our lives and our attitudes. Our experiences are heavily influenced by how we think and conversely how we think is influenced by our experiences.

People often have a way of thinking that always puts them first. When they are engaged in such egocentric thinking they tend to make judgments about how things are, but they may base those judgments on wishful thinking or mere self-interest. It is easy to delude ourselves into believing that we are working in the best interest of humanity as a whole, when in fact we are working for our own best interests and even against the interest of humanity. This is always easy to see egocentrism in other people than it is in oneself. Egocentrism interferes with critical thinking.

Furthermore, egocentrism interferes with the ability to give a fair evaluation. Technology learners should be encouraged to avoid egocentrism that can interfere with valid judgment, which can in turn lead to a creative product that can solve the technological problem. The Technology teacher who possesses a vast knowledge of Technology is able to alert their learners of how egocentrism can be a stumbling block to critical thinking. Egocentrism can mislead learners and result in deluded conclusions.

2.9.3.2 Developmental patterns of thinking

According to Nosich (2005:28), people acquire patterns of thinking as they go through different stages of psychological and physical development. These thinking patterns can impede critical thinking. Technology teachers must help their learners to analyse problems at hand and deal with them according to the current need(s). They must learn to find new avenues of dealing with current problems rather than to resort to childhood patterns.

Thinking patterns can be very detrimental to critical and creative thinking as learners who always resort to old thinking patterns may not be able to think creatively and critically. The Technology teachers who are knowledgeable in Technology can alert their learners about thinking patterns that can impede critical thinking skills to thrive. The teachers who possess a sound knowledge of Technology can also help their learners to avoid reinventing the old ideas in order solve a technological problem.

2.9.3.3 Previous commitments and experience

Personal experience can be an impediment to critical thinking. According to Nosich (2005:28), if we make generalisations from personal experience that go beyond what we are acquainted with, we stand a good chance of drawing distorted conclusions. In order to broaden our knowledge we must consider a variety of experiences and conclusions beyond our own. Nosich (2005:28) concludes that it is advisable to rely on reputable books, studies, journal articles, sources that gather and assemble information from a great variety of human experiences rather than relying in only your personal experience.

According to Orr and Klein (1991:131), teachers should systematically evaluate the general culture of their classrooms and school, and should estimate how this culture affects their ability to promote critical reasoning habits among learners. Competent Technology teachers can help their learners to be aware of unreliable sources of information that can lead the learners to having distorted conclusions. Technology teachers should be conversant with the impediments of critical thinking, so that they can teach their learners to avoid them.

2.10 SUMMARY

The literature review revealed that constructive theory can play a significant role in the learning of Technology. According to this review, the interaction of learners with their peers and with adults, like teachers, can enhance the learning of Technology. The literature review also showed that there is a relationship between conceptual knowledge and procedural knowledge. In addition, there is relationship between higher order thinking skills and teachers' knowledge.

According to this review, teachers' knowledge of curriculum, assessment and subject are crucial in the learning of Technology. The literature showed how creative and critical skills can be acquired as pillars of higher order thinking. It highlighted the favourable conditions and factors which can enhance the acquisition of higher order thinking skills. The review also described the impediments of higher order thinking skills.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In Chapter One, a brief description of the study, together with the problem statement and motivation for this research was discussed. Chapter Two dealt with the literature review, with the purpose of establishing the findings of other researchers within the field. This focused strongly on the effects of conceptual and procedural knowledge on learners' acquisition of higher order thinking skills in relation to Technology Education. Here, the significance of higher order thinking skills like creative and critical thinking skills was explored. Included in this review were the effects of teachers' knowledge, namely, content, curriculum and assessment, as tenets of conceptual and procedural knowledge in promoting the acquisition of higher order thinking skills.

In this chapter the research approach and research design are discussed. According to Johnson and Christensen (2008:77), the research design is the plan or strategy which one uses to investigate the research question. The following aspects of the research design are unpacked, namely, qualitative research, data gathering or collection methods, validity and trustworthiness.

3.2 QUALITATAIVE RESEARCH

According to Welman et al. (2010:188), qualitative field studies can be used successfully in the description of groups, small communities and organisations. Welman et al. (2010:192) state that qualitative research approaches originated from ethnographic methods. Ryan, Coughlan and Cronin (2007:740) claim that the ethnographic approach attempts to examine the experiences of the person in the context for interpreting. Welman et al. (2010:193) assert that ethnography can be described as an essential descriptive design which is used in investigations amongst individuals or groups within a given community, group or organisation. Welman et al. (2010:193) illustrate that ethnography focuses on the behavioural regularities of everyday situations, for example, relationships between individuals or within groups, attitudes and rituals. These regularities are usually expressed as patterns, roles and language and they are meant to provide the inferential keys to the group of people being studied.

According to Welman et al. (2010:8), qualitative research deals with subjective data that are produced by the minds of respondents or interviewees. Roberts, Priest and Traynor (2006:42) assert that this research tends to use exploratory approaches and produce textual data rather than numbers and measurements. Therefore, according to these authors, qualitative research data is presented in language as opposed to numbers where the researcher tries to understand the significance the respondents attach to their environment. According to Welman et al. (2010:9), qualitative research involves small samples of people. Therefore, for this study a qualitative approach was used with a small sample of participants.

Welman et al. (2010:8) further state that the purpose of qualitative researchers is to investigate the constraints of day-to-day events and based their results on the daily events and behaviour of people. Strauss and Corbin cited by Hoepfl (1997:2) claim that qualitative methods can be used to better understand any phenomenon about which little or much is known. In the case where much is known, further research is conducted in order to gain more in-depth information that may be difficult to convey quantitatively.

Qualitative research methodology is therefore relevant to this study as there is a dearth of information about factors which can play a significant role in helping learners to acquire higher order thinking skills. Welman et al. (2010:9) point out that qualitative researchers try to achieve an insider's view by talking to subjects and/or observing their behaviour in a subjective way. These researchers believe that first-hand experience of the object or subject under investigation produces the best data. Vishney and Beanlands, cited by Ryan et al. (2007:738), assert that qualitative research does not regard truth as objective, but as a subjective reality that is experienced differently by each individual. The findings of this study are regarded as subjective as this study is conducted through qualitative research.

3.3 SELECTION OF PARTICIPANTS

The target population for this study is Technology Education teachers in Johannesburg West District. Ryan et al. (2007:740) points out that a qualitative researcher usually uses a small sample in number, but the sample consists of those who are able and willing to describe the experience. Wallen and Fraenkel (1991:138) indicate that an investigator may use a personal judgment to select a sample and this is called purposive sampling. According to Fossey cited by Ryan et al. (2007:741), purposive or purposeful sampling tends to ensure richness in the data gathered. According to Wallen and Fraenkel (1991:138), in purposive sampling the researcher assumes that personal knowledge of the population can be used to judge whether a particular sample is representative. Wallen and Fraenkel (1991:139) assert that in purposive sampling the researcher does not study whoever is available, but uses his or her judgment to select the sample for a specific purpose. Ryan et al. (2007:741) claim that in qualitative research, participants are usually recruited to a study because of their exposure to or experience of the phenomenon in question. Purposive sampling was used for this research.

The target population for this study was selected from public schools in Johannesburg West District. The twelve selected Technology teachers from four public schools were selected and are therefore representatives of the population of Technology teachers in Johannesburg West District. The researcher selected three teachers from each of the four selected schools. The participants in this study are all Grade 7 Technology teachers.

The researcher used purposeful sampling as he targeted participants who possessed experience in teaching Technology. According to Cohen, Manion and Morrison (2000:103), in purposive sampling, researchers select the cases to be included in the sample on the basis of their judgment of their typicality. The researcher therefore selected the Technology teachers who are currently teaching Technology. In this way they build up a sample that is satisfactory to the researcher's specific needs. These teachers who are currently teaching Technology can help the researcher to establish if the Technology teachers' knowledge plays a role when learners are acquiring higher order thinking skills. However, according to Wallen and Fraenkel (1991:139), the major disadvantage of purposive sampling is that the researcher's judgement might be erroneous.

3.4 DATA COLLECTION METHODS

Observation and interviews were used to collect data in this study. These methods are discussed in turn.

3.4.1 Observation

According to Mason (2010:84), observation refers to a method of collecting data that entails the researcher immersing himself or herself in a research setting. In this study, observation method was used to collect data in order to enhance the quality of the research results. Observation is a collection method that can be used to collect data, without direct questioning by the researcher.

According to Hoepfl (1997:6), the classic form of data collection in naturalistic or field research is observation of participants in the context of a natural scene. Leydens, Moskal and Pavelich (2004:66) state that the purpose of observation is to focus on the key components of the activities that are of research interest. Hoepfl (1997:6) asserts that observational data is used for the purpose of description of settings, activities, people and meaning of what is being observed from the perspective of participants. In this study, Grade 7 Technology teachers were observed in the process of teaching in order to determine whether their knowledge played any role in learners' acquisition of higher order thinking skills. A checklist was used to collect data from the observations. According to Patton cited by Hoepfl (1997:6), observation can lead to a deeper understanding than interviews alone, because it provides knowledge of the context in which the events occur and may enable the researcher to see things that participants themselves are not aware of or that they are not willing to discuss. The researcher observed twelve teachers from four different schools.

3.4.2 Interviews

In qualitative research, knowledge and evidence are contextual, situational and interactional. According to Mason (2010:64), most qualitative researchers view knowledge as situational and interviews is just as much a social situation as is any interaction. The data that answers the research question can be collected through interaction with the participants. In this study, the researcher interacted with participants who are Technology teachers.

Mason (2010:62) points out that a common feature of qualitative interviews is the interactional exchange of dialogue. Mason (2010:62) elaborates further that qualitative interviewing may involve one-to-one interactions, larger group interviews or focus groups and may take place face-to-face. In this study the researcher used the face-to-face, semi-structured interview to collect data.

In addition, the researcher developed an interview guide for the semi-structured interviews. According to Welman et al. (2010:166), an interview guide involves a list of topics and aspects of these topics that have a bearing on the given theme and that the interviewer should raise during the course of an interview. Welman et al. (2010:166) suggest that the order of questions may vary depending on the way in which the interview develops. In addition, although the respondents are asked the same questions, the interviewer may adapt the formulation, including terminology to fit the background and educational level of the respondents (Welman et al., 2010:167). Therefore, the researcher rephrased the questions to ensure that all the interviewees had a clear comprehension of the information the study was aiming to collect.

In this study an interview guide was drawn up that consisted of in-depth, open- ended questions to guide the researcher. The researcher used the in-depth interviewing strategy. The in-depth interview was conducted individually with the interviewees in order to obtain their perspective about the research problem at hand. The time frame for the interview varied from participant to participant, but the minimum time expected for each interview was at least twenty five minutes. The in-depth interview included the depth of conversation that might lead to a rich discussion of thoughts, perceptions and feelings.

3.4.3 Compliance with ethical standards

The compliance to ethical standards and strategies as recommended by Mason (2010:79) were considered as part of this study. These are explained subsequently.

3.4.3.1 Asking relevant questions

The researcher asked the participants relevant questions that did not infringe on private or personal issues. All the questions focused on the research topic at hand. The researcher did not divert to other issues which could provoke the participants. Therefore, asking the participants irrelevant questions to the study was avoided.

3.4.3.2 Do not ask tricky questions which may confuse the participants

Every attempt was made to avoid using tricky questions that could confuse the participants. All the questions were simple and as straight forward as possible for ease of comprehension.

3.4.3.3 Make the interview to be enjoyable

The researcher ensured that the atmosphere created would make the participants feel comfortable and at ease to answer the questions. Prior to the interview, the participants were requested to be open in their responses and to feel free to ask clarity-seeking questions if required. They were also encouraged to ask the interviewer to rephrase questions that were unclear to them.

3.4.3.4 Guarantee the confidentiality and anonymity

The researcher explained explicitly to all participants how their confidentiality would be maintained. Here, none of the participants' real names were used. Instead, codes were instituted as a means of differentiating interview responses. The names of the teachers were substituted with the following codes, namely, T1 for Teacher 1, T2 for Teacher 2 and T3 for Teacher 3, etc. The researcher also replaced school names with codes, that is, S1 for School 1, S2 for School 2, S3 for School 3 and S4 for School 4. The codes used to represent each teacher per school followed a similar pattern, namely, S1T1 for School 1 Teacher 1, S1T2 for School 1 Teacher 2, S1T3 for School 1 Teacher 3, S2T2 for School 2 Teacher 2, etc.

3.4.3.5 The power relations

The researcher avoided by all means to exercise power over the participants, such as, dictating what can be done without accepting the input of the participants. The participants were requested to adopt the agenda before the interview commenced and given an opportunity to have input regarding the agenda items.

3.4.3.6 Caring and fairness

The researcher protected the participants from mental harm, like stress due to fear of embarrassment for possessing inadequate knowledge about Technology. Also, the researcher ensured that the participants were not humiliated. For example, if a participant was not proficient in the use of the English language, the researcher would not humiliate that participant by finding humour in a linguistic error. The researcher had open discussions with the participants and acknowledged their inputs to ensure fairness.

3.4.3.7 Falsification of results

The researcher was cognisant not to falsify any of the research results. According to Welman et al. (2010:182), the falsification of results or giving misleading reports of results is unethical. The researcher ensured that the results reflected the collected data.

3.4.4 Data analysis

3.4.4.1 Coding

McMillan and Schumacher (2010:370) explain that after collecting the data the researcher begins to identify pieces of data that stands alone. The pieces of data are called segments. McMillan and Schumacher (2010:370) assert that a data segment is a text that is comprehensible by itself and contains one idea, episode or piece of relevant information.

After collecting the data the researcher transcribed it and started the process of coding. According to Welman et al. (2010:213), after the researcher has compiled and processed all the information, the challenge is to reduce the huge amount of data to manageable and understandable texts. According to Welman et al. (2010:213), in qualitative research the researcher must convert words to numbers or symbols, but retain the words and use these together with symbols or numbers throughout the analysis. According to Welman et al. (2010:214), codes are tags or labels that attach meaning to the raw data or notes collected during field work.

3.4.4.2 Forming categories

According to McMillan and Schumacher (2010:376), categories or themes are entities comprised of grouped codes. The researcher in this study formed categories as a second step in analysing the collected data. McMillan and Schumacher (2010:376) point out that a single category is used to give meaning of similarly coded data. The researcher grouped the same data to form categories.

According to McMillan and Schumacher (2010:377), when the researcher is engaged in forming categories a very important process called recursive process occurs. McMillan and Schumacher (2010:377) claim that a recursive process involves the repeated application of a category to fit codes and data segments. The recursive process is also called constant comparison in which a researcher is continually searching for both supporting and contrary evidence about the meaning of the category (McMillan and Schumacher, 2010:377). The researcher in this study used the constant comparison method to identify similar and contrary data. Howell (2005:82) states that the constant comparative method involves comparing any particular incident in the data with another incident in the data or in another set of data.

3.4.4.3 Discovering patterns

Cresswell cited by Howell (2005:82) recommends that any analysis of qualitative data be fully supported by rich, thick descriptions of the case complete with examples illustrating the various aspects of categories, patterns or relationship proposed by the researcher. According to McMillan and Schumacher (2010:378), the ultimate goal of qualitative research is to make general statements about relationships among the categories by discovering patterns in the data. The researcher searched for overlapping categories within the data and divided the data into headings and sub-headings that summarised the content to form patterns. According to McMillan and Schumacher (2010:378), a pattern is a relationship among categories.

3.5 VALIDITY AND RELIABILITY OF THE STUDY

Validity is concerned with the accuracy of the results and checking whether the instrument is measuring what it is intended to measure. According to McMillan and Schumacher (2010:330), validity in qualitative research is the degree to which the interpretations have mutual meanings between the participants and the researcher. "Validity determines whether the research truly measures what was intended to be measured or how truthful the research results are. In other words, does the research instrument allow you to hit the bull's eye of your research object? (Joppe in Golafshini, 2003:599). According to Golafshini (2003:602), some qualitative researchers have argued that the term validity is not applicable in qualitative research, but at the same time they have realised the need for some quality checks or measures for their research.

According to Mason (2010:39), reliability involves the accuracy of research methods and techniques. Reliability seeks to establish how reliably and accurately do research methods and techniques produce data and how one can maximize their reliability. "Reliability refers to the extent to which results are consistent over time and an accurate representation of the total population under the study is referred to as reliability" (Joppe in Golafshini, 2003:598).

The term reliability is about being able to replicate results or observations. Golafshini (2003:599) states that the stable data collection instrument is able to produce the same results if it is to be used again. If the results are the same, it means the instruments being applied are reliable. For example, if this study can be repeated and the results repetitively indicate that Technology teachers' knowledge plays a role in teaching higher order thinking skills, it will mean that the data collection instruments are reliable.

According to McMillan and Schumacher (2010:330), in qualitative research, the researcher and the participants agree on the description or composition of events and especially on the meaning of the events in order to produce reliable data. The researcher cooperates with the participants to obtain reliable findings. According to Glesne and Peshkin, cited in Golafshini (2003:600), the question of reliability does not concern qualitative research but precision, credibility and transferability provide lenses of evaluating the findings of a qualitative research. In qualitative research, the terms credibility, neutrality or confirmability, consistency or dependability are essential criteria for quality (Lincoln and Guba cited in Golafshini, 2003:601).

Golafshini (2003:601) suggests that in order to ensure reliability in qualitative research, examination of trustworthiness is crucial. In support of this view, Merriam, cited by Mahfoodh (2011:4) points out that trustworthiness is considered an essential element for conducting any type of qualitative research. In this study the researcher ensured that trustworthiness is maintained by using different strategies. According to Lincolm and Cuba cited by Mahfoodh (2011:21), trustworthiness consists of credibility, transferability, dependability and confirmability. Instead of using the words reliability and validity, the researcher in this study used the words associated with qualitative research to ensure that the research findings in this study are worth paying attention to. Therefore, the following words were used: credibility, dependability, transferability and confirmability.

3.5.1 Credibility

According to Wise (2011:1), credibility deals with the accuracy of identifying and describing the subject of the study. In this study the researcher ensured that the study measures what it actually intended to measure. The study measured the role of Technology teachers' knowledge when teaching higher order thinking skills. Howell (2005:380) states that internal validity explains whether or not the study's findings are congruent with reality. According to Koch as cited by Ryan et al. (2007:743), credibility may be enhanced by the researcher describing and interpreting their experiences and also by consulting with participants and allowing them to read and discuss the research findings. Ryan et al. (2007:743) purports that credibility may be demonstrated through prolonged engagement, observation and audit trails. In this study the researcher used the various methods to enhance credibility, namely, triangulation, prolonged engagement and observation, negative cases, member checks and external audits.

Triangulation is one of the strategies that can enhance the validity of qualitative research. According to Golafshini (2003:604), triangulation may include multiple methods of data collection and data analysis, but does not suggest a fixed method for all researchers. Shenton (2004:65) states that triangulation may involve the use of different methods, especially observation, focus groups and individual interviews which form the major data collection strategies for most qualitative research. Robert et al. (2006:44) concurs that triangulation describes the combination of two or more theories, data sources, methods or researchers in a study. In this study the researcher triangulated interview and observation to collect information about the role of Technology teachers' knowledge in acquiring higher order thinking skills.

According to Golafshini (2003:604), engaging in multiple methods such as observation, interviews and recording, leads to more valid, reliable and diverse construction of realities. McMillan and Schumacher (2010:331) believe that different strategies may yield different insights about the topic of interest and increase the credibility of findings obtained from observations and interviews in this study. Mahfoodh (2011:17) argues that credibility should address the questions of whether the reconstructions (i.e. the research findings and interpretations) arrived at through the study are acceptable to the research participants. The use of interviews and observations in this study has played a role in ensuring that the findings are acceptable.

Merriam (1995:55) argued that submersion in the research situation entails collecting data over a long enough period of time to ensure an in-depth understanding of the phenomenon. For this study, the researcher spent adequate time (one hour per participant) observing them teach Technology to establish if their knowledge played any role in the learners' acquisition of higher order thinking skills. Wise (2011:1) argues that prolonged time in the field and persistent engagement with participants allows the researcher to develop trusting relationships; to develop more in-depth understanding of the phenomenon being studied; convey details about the site and the people; and to clarify misunderstandings.

Lewis (2009:11) suggests that after the themes or categories are determined, researchers must then search for data that would disprove the established themes or for data that does not fit into one of the categories. For any discrepant data in this study, the researcher intended not to disqualify the findings, but to alert his audience about the discrepant data.

Cresswell and Miller, as cited by Lewis (2009:11), however points out that in practice the search for disconfirming evidence is a difficult process because researchers have the proclivity to find confirming, rather than disconfirming evidence. Further, the disconfirming evidence should not overweigh the confirming evidence. As evidence for the validity of a narrative account, however, this search for disconfirming evidence provides further support of the account's credibility because reality according to constructivists is multiple and complex.

According to Merriam (1995:54), member checks is about taking the collected data and tentative interpretations of this data back to the participants from whom it was collected and asking if the interpretations are plausible and true. McMillan and Schumacher

(2010:332) suggest that researchers, who interview a person in-depth or conduct a series of interviews with the same person, may give that person an opportunity to review the transcript or synthesise the data obtained.

In this study, the researcher allowed the interviewed participants to review the data they provided to confirm its accuracy. According to Lewis (2009:11), member checking provides the respondent with both an immediate and continuous opportunity to correct errors and misinterpretations of what was stated or observed. It provides the respondent with the opportunity to volunteer additional information and to summarise information. The researcher confirmed the collected data by creating a platform for informal discussions about the observations and participants' interview data meaning.

According to Wise (2011:2), the external auditor examines the process (research steps, decisions, activities) and product (narratives and conclusions) of the study to determine its accuracy. As this is a supervised study to fulfill a Master's research requirement, the data analysis validation forms part of the role of the supervisor.

3.5.2 Dependability

According to Lise (2007:9), dependability refers to the degree to which a study can be replicated. Howell (2005:8) supports that reliability explains whether or not the results are consistent with the data or whether or not the data makes sense. Bryman (2004:275) states that in order to establish dependability, researchers must ensure that records of all phases of the research process are kept so that peers can act as auditors to assess the procedures.

The researcher ensured that records of all the procedures that was followed in this study have been kept so that the Technology teachers could assess the reliability of this study. According to Lise (2007:9), in order to enhance reliability in qualitative research the researcher must provide readers with a wealth of information to work from them. In this study the researcher intended to provide the readers with as much applicable information as possible, which could help them to detect the reliability of the study.

According to Mason (2010:187), conventional measures of reliability are comfortably associated with quantitative research where standardised research instruments are used, than they are in qualitative research. Qualitative research uses non-standardised research instruments to collect data (Mason, 2010:187). In this study dependability was established with an audit trail, which involved maintaining and preserving all transcripts, notes and audiotapes.

The researcher also used authenticity to enhance dependability of this study. According to Maldonado (2012:5), authenticity refers to the reporting of each participant’s experiences in such a way that it maintains respect for the context of the data and presents all perspectives equally so that the reader can arrive at an impartial decision.

According to Hughes (1999:492), reliability describes the likelihood that the results of a study would be replicated if the study was repeated. According to Hughes (1999:492), both quantitative and qualitative methods seek to establish a degree of confidence that the results of a test would be consistent if the test were conducted again. The researcher in this study used audiotape to record the interviews with participants in order to ensure that the results are consistent if the interviews can be repeated.

The researcher in this study also used triangulation to enhance dependability. According to LaVerne and Gene (2011:139), triangulation can be achieved by comparing the transcripts with the audio taped interviews and member checking. In this study, triangulation was achieved by comparing observation notes, transcripts and audiotapes from interviews.

According to LaVerne and Gene (2011:139), a question must be asked two or more times in each interview to verify that the participant understood the question and the researcher understood the response. In this study, the researcher rephrased the questions so that all the participants could comprehend what information was required.

Using a variety of different phrases to ask the same questions verified that the interviewee and the interviewer used words with shared meaning. The researcher listened to the entire audio taped interview before transcribing the data. The purpose of re-hearing the interview was to ensure that each question was answered adequately.

3.5.3 Transferability

According to Babie and Mouton (2001:277), Howell (2005:8), Lise (2007:9) and Wise (2011:1), transferability explains whether or not the findings are generalizable or applicable to other situations. According Ryan et al (2007:743), when critiquing qualitative research, a study can be deemed to have met the criterion of transferability when the findings can fit into other contexts and readers can apply the findings to their own experiences. A study is transferrable if it can be applied by other researchers in new contexts. Ryan et al. (2007:743) further elaborate that transferability is also enhanced when the results are meaningful to individuals who are not involved in the research study.

Qualitative studies are context-based studies. This study might help Technology teachers to some extent in other schools to understand the role of Technology teachers' knowledge in learners' acquisition of higher order thinking skills. Mahfoodh (2011:17) states that transferability addresses such questions as whether the researcher has provided a clear description of the research context to make it possible for others to replicate the study or make judgments about contextual similarity.

External validity was enhanced by using thick and rich description of the results. According to Hughes (1999:494), rich and thick description of data means that the researcher provides as much information as possible to the reader so that the reader can make an informed decision about transferability of the findings. According Wise (2011:2), the researcher provides rich, thick description to create context for the reader and to allow the reader to determine if findings are transferable.

Lincolm and Guba as cited by Hoepfl (1997:59), state that the researcher cannot specify the transferability of findings, but they can provide sufficient information that can then be used by the reader to determine whether the findings are applicable to the new situation. Miyata and Kai (2009:72) assert that the original inquirer cannot specify the sites to which transferability might be sought, but the implementers can. It is the responsibility of the original investigator to enable someone who is interested in making a transfer to reach a conclusion about whether the transfer can be contemplated as a possibility (Miyata & Kai, 2009:72). In order to improve the quality of transferability, original researchers are responsible for providing sufficient descriptive data for implementers to make better transferability judgments (Miyata & Kai, 2009:72). Lewis (2009:12) concurs that the researcher must describe clearly the research setting, the participants and the themes. According to Lewis (2009:12), the qualitative researcher must present the entire picture, therefore transporting the reader into the environment, setting and situation.

3.5.4 Confirmability

According to Ryan et al. (2007:743), confirmability is usually established when credibility, transferability and dependability are achieved. Wise (2011:1) states that confirmability deals with whether the findings could be confirmed by another researcher. The researcher will therefore ensure the removal of any subjectivity that might exist. This could hinder confirmability of this study.

According to Babbie and Mouton (2001:278), confirmability is the degree to which the findings are the product of the focus of the inquiry and not the biases of the researcher. Coll and Chapman (2000:5) elaborate this fact that confirmability seeks to ensure that the results of an inquiry have not been subject to influence by the investigator and are enhanced when the raw data and processes used to compress them are made available for scrutiny by the reader, therefore providing an audit trail.

In this study the researcher will keep the field observation notes, interview notes, and audio tapes for the readers. The researcher will also try to avoid applying their personal views and thoughts. The personal views and thoughts can lead to self-fulfilling prophecy which can compromise the confirmability of the study.

According to Lewis (2009:11), the researcher must describe to the consumer of the research any assumptions, beliefs, values or biases that the researcher possesses that could have affected the study. The researcher did not allow his experience of teaching Technology to interfere with the findings. Cresswell and Miller, 2000, cited by Lewis (2009:11) points out that the researcher must identify how these assumptions, beliefs, values and biases were suspended or controlled during the research. The researcher in this study will remain neutral when collecting and analysing data.

3.6 SUMMARY

Chapter Three outlined in detail the plan for collecting data. This was achieved by discussing and explaining the design and methods chosen within the qualitative research approach. The researcher discussed how the participants were selected and provided reasons for choosing purposive sampling for participants' selection. Different data gathering methods used were discussed together with the reasons for choosing the two data collection methods.

The chapter included ethical considerations and showed how validity and reliability of the study was enhanced. The credibility was enhanced by applying different strategies like triangulation, prolonged engagement and observation, negative cases, discrepant data member checking and external auditing.

Dependability was enhanced by applying strategies like triangulation, mechanically recorded data and audit trail. The transferability was enhanced by using strategies like providing sufficient information that can allow the readers to apply it to new situations. Confirmability was enhanced by ensuring that the researcher's personal objectivity is not allowed. The next Chapter 4 will present the findings of the study.

CHAPTER FOUR

ANALYSIS AND INTERPRETATION OF FINDINGS

4.1 INTRODUCTION

The first chapter of this research presented a brief description of the nature of the study, how data would be collected and analysed. In Chapter Three the research design and methods were further explained and justified. Here, the researcher conducted in-depth interviews and observations in four schools with twelve Technology teachers only. The main aim of the interview was to establish if the teachers' knowledge plays a role in learners' acquisition of higher order thinking skills. Each teacher was observed giving the lesson in class. The observation of teachers in practice helped the researcher to assess how teachers' knowledge plays a role in the acquisition of higher order thinking skills. In order to achieve this, the teachers' teaching strategies and questions asked to the learners were observed closely. A checklist was used for this purpose.

The researcher analysis began with transcribing the data obtained from the interviews. Here, the patterns of meaning and themes manifesting from the data was examined. Next, the transcribed data was segmented and analysed. Similar codes were then grouped through recursive process to form categories and the relationships among categories were identified and patterns were formed. Codes, categories and patterns were dissected to confirm the correct use of inductive analysis. Here, inductive analysis was also used to analyse the data collected through the observational checklist. Having done all this, findings are ready for presentation.

This chapter deals with the analysis and interpretation of the results with the aim of addressing the research question. It comprises of the following sections, namely, presentation of findings, discussion of findings and conclusion.

4.2 PRESENTATION OF FINDINGS

Six categories were identified based on the data collected that arose from the semi-structured interview (Appendix A: Interview guides for Technology teachers) from respondents, namely, pedagogical knowledge, subject matter knowledge, knowledge of assessment, knowledge of nature and purpose of Technology, and concerns of Technology teachers. Here, where applicable, the researchers observations (Appendix B: Classroom observation checklist) are included in the discussion of the semi-structured interview findings.

4.2.1 Pedagogical knowledge

4.2.1.1 How can Technology teachers' pedagogical knowledge capture and contribute to learners' higher order thinking skills?

The majority of the participants were able to explain how pedagogical knowledge can contribute towards promoting learners' higher order thinking skills. They indicated that the Technology teachers who possess a sound knowledge of Technology are able to use different pedagogies in their teaching in order to promote the acquisition of higher order thinking skills. Participant S2T1 stated that: "The Technology teachers should possess a deep knowledge of teaching and learning processes in order to be able to help their learners to acquire higher order thinking skills." S1T1 concurred with S2T1, stating that, "The teachers who possess pedagogic knowledge such as teaching strategies, planning of lessons and classroom management can help their learners to acquire higher order thinking skills." S3T2 similarly stated that: "Pedagogical knowledge can help the Technology teachers to use the correct teaching methods which can make learners to think creatively and critically." Lastly, participant S3T1 indicated that the Technology teachers who possess a sound knowledge of the pedagogical knowledge can select teaching methods that allow the acquisition and flourishing of higher order thinking skills. According to these participants, pedagogical knowledge can play a crucial role in assisting the Technology learners to acquire higher order thinking skills.

Collectively, the participants mentioned that learning methods such as discovery, experimental and experiential learning can promote the acquisition of higher order thinking skills. According to their responses, all the participants believed that the pedagogical knowledge can play a role in teaching Technology learners to acquire higher order thinking skills.

4.2.1.2 How can the knowledge of teaching approaches and strategies play a role in promoting higher order thinking skills?

The participants believed that the knowledge of teaching approaches and strategies can play a role in higher order thinking skills. The respondents indicated that the Technology teachers who possess a sound knowledge of teaching approaches and strategies are able to choose the relevant teaching strategies that can promote the acquisition of higher order thinking skills. S4T3 stated: "The knowledge of different approaches can help the Technology teachers to use appropriate approaches and strategies which can promote the acquisition of higher order thinking skills."

The respondents identified constructivism as the best approach for promoting higher order thinking skills and a few mentioned the strategies that belong to the constructivist approach. Accordingly, S1T1 indicated that the Technology teachers who possess a sound knowledge of pedagogical knowledge select teaching strategies like problem solving, discussion, debates, brainstorming, experiential, discovery and question-and-answer methods, that can allow the acquisition and further development of higher order thinking skills. Few respondents also mentioned demonstration as the best method for promoting higher order thinking skills.

The respondents were convinced that the knowledge of these teaching strategies can play a crucial role in the promotion of higher order thinking skills in learners. Participant S3T3 confirmed this view by stating: "The Technology teachers can use the demonstration method to help their learners to acquire soldering skills, cutting skills, etc." The Technology learners need to acquire manual skills in order to be able to make a product which can solve a technological problem at hand. When the Technology learners are engaged with the planning stages of their solution (technological process) for a technological problem they need to engage critical thinking to process information.

They involve generating skills when they use prior knowledge to add new information that can be useful in the making of a new product.

The learners can use a decision making skill to decide on the suitable tools, materials and appropriate skills for shaping, drilling, joining, finishing and measuring. When the learners select the manual skills in the planning stage, they use higher order thinking skills as they analyse and decide on the applicable manual skills that is useful for making the product.

The observations revealed that participants who seemed to be more knowledgeable about the teaching approaches and strategies that can promote the acquisition of higher order thinking skills were able to choose the best teaching approaches and strategies to appropriately engage their learners in design and making processes. These Technology teachers were using the constructive approach in the form of discussions, brainstorming and question-and-answer. Their learners were actively engaged and evidently used their critical and creative thinking to solve technological problems. They were very involved in group discussions, considering and reviewing their decisions and choices.

4.2.1.3 How do the teaching strategies benefit learners with regard to higher order thinking skills?

The respondents indicated that the constructivist approach and its strategies allow the learners to participate actively in learning. According to S3T1, “when Technology teachers use the constructivist approach the learners are engaged in constructing knowledge.” S2T1 stated: “The constructivist approach does not allow the learners to become passive recipients of knowledge”. S3T1 further stated: “The constructivist approach gives learners an opportunity to construct knowledge instead of obtaining knowledge without any contribution.” The responses indicated that the constructivist approach can benefit the Technology learners when they are afforded the opportunity to execute their higher order thinking skills. The Technology learners can execute higher order thinking skills when they try to identify a problem and find a solution to it.

The participants suggested that the constructivist approach must be complemented with the behaviourist approach in teaching. S4T3 and S1T2 substantiated this view that the Technology teachers should possess a sound knowledge of the behaviourist approach in order to help their learners to acquire higher order thinking skills. The teachers projected the view that the Technology learners should be equipped with conceptual knowledge, like knowing the properties of materials before they can be engaged in applying higher order thinking skills that can be learned through the constructivist approach.

Only two respondents indicated that they rely solely on the teacher-centred approach as opposed to the constructivist learner-centered approach. This is therefore quite an undesired situation given the more practice-based approach that Technology Education suggests. Therefore, the observation in these teachers' classes revealed a passive atmosphere when learners were not engaged actively. This proved to be a contradiction in views versus application, because these teachers spoke in support of the constructive approach. The researcher concluded that these participants might have a gap in knowledge regarding the principles of constructivism.

4.2.1.4 How can the link between pedagogical and content knowledge help learners in acquiring higher order thinking skills?

The respondents were of the view that there is a strong link between the pedagogical knowledge and the content knowledge. This was expressed by S2T1: "The Technology teachers who possess the pedagogical knowledge are able to start their lessons from the known to the unknown." This respondent further explained that the Technology teachers who possess a sound pedagogical knowledge can start their new lessons by helping their learners to understand simple things, before the complex new lessons are introduced to their learners. It appeared that to this respondent one has to start by relating the subject matter to the learners' previous knowledge, then lead them to making meaning of the new content knowledge being taught.

S1T2 added that the Technology teachers who possess sound knowledge of pedagogy are able to relate their lessons to common things that the learners know. The respondents projected the view that the Technology teachers who possess pedagogical knowledge are able to use appropriate strategies to extend knowledge of their learners. This can be demonstrated by what S3T2 stated: “The Technology teachers who possess knowledge of pedagogy are able to use skillfully a learner-centred approach to engage learners in constructing knowledge”. The Technology teachers who possess pedagogical knowledge are able to use the learner-centred approach to ensure the transfer of content knowledge to create meaningful opportunities for higher order thinking.

The classroom observations revealed that S3T3 and S4T1, who were applying the behaviouristic approach, did not cater for varying learning tasks in their teaching so as to instill critical and creative thinking in their learners. These two teachers predominantly used the teacher-centred approach of teaching. As a result, most of their learners appeared to be absolutely disengaged and bored. This made the researcher conclude that these two teachers did not promote the acquisition of higher order thinking skills in their learners as they did not create opportunities to engage learners.

The remaining participants were able to use different teaching strategies like the experiential, inquiry, cooperative and discovery learning as the catalyst for knowledge creation. Their lessons were lively and learners appeared to be interested in learning. The learners were using higher order thinking skills as they were allowed space to interrogate through active involvement. This confirmed that the Technology teachers’ knowledge of different teaching strategies can promote acquisition of higher order thinking skills.

4.2.1.5 How can the knowledge of the National Curriculum Statement help Technology teachers in acquiring higher order thinking skills?

The respondents’ views were that knowledge of the NCS helped them plan their lessons. They strongly agreed that Technology teachers who possess adequate knowledge of NCS will know exactly what higher order thinking skills the Department of Basic Education seeks to inculcate in learners. S4T2 substantiated this view by stating that, “According to the NCS, one of the critical outcomes seeks to inculcate creative and critical thinking skills, which are higher order thinking skills.”

According to the participants, knowledge of NCS can also help the Technology teachers in integrating different learning outcomes and integrating Technology with other learning areas. S4T1 stated: “Technology cannot be taught in isolation from other learning areas.” S4T1 elaborated that the content knowledge of other learning areas can be used to promote higher order thinking skills in Technology learning. S2T3 and S4T3 also stated that the Technology teachers who understand NCS are able to ensure progression of conceptual and procedural knowledge from one grade to the next.

It was also expressed that the Technology teachers who possess knowledge of the curriculum can give their learners an extended learning opportunity. S2T3 said: “Extended opportunity is another part of a lesson that seeks to help learners to acquire a skill that some learners were not able to acquire immediately when the lesson was initially presented.”

According to the conducted observations, the respondents who possessed the curriculum knowledge were able to integrate assessment standards, critical outcomes and learning in their term plans and yearly plans. These respondents were able to promote higher order thinking skills and relate them to the content knowledge of other learning areas, which confirms that Technology teachers’ knowledge of curriculum can play a significant role in letting their learners acquire higher order thinking skills.

During the researcher’s observations, it was noted that there were a few teachers who were not able to clearly communicate the outcomes of their lessons to their learners. These teachers also did not use the knowledge of other learning areas when learners engaged in solving technological problems. In addition, these learners were not as active as the learners of the teachers who used the knowledge of other learning areas.

4.2.2 Subject matter knowledge

4.2.2.1 How is the importance of the teachers' knowledge of Technology subject matter for promoting higher order thinking skills in learners?

Teachers' knowledge of subject matter was viewed as one of the important factors for learners' acquisition of higher order thinking skills. The respondents indicated that the Technology teachers who possess the subject knowledge are able to provide alternative ideas in their lessons. According to S3T2, "the Technology teachers who possess the subject matter knowledge are able to teach demanding tasks to their learners". This respondent further explained that the Technology teachers should teach their learners a demanding task by suggesting a solution to a technological problem.

The respondents all held the view that the Technology teachers can give their learners demanding tasks in order to inculcate creative and critical thinking skills. This can be in a form of a scenario that can help lead the learners to identify a problem and propose a solution. S1T3 added that a demanding task in Technology can compel the learners to use their higher order thinking skills like creative and critical thinking skills. S4T2 confirmed this by stating: "When the learners are engaged with the initial ideas stage of the technological process, the Technology teachers can guide them to generate three ideas that can solve a real life problem".

According to these participants, the Technology teachers who possess the subject knowledge are able to give practical examples that can simplify the learning of Technology. But teachers who possess less content knowledge may not be able to help their learners to acquire the content knowledge that is a prerequisite for higher order thinking skills. S3T3 explained that the Technology learners must acquire adequate Technology knowledge in order to be able to succeed in solving technological problems. The respondents' views suggest that teachers' technological knowledge affects learners' acquisition of higher order thinking skills. S2T2 confirmed this view by stating: "The Technology teachers must possess adequate content knowledge in order to be able to help their learners to acquire adequate content knowledge that is a prerequisite for solving technological problems".

4.2.2.2 How can the knowledge of different strands of Technology help teachers in promoting learners' higher order thinking skills?

The respondents all strongly believed that the knowledge of different strands of Technology can help the Technology teachers in promoting higher order thinking skills effectively. These respondents indicated that the Technology teachers who possess adequate knowledge of different strands of Technology are able to integrate different strands of Technology in order to promote the acquisition of higher order thinking skills. S4T1 gave a practical example that when a Technology teacher teaches the learners about structures, they can support that strand by integrating it with the critical consumer strand that seeks to generate the criteria to evaluate and select products. S4T3 stated succinctly: "The teachers who do not know different strands are unlikely to integrate different strands in their lessons".

On the other hand, the Technology teachers who have a poor background regarding the different strands of Technology may not be able to facilitate higher order thinking skills effectively. According to S2T3, the Technology teachers should always try to integrate technological process strands with each strand that they are teaching in order to promote the learners' acquisition of higher order thinking skills. Technology teachers with a sound knowledge of different strands are able to teach the Technology content knowledge, which can lead to the successful use of higher thinking skills. S3T1 said pertaining to sound knowledge that: "The content knowledge of properties of materials can help learners to evaluate the existing products and identify their advantages and disadvantages".

The classroom observations revealed that the Technology teachers who displayed the knowledge of different strands were able to integrate the technological process with all the strands that they were teaching. The Technology teachers who explained evidently the knowledge of different strands, were able to engage their learners with the steps of the technological process in order to foster the acquisition of higher order thinking skills.

4.2.2.3 In which way does the knowledge of construction and manufacture help Technology teachers in promoting learners' higher order thinking skills?

The findings showed that the Technology teachers' knowledge of construction and manufacturing can play an important role in promoting learners' higher order thinking skills. According to the interviewees, the Technology teachers who have a good knowledge of construction and manufacturing can teach the conceptual and procedural knowledge that is needed to solve the technological problems. In order to solve the technological problems a learner must execute higher order thinking skills.

S3T2 stated in this regard that, "The Technology teachers who possess the manufacturing knowledge of different products are able to help their learners to acquire a procedural knowledge about how different existing products are made". The knowledge of how the existing products were made can play a crucial role when learners make a new product to solve new emerging problems because learners can use factual knowledge and basic skills to manipulate materials.

Here, the respondents mentioned a range of processing techniques, namely, welding, lathe, soldering, sawing, sewing, moulding, sanding, weaving, knitting, welding, blanking, press forming, forging, cold heading, thread rolling, extrusion, casting, lathe, milling, grinding and drilling required in the making of a new product. The knowledge of these processing techniques by teachers can help to provide learners with technological processing techniques to choose from when making a new product.

The observation findings revealed that teachers who had poor background knowledge of construction and manufacturing were not able to explain to their learners how Technology is used in real situations, like in factories. The Technology teachers who only possessed surface knowledge of manufacturing process were equally not able to guide their learners to manipulate materials and use the appropriate tools. Due to the inability of these Technology teachers to explain manufacturing processes and techniques, many learners were not versatile to use higher order thinking skills to find a new solution when making a new product.

4.2.2.4 What do you see as the role of the practical expertise of Technology teachers in helping learners to acquire higher order thinking skills?

From the interviews it became clear that the practical expertise of Technology teachers can help learners in acquiring higher order thinking skills. The respondents absolutely believed that practical expertise of Technology teachers can facilitate teaching and learning of higher order thinking skills. S1T2 substantiated this view by stating: "For Technology teachers to be able to incite the learners' interest in acquiring higher order thinking skills, they must be conversant with practical technological skills." The practical expertise of Technology teachers can therefore assist them to demonstrate some of the practical skills that learners are required to acquire before applying higher order thinking skills. S2T1 stated that the Technology teachers who possess practical expertise of Technology are able to demonstrate practical skills to their learners. It also became clear, as stated by S3T2, that teachers who do not possess practical skills of Technology are not able to facilitate procedural knowledge.

The observations clearly showed that the teachers who possessed the subject knowledge were able to build their lessons on the past experience and knowledge of the learners. The participants who were able to demonstrate technological skills to their learners encouraged their learners to be active in their learning and these learners were eager to use higher order thinking skills. On the other hand, the learners of the teachers who were not able to demonstrate technological skills were not interested in using higher order thinking skills and those learners struggled when making new products.

In addition, the teachers who possess subject knowledge were able to use a variety of appropriate modes of teaching to clarify technological concepts and processes. The observations further revealed that the Technology teachers who were able to display the knowledge and understanding of materials were able to help their learners to analyse different materials for making a suitable product that could meet human needs. The learners of the Technology teachers who displayed surface knowledge and understanding of different materials such as wood, metal and waste materials were able to analyse and select suitable materials for making their products.

4.2.3 Knowledge of assessment

4.2.3.1 What is your understanding of assessment?

The respondents generally had a very clear definition of assessment. For example, S1T3 indicated that assessment seeks to measure a learner's achievement. The respondents also indicated that assessment can promote active participation in learning. S3T3 stated that assessment should be administered throughout the lesson presentation so that learners can be actively engaged in learning. While, S2T1 said that when teachers ask questions they must give their learners enough time so that all the learners have a chance to answer questions.

Also in the interviews, respondents indicated that the Technology teachers should be able to use the diagnostic assessment to assess the learners' level of conceptual and procedural knowledge that they need in order to be able to execute higher order thinking skills. S2T2 said in this regard: "The diagnostic assessment can help the Technology teachers to establish the strengths and weaknesses of their learners in relation to conceptual and procedural knowledge". S3T2 concurred with participant S2T2 by stating: "The diagnostic assessment is used when teachers want to determine a learner's level of competence". Diagnostic assessment can help teachers to determine how much their learners already know and can do and this in turn can help the Technology teachers in their plan to promote higher order thinking skills.

The researcher observed that the few teachers, who were not conversant with the definition of assessment, were not able to use different types of assessment in their teaching. The learners of these teachers did not participate actively nor did they seem to engage their higher order thinking skills. The teachers who were clear about the definition of assessment were however able to employ continuous assessment throughout their lessons and their learners were challenged by being asked questions that demanded the use of higher order thinking skills.

4.2.3.2 How can Technology teachers' knowledge of assessment help learners in acquiring higher order thinking skills?

The respondents believed that the Technology teachers' knowledge of assessment is one of the major factors that can help learners in acquiring higher order thinking skills. This was evident in S1T3's view, that assessment can help the Technology teachers in knowing the suitable types and forms of assessment that can be used to assess higher order thinking skills. This suggests that some Technology teachers are able to use the assessment methods, techniques and tools that can incite learners to use higher order thinking skills.

Most of the respondents indicated that they do not rely on one mode of assessment techniques to assess their learners but use different modes of assessment techniques. It was further indicated that the Technology teachers who possess a sound knowledge of assessment are able to choose the suitable assessment types to assess the process and results of a technological learning activity.

These respondents cited some assessment methods that can promote higher order thinking skills, such as teacher, self-assessment and peer-assessment, coupled with assessment techniques such as projects, observations, interviews and tests and examinations. To this they added the needed tools like rubric, observation sheet and checklist. S4T3 confirmed their view by stating that: "The self- and peer-assessments are the most suitable types for assessing higher order thinking skills."

As such, respondents believed that the assessment knowledge can help learners in using a suitable assessment tool for assessing higher order thinking skills. Therefore, respondents indicated that the Technology teachers should always choose to use multiple assessment techniques, tools and methods in order to accommodate different learners. S4T3 stated how learners can be helped in this regard: "Technology teachers can use the exhibition assessment technique for learners who are not shy to speak in front of other learners and they can ask their learners challenging questions as they exhibit their products".

4.2.3.3 Which questions are most suitable for enhancing higher order thinking skills?

The respondents preferred to set demanding tasks for the learners in order to promote the acquisition of higher order thinking skills. They believed that higher order questions can play a pivotal role in teaching higher order thinking skills. There was also consensus that Technology teachers must ask their learners probing questions in order to incite them to use their higher order thinking skills. S3T1 confirmed this assertion by stating: "The Technology teachers must ask their learners challenging questions if they really want to enhance higher order thinking skills".

The respondents also indicated that Technology teachers should ask their learners open-ended questions instead of closed questions that have only one answer. The rationale was that those teachers who ask closed questions do not encourage their learners to use their higher order thinking skills.

According to S3T2, the Technology teachers should confront their learners with problems and contradictions in order to promote the acquisition of higher order thinking skills. S3T2 further stated: "Technology teachers should ask their learners to draw conclusions". S1T1 stated that Technology teachers should afford their learners an opportunity to interpret, explain and justify conclusions.

The respondents' demonstrated knowledge about Bloom's Taxonomy and were therefore able to ask questions accordingly. This means they can mix challenging questions with simple ones. Technology teachers should however ask learners a series of probing questions that will lead them to critically examine a problem and create a solution.

The observation also revealed that the Technology learners who were asked low order questions according to Bloom's Taxonomy did not use higher order thinking skills to answer questions. However, Technology learners who were asked higher order questions were incited to use higher order thinking skills as they were applying critical and creative thinking skills.

4.2.3.4 How do you evaluate the process and results of a technological learning activity which involves higher order thinking skills?

The teachers' views revealed that the Technology teachers who possess knowledge of assessment use varying assessment techniques with clearly defined purposes in order to help their learners to develop higher order thinking skills. S2T3 stated that projects, product assessment and observation assessment techniques can be used to assess higher order thinking skills. According to S4T3, investigation and project assessment techniques are more likely to enhance higher order thinking skills.

Further feedback from respondents revealed that Technology teachers apply informal observation assessment to establish the competency of their learners in using higher order thinking skills when they evaluate their products. They can ask them questions about justifying their choices and decisions. The Technology teachers can also use informal observation assessment in order to promote learners' fairness when they assess their own products. The self-assessment method can help learners to develop higher order thinking skills like creative and critical thinking skills.

The respondents indicated that the Technology teachers should help their learners to acquire evaluation skills. S2T3 said: "Technology teachers must give their learners an opportunity to use a critical thinking skill for testing the product". The learners must use critical and creative thinking skills to evaluate the process and results of a technological activity. S1T3 confirmed this by saying: "Technology teachers must afford their learners an opportunity to test their products in order to establish if they fulfill the job they were meant for". When learners test their products, they are required to apply the decision making process as they draw conclusions about the functionality of the product. Self-assessment can help learners to acquire the analysing skills. The learners also apply creative thinking skill as they establish criterion which will be used to assess the product and when they identify product errors.

The respondents projected the view that the teachers who possess assessment knowledge are able to use continuous assessment throughout their lessons to identify errors of their learners and amend them as soon as possible. It was however evident from the observations that the Technology teachers who did not use continuous assessment throughout their lessons did not promote the acquisition of higher order thinking skills as their learners passively received knowledge.

During the interview process, the respondents agreed that feedback can play a crucial role in acquiring higher order thinking skills. S3T2 stated: “Feedback can help Technology learners to see their errors and try to improve their thinking skills by avoiding repeating errors when they are involved in other technological activities”. The respondents who were able to give regular feedback to their learners throughout their lessons managed to incite their learners to be actively involved, as learners answered more challenging questions from their teachers.

4.2.4 Knowledge of nature and purpose of Technology

4.2.4.1 How can the teachers’ knowledge of the nature and purpose of Technology help learners in acquiring higher order thinking skills?

The findings revealed that the Technology teachers who understand the nature and the purpose of Technology are more likely to be able to inculcate higher order thinking skills than their counterparts who do not. From the interviews it emerged that some of the respondents were aware of the rationale of Technology, for instance, S4T3 described the rationale of Technology as follows: “The rationale of Technology is to eradicate technological illiteracy in our society through teaching learners to acquire technological knowledge and skills that are highly needed in modern societies”.

According to the responses received, the Technology teachers who understand the rationale of Technology are eager to assist their learners to acquire technological skills that include higher order thinking skills. S4T3 and S1T3 pointed out that Technology teachers should understand the rationale of Technology in order to be able to strive for what Technology seeks to attain in our society. S1T3 further explained that Technology teachers who understand the rationale of Technology are always eager to eradicate technological illiteracy in their learners.

Many of the respondents pointed out that the Technology teachers should acquire a sound content knowledge and process skills to help their learners to acquire higher order thinking skills. S4T1 confirmed this by stating: “The Technology teachers who understand that the main aim of Technology is to equip learners with the content knowledge and process skills are likely to balance content knowledge and process skills in their lessons”. S1T3 stated: “The Technology teachers should be able to facilitate the stages of the technological process in order to help their learners to acquire higher order thinking skills”. The Technology teachers should therefore assist their learners to understand technological processes and the stages of the technological process in order to be able to develop learners’ higher order thinking skills.

The respondents further indicated that Technology in schools aims to teach the learners to identify problems and think of products that can solve them. S4T1 in particular indicated that Technology teachers’ knowledge of the aims of teaching Technology can help them to be able to engage their learners in identifying problems and think deeply of a better solution to deal with the identified problems.

It is important to realise that Technology uses the knowledge of other learning areas in order to solve technological problems, a critical fact that the respondents were aware of. They stated that in the Technology learning area learners are taught to use the knowledge from other learning areas to address real problems in life. S3T3 explained that Technology learners may use the Natural Science knowledge to make a new product to solve a technological problem and that this could facilitate the lesson on the properties of materials. From a Natural Science perspective properties of materials can be learned, and the knowledge be extended to knowing these properties for an intended use in Technology. According to the respondents, the learners should always be provided with an opportunity in a lesson of this nature, to solve problems in order to use their higher order thinking skills.

4.2.4.2 What is your understanding of Technology as a learning area and how can that understanding make you help learners in acquiring higher order thinking skills?

The respondents seemed to have a fair understanding of the definition of Technology (as stated in 4.2.4.1). It was defined as a new learning area which seeks to teach learners to use knowledge, skills and resources to meet human needs and wants. They argued that teachers who understand the definition of Technology are able to promote the acquisition of higher order thinking skills. S4T3 stated that "Technology teachers who understand the definition of Technology can teach their learners to use knowledge critically and apply higher order thinking skills". The learners are therefore able to shift the information that they have collected about different materials into other areas of learning. The Technology learners can also use decision making skills to sift ideas in order to get the best idea that can solve the problem.

The respondents also confirmed that Technology can help the learners to make and evaluate products. When the learners make and evaluate products their higher order thinking skills are called upon. The respondents stated that the Technology teachers who understand the definition of Technology always seek to develop creative and critical skills that are higher order thinking skills.

4.2.4.3 How can the Technology teachers' knowledge of the similarities and differences between Technology and other learning areas help learners in acquiring higher order thinking skills?

The respondents expressed that knowledge of other learning areas can play a role in solving the technological problems that require higher order thinking skills. The example given by S4T2 is that the Technology learners can use the mathematical knowledge of measurement when they make a new product like measuring the materials that will be used to make a new product.

The respondent elaborated by proving further examples of actual application. According to respondent S4T2, mathematical knowledge is highly needed for solving technological problems. When the learners are engaged with the planning stage of the technological process they will have to make working drawings with accurate measurement. With regard to the integration of Natural Science, S4T3 stated that science knowledge can help the learners to choose stainless steel for making knife blades. The learners' knowledge of the properties of stainless steel will make them prefer this material because it does not corrode in water. According to S4T1, learners need to have the knowledge of Economic and Management Sciences in order to consider the economic imperatives when buying the materials for making a new product. The Technology learners must also learn to improvise by using recycled materials at their disposal instead of buying every material that is needed to solve an identified problem.

The respondents indicated that the knowledge of the similarities and differences of Technology with other learning areas can help the Technology teachers to differentiate between Technology and Science and between Technology and other learning areas. Knowledge of the similarities and differences between Technology and other learning areas can help the Technology teachers to keep the distinction between Technology and other learning areas when they teach Technology. S3T1 said: "Technology teachers must help their learners to acquire the knowledge of other learning areas, but they must also teach them how to apply it in Technology". Technology therefore involves the application of natural scientific knowledge and other organised knowledge. Science is the study of the natural world and the scientific laws, rules and theories which can be applied to Technology to make a real product. Technology is involved in making things, whereas Science is about understanding things.

4.2.4.4 How can the Technology teachers' knowledge of the relationship between conceptual and procedural knowledge help learners in acquiring higher order thinking skills?

The respondents felt that the Technology teachers' knowledge of conceptual and procedural knowledge can play a significant role in teaching higher order thinking skills. The Technology teachers, who possess sound knowledge of conceptual knowledge, can lead their learners to acquire these two types of knowledge needed for higher order thinking skills to thrive. S4T1 said: “Our learners should acquire conceptual and procedural knowledge before they are equipped with higher order thinking skills”. The respondents regarded conceptual knowledge as the stepping stone for the execution of higher order thinking skills. S3T2 explained that the Technology teachers can show their learners a finished product in order to help them to acquire conceptual knowledge about different existing shapes that are being used to solve the existing technological problems.

The Technology teachers can teach their learners about the stages of technological process. S3T1 stated the following: “Technology teachers can show the learners how to apply the steps of the technological processes so that learners can have a background of forming different ideas to solve an identified problem. Learners who have acquired a sound procedural knowledge are able to use their creative and critical thinking skills to solve the technological problems”. Technology teachers who possess a sound knowledge of procedural knowledge are able to demonstrate to their learners how to follow the steps of a technological process and learners can use that knowledge to create new products to solve existing problems.

4.2.5 Concerns

4.2.5.1 Do you get adequate support from your seniors in your school which can help you to teach higher order thinking skills as a Technology teacher?

The respondents did not get the adequate support from their immediate seniors in their respective schools or from their district offices. S4T2 expressed the following concern: “There is only one district workshop per term that concentrates mainly on assessment. The content of Technology is often not included in those workshops. The minimal support from the District Office focuses too much on the assessment”. The respondents stated that there were very few learning area meetings in their schools for sharing information. S3T1 confirmed by saying: “We have only one learning area meeting per term, but sometimes we do not hold a learning area meeting for the whole term.”

The respondents expressed the view that some of their seniors are not conversant with the content of Technology and it is therefore difficult for them to assist the Technology teachers. Only a few respondents indicated that they got adequate support from their seniors. In appreciating the efforts that they received from their immediate seniors, S1T1 said: “I like my HoD because she is always open to help us whenever we need help to be competent in teaching Technology”.

4.2.5.2 What is the impact of the development you get from your seniors and how do you feel about the support you get from them?

The respondents projected the view that they did not get any developmental support from their immediate seniors with regard to curriculum issues to help them to understand the rationale of Technology. S1T2 said: “The Technology meetings can help many Technology teachers to understand the rationale of Technology that can in turn help them to seek ways to help their learners execute higher order thinking skills when they apply the design process.” The respondents indicated further that the developmental support from their seniors can help them to understand the different strands of Technology in order to employ appropriate teaching and assessment methods.

The few respondents who indicated that they receive good support from their immediate seniors explained that this support helps them to teach Technology in a better way. S4T3 said: “I am able to help my learners to acquire knowledge and skills due to the assistance I get. I keep on improving my teaching day by day due to this assistance.” The remark by S4T2 further confirms the importance of support that can help Technology teachers. This respondent said: “As Technology teachers we need more support from our seniors”. This concern is an illustration of how desperate Technology teachers are for assistance to help them to be competent in promoting their learners’ higher order thinking skills. This thinking is echoed by S2T3 and S3T1, who indicated that they should be supported by their HoDs and Technology facilitators from their District Office. Therefore, for Technology teachers to perform their teaching duties effectively, they need constant support from their seniors.

4.2.5.3 What are your barriers for teaching higher order thinking skills?

Inadequacy of resources in the respondents' respective schools was identified as a critical barrier to the acquisition of higher order thinking skills in their learners. They indicated that their schools do not have the adequate technological aids. All the respondents indicated that lack of practical teaching aids hampers the acquisition of higher order thinking skills in learners. S3T3 confirmed this by stating: "There isn't any other option except teaching learners the theory of Technology as there are no practical objects that can help learners understand Technology". According to all the respondents, the Technology learners who understand the practical part of Technology are able to think about different ways of solving technological problems that demands the utilisation of higher order thinking skills.

The respondents' were also concerned about overcrowding in their classes that makes it difficult to manage the class and individual learning. They claimed that overcrowding is a stumbling block to the acquisition of higher order thinking skills. S1T1 confirmed the problem caused by overcrowding by adding: "It makes it so difficult to engage all the learners to participate actively in constructing new ideas that can solve an identified technological problem." According respondents some of their learners may hide themselves in order to avoid answering questions that require the utilisation of higher order thinking skills.

The respondents also identified lack of adequate knowledge of practical expertise as a barrier to acquiring higher order thinking skills. They stated that the Technology teachers who possess inadequate knowledge of practical expertise are not able to demonstrate practical technological skills required to compliment higher order thinking skills. S3T2 stated that the Technology teachers must know the practical part of Technology in order to facilitate higher order thinking skills. This respondent further added that the District Office facilitators must conduct workshops to empower the Technology teachers with practical skills.

According to the conducted observations the teachers who indicated that they get good support from their immediate seniors were able to facilitate higher order thinking skills in their learners with regard to how they approached their class teaching activities. This is in contrast with the teachers who indicated that they do not get adequate support from their immediate seniors and struggled to facilitate higher order thinking skills. The respondents commonly expressed a need for in-service training. Specifically, S2T3 stated: “Some Technology teachers need a lot of support to be able to promote higher order thinking skills effectively”. S4T3 added that there is an acute need for assisting the Technology teachers to acquire the pedagogical, subject and assessment knowledge needed to promote higher order thinking skills.

4.3 DISCUSSION OF FINDINGS

This section deals with the discussion of the findings. Here, the findings on pedagogical knowledge, subject matter knowledge, knowledge of assessment, knowledge of nature and purpose of Technology and concerns of Technology teachers are discussed.

4.3.1 Pedagogical knowledge

The interviews and observations showed that the Technology teachers’ pedagogical knowledge plays a crucial role in the acquisition of higher order thinking skills. In order for the Technology teachers to equip their learners with higher order thinking skills they must acquire a vast knowledge of the various teaching methods. This study established that the Technology teachers who possess a deeper pedagogical knowledge are able to select teaching methods that are suitable for teaching particular content.

The Technology teachers who are conversant with different teaching methods are able to challenge their learners to use higher order thinking skills. The observations and interviews show that the Technology teachers’ knowledge can influence the acquisition of higher order thinking skills. According to Rohaan (2009:8), inquiry-based and problem-based learning are generally accepted to be the most appropriate approaches for the promotion of higher order thinking skills in Technology. The observations showed that the Technology teachers with rudimentary knowledge of pedagogy were using methods that are not favourable to the acquisition of the skills that their lessons sought to achieve.

The observations also revealed that the Technology teachers who possess a deeper knowledge of pedagogy managed to use suitable teaching methods favourable to promote the acquisition of higher order thinking skills that they sought to attain in their lesson plans. In addition, the findings revealed that the Technology teachers who are conversant with pedagogical knowledge are able to compliment the constructivist approach with behaviourist approach. The Technology teachers should understand that constructivist approach on its own cannot succeed in promoting higher order thinking skills. The Technology teachers should possess pedagogical knowledge in order to be able to balance the teaching approaches and methods that are relevant to promoting the acquisition of higher order thinking skills.

This study established that the Technology teachers who are conversant with the NCS are able to lead their learners to acquire higher order thinking skills. According to Department of Education (2004:5), one of the critical outcomes envisages learners who will be able to identify and solve problems and make decisions using creative and critical thinking. The Technology teachers with a deeper knowledge of NCS will certainly lead their learners to acquire higher order thinking skills like creative thinking and critical thinking skills.

4.3.2 Subject matter knowledge

The teachers' subject matter knowledge is of uttermost importance in promoting higher order thinking skills. The subject matter knowledge is knowledge about the subject being taught. The Technology teachers strongly need to show a command of subject matter knowledge in order to develop higher order thinking skills in their learners. This finding is supported by Moore and Stanley (2010:2) who state that the better you understand the lower levels of thinking, the easier it will be to achieve the higher levels of Bloom's Taxonomy. If teachers themselves do not have good command of the content, they cannot effectively facilitate lower order thinking skills to their learners and the learners cannot be expected to attain the higher order thinking skills. This study revealed that the Technology teachers should acquire conceptual and procedural knowledge in order to teach higher thinking skills effectively. According to Rohaan (2009:11), conceptual knowledge in Technology includes knowledge about energy, constructions, transportation, ICT and electronics.

The respondents indicated that Technology teachers must possess conceptual knowledge like processing techniques in order to help their learners to solve technological problems using higher order thinking skills. According to the respondents, Technology teachers also need to have procedural knowledge in order to impart it to their learners as procedural knowledge is highly needed for higher order thinking skills to thrive. According to Rohaan (2009:11), the procedural knowledge of Technology is mainly concerned with knowledge to solve technological design problems, but also includes determining and controlling, utilizing and assessing the impact of technology. If the learners do not use the conceptual and procedural knowledge that they have acquired they cannot expect to gain anything from it. The Technology teachers who possess a deeper knowledge of different strands are able to integrate the strands of Technology in order to promote holistic learning that can also promote the acquisition of higher order thinking skills.

4.3.3 Knowledge of assessment

This study revealed that the Technology teachers' assessment knowledge can promote the acquisition of higher order thinking skills. The Teachers' knowledge of assessment is an important element of teaching and learning. The interviews and observations show that the knowledge of assessment can play a significant role in promoting higher order thinking skills. Rohaan (2009:13) asserts that the Technology teachers should know profoundly how to evaluate the process and results of a technological learning activity.

The Technology teachers should also know what type of questions is suitable to promote a particular learning activity. The Technology teachers who possess the assessment knowledge know suitable assessment methods and techniques that can be used to assess and promote higher order thinking skills. The more the learners are given opportunities to practice to use higher order thinking skills, the more they will acquire higher order thinking skills. The Technology teachers should pose suitably demanding questions in order to promote higher order thinking skills in their learners. This study established that the Technology teachers who understand formative and summative assessment are able to diagnose the learning difficulty of their learners and provide the suitable remediation at the right time.

4.3.4 Knowledge of nature and purpose of Technology

It is true that the Technology teachers' knowledge can help the learners to facilitate higher order thinking skills. The majority of the participants believed that the Technology teachers’ knowledge of nature and purpose of Technology can play a significant role in teaching and learning of Technology; thus it can promote the acquisition of higher order thinking skills. The Technology teachers should understand the features of Technology in order to succeed in inculcating higher order thinking skills. According to Rohaan (2009:13), the Technology teachers should know how to translate the nature and purposes of Technology in the learning activities.

The Technology teachers should know the rationale for teaching Technology in schools. These teachers who understand the differences between Technology and Science are able to integrate Science in teaching Technology, but ensure that Science does not take the position of Technology. According to Rohaan (2009:13), the Technology teachers should know how to formulate tasks that meet the learning goals and stimulate learners’ problem solving and inquiry skills. The respondents indicated that the Technology teachers who understand the rationale for teaching Technology can strive to ensure that their lessons achieve economic, educational and social goals of Technology. As an example, S2T1 stated: “The Technology teachers who understand the rationale for teaching Technology in schools can engage his or her learners in activities that seek to achieve economic, educational and social goals”.

4.3.5 Concerns of Technology teachers

This study revealed that if Technology teachers who have rudimentary knowledge about Technology were given adequate support they would improve their performance in promoting their learners' higher order thinking skills. This finding is supported by Ertmer and Ottenbreit-Leftwich (2009:4), who state that if teachers are going to prepare their learners to be technologically capable, they need to have basic Technology skills.

The training of the Technology teachers is much more important and should be heeded by the district officials under the auspices of Department of Basic Education. The respondents believed that teachers' training can contribute towards promoting higher order thinking skills. This study revealed that the hindrances for promoting higher order thinking skills are due to the shortage of resources and inadequate training of the Technology teachers. The Technology teachers should be well-trained in pedagogical, subject and assessment knowledge in order to be able to equip their learners with higher order thinking skills. This study also revealed that the Technology teachers have very little learning area meetings and limited senior support

4.4 CONCLUSION

This chapter presented the findings of the conducted semi-structured interviews and observations. The findings of this study show that the Technology teachers' knowledge plays a significant role in the promotion of higher order thinking skills in learners by teachers. According to the respondents, there is a dire need of the Technology teachers' knowledge for the promotion of higher order thinking skills in learners. The Technology teachers who possess Technology knowledge are more effective in promoting the acquisition of higher order thinking skills, than their counterparts who possess rudimentary knowledge of Technology in the areas presented in the findings. The Technology teachers' knowledge allows the effective acquisition of higher order thinking skills. The overcrowding of learners, inadequate teachers' support from their seniors and lack of teaching aids all hinder the acquisition of higher order thinking skills.

CHAPTER 5

RESEARCH OBJECTIVES, MAIN FINDINGS, LIMITATIONS AND RECOMMERNDATIONS

5.1 INTRODUCTION

This chapter provides the main findings and conclusions of this study that investigated the role of Technology teachers' knowledge in the acquisition of higher order thinking skills when learners engage in solving technological problems. This research was conducted at four primary schools in Johannesburg West District in Soweto. In this chapter the researcher outlines the limitations of the study and suggests recommendations which are based on the findings. The researcher also provides suggestions for further research, practice and social change. The final section of this chapter deals with the conclusions of the research findings.

5.2 AIMS OF THE RESEARCH

Chapter One of the study stipulated the research problem and the motivation for this research. The primary aim of this study was to investigate the role of Technology teachers' knowledge in the acquisition of higher order thinking skills when learners engage in solving technological problems (see 1.3 in this regard). The secondary aims were stated as follows:

- To establish the role that Technology teachers' subject matter knowledge plays in Grade 7 learners' acquisition of higher order thinking skills. This study probed the role of Technology teachers' knowledge in promoting higher order thinking skills.
- To explore the role that the Technology teachers' pedagogical knowledge plays in Grade 7 learners' acquisition of higher order thinking skills.
- To explore the role that the Technology teachers' assessment knowledge plays in Grade 7 learners' acquisition of higher order thinking skills.

Chapter Two helped to address the research objectives from a literature perspective. It presented a detailed survey of conducted studies on the construct of Technology teachers' knowledge and the role that it can play in promoting the acquisition of higher order thinking skills in learners. The study was anchored on the theories of cooperative learning and constructivism. The literature survey hovered on the conceptual framework of technological knowledge and thinking.

The empirical investigation was conducted as outlined in Chapter Three. This entailed interviewing Grade 7 Technology teachers and observing their lessons in a classroom environment. Findings from this investigation were presented in Chapter Four. It can therefore be confirmed that the study addressed the research problem together with all three objectives as stated in 1.3 and thus achieved the research aim. The study has established that the Technology teachers' knowledge plays a crucial role in the learners' acquisition of higher order thinking skills.

5.3 MAIN RESEARCH FINDINGS FROM THE QUALITATIVE RESEARCH

5.3.1 The research programme

This research study used qualitative research as a research technique to collect and present data in the form of words. The researcher used interviews and observation to collect data. Twelve participants were interviewed and observed to answer the research question which sought to establish the role of Technology teachers' knowledge in promoting higher order thinking skills when learning of Technology takes place in Grade 7.

As briefly indicated in 5.2, the researcher has intensively consulted relevant literature about the contribution of Technology teachers' knowledge in the acquisition of higher order thinking skills. The researcher interviewed twelve Technology teachers who teach Technology in Grade 7.

Triangulation was used in the treatment of data as a technique to ensure the credibility of the study. Data analysis was done using coding, forming categories and discovering patterns. After the researcher had conducted the interviews, transcriptions and observations, the data was categorised. Similar responses were clustered together and organised into categories and the findings were presented.

5.3.2 The main findings and conclusion

The findings of this study concur with the literature reviewed that there is a strong relationship between Technology teachers' knowledge and the acquisition of learners' higher order thinking skills. This research study revealed that Technology teachers' knowledge plays a significant role in promoting the acquisition of higher order thinking skills. The Technology teachers who possess a deep knowledge of Technology are able to facilitate the acquisition of higher order thinking skills more aptly than their counterparts who have a shallow knowledge. The knowledge possessed by Technology teachers was a major factor in learners' acquisition of higher order thinking skills.

5.3.2.1 Content knowledge

This study revealed that the level of the Technology teachers' knowledge determines the effectiveness of a teacher in helping the learners to acquire higher order thinking skills. The findings revealed that the Technology teachers' content knowledge can enable them to assist their learners to acquire higher order thinking skills. Teachers who possess a sound knowledge of technological content knowledge are able to give their learners demanding tasks in order to inculcate higher order thinking skills in their teaching of content. However, those Technology teachers who possess rudimentary Technology content knowledge struggle to promote the acquisition of higher order thinking skills.

The study discovered that the Technology teachers who had adequate content knowledge were able to teach the sub-strands in a comprehensible way to their learners. The Technology teachers who possess content knowledge are able to use scaffolding to help learners to think creatively and critically. In contrast, the Technology teachers who had shallow knowledge of Technology, struggled to explain the conceptual knowledge and to help their learners to acquire procedural knowledge. Therefore, the Technology teachers' content knowledge directly influences Technology teachers in teaching higher order thinking skills.

5.3.2.2 Pedagogical knowledge

This study showed that the Technology teachers who possess a sound pedagogical knowledge have an advantage of being able to select the optimum teaching methods to promote the acquisition of higher order thinking skills. This study revealed that the Technology teachers who were unfamiliar with different teaching methods struggled to select teaching methods that favoured to promote the inculcation of higher order thinking skills. Based on the findings, the Technology teachers who had a sound pedagogical knowledge were able to raise their Technology learners' thinking to zones of proximal development, which motivated the learners to strive to generate new quality ideas.

On the other hand, the teachers who had a shallow knowledge of pedagogy, failed to a greater extent to stretch their learners' thinking to the required level. Hence, these learners were stuck with their activities as they were not able to generate quality ideas like those who were stretched to the zone of proximal development. The Technology teachers who possess a sound knowledge of pedagogy are also able to integrate Technology with other learning areas. Therefore, pedagogical knowledge can play a pivotal role in the acquisition of higher order thinking skills.

5.3.2.3 Assessment knowledge

The research findings revealed that the Technology teachers' knowledge of assessment has a significant impact in the learners' acquisition of higher order thinking skills. Teachers, who possessed a sound knowledge of assessments, are able to promote acquisition of higher order thinking skills by asking provoking questions which demanded the utilisation of higher order thinking skills.

The study established that the teachers who possessed rudimentary knowledge of assessment were unable to promote the acquisition of higher order thinking skills. They were asking questions that were not demanding the utilisation of higher order thinking skills. They were however asking questions which just demanded recalling of facts. They used undesirable assessment methods in an attempt to promote the acquisition of higher order thinking skills. It can therefore be concluded that the teachers' assessment knowledge can play an important role in the acquisition of higher order thinking skills.

5.3.2.4 Technology teachers' knowledge

The study established that the Technology teachers who possessed a sound knowledge of conceptual and procedural knowledge were able to assist their learners to acquire higher order thinking skills. They are able to use scaffolding to assist their learners to acquire the knowledge that can help them to think creatively and critically when they solve a technological problem. The study also revealed that the support provided to Technology teachers can play a meaningful role in empowering them to teach higher order thinking skills in an effective way.

5.4 LIMITATIONS OF THE STUDY

The following limitations were identified in the study:

a. Selection of participants

- The study was limited to 12 participants from four schools due to the limited scope (course work) characterising the study. A few more schools could have possibly added to the dimensions of the findings. In addition, engaging the learners could have added a different perspective to the findings.

b. Data collection

- Some participants were reluctant to allow classroom observation as they suspected that the information would be submitted to their employer (Gauteng Department of Education), omitting their confidentiality. They were therefore suspicious of the motives of this research project, despite the researchers reassurances of confidentiality and that their anonymity would be maintained by replacing the participants' names with codes.

- The researchers' presence during data gathering may have affected the participants' responses due to their suspicion concerning the research and their nervousness. This might have caused them to skew the truth or lie. The researcher however always motivated the participants to express their ideas freely without any fear.

c. Data analysis

- A time constraint was also a limiting factor with regard to data analysis. The overall analysis and interpretation of data proved to be time consuming due to the volume of data collected. In addition, the researcher was a novice in analysing and interpreting data, so the time required for extensive analysis proved to be a challenge.

- There was only one researcher analyzing and interpreting the data, so there was no validation for the interpretation of the textual data. The interpretation of the data was assessed as best as possible, but realistically, another researcher could have reached a different understanding or interpretation.

However, despite the aforementioned limitations, the researcher collected and analysed the data to the best of his ability irrespective of these potential constraints.

5.5. RECOMMENDATIONS

There are various recommendations that can be made based on this study. These are discussed in turn.

5.5.1 Recommendations in terms of content knowledge

The Technology Heads of Departments should organise school-based support workshops to develop the Technology teachers who possess rudimentary content knowledge of Technology. The Technology teachers should be encouraged to have discussion sessions on a weekly basis to discuss the different strands of Technology in order to help the teachers who have shallow content knowledge.

5.5.2 Recommendation in terms of pedagogical knowledge

The Technology teachers should be adequately trained to understand different teaching methods that can enhance learners' acquisition of higher order thinking skills. The Department of Basic Education should provide the Technology teachers with bursaries to advance their studies in Technology in order to equip them to teach Technology more effectively.

5.5.3 Recommendations in terms of the assessment knowledge

The District Technology facilitators should organise regular workshops that are aimed at equipping the Technology teachers with knowledge about different assessment methods, techniques and forms. This will lead Technology teachers to being better equipped to understand the suitable assessment methods, forms and techniques that can promote the acquisition and retention of higher order thinking skills.

5.5.4 Recommendation in terms of the Technology knowledge

The School Management Teams with the members of the Learners and Teachers Support Materials (LTSM) committee should prioritise Technology teaching aids. Procedural knowledge cannot be transmitted to learners in a lecture type learning environment. The procedural knowledge can be acquired by allowing learners to participate in practicing a particular skill.

5.5.5 Recommendations for further study

This study has investigated successfully the role of Technology teachers' knowledge in the learners' acquisition of higher order thinking skills. The researcher has given the following suggestions in order to encourage future research in the area of promoting the learners' acquisition of higher order thinking skills in Technology. The suggestions aim to assist Technology teachers who are eager to advance their Technology knowledge and enhance their teaching skills of Technology that is a fairly new subject in South Africa.

- Investigate the role of School Management Teams (SMTs) in their efforts to develop Technology teachers' content, pedagogical and assessment knowledge.
- Investigate the role played by the District facilitators in providing support to the Technology teachers to help enhance their technological knowledge in the said areas – content, pedagogy and assessment.

5.6 REFLECTIONS ON MY INTELLECTUAL JOURNEY FOR THIS STUDY

5.6.1 Challenges and how I overcame them

This mini dissertation of MEd (Masters in Education) was indeed a challenge for me as it stretched my intellectual capacities. At the onset of this mini dissertation I had a vague idea of higher order thinking skills. I had to consult a lot literature in order to establish if there is a link between Technology teachers' knowledge and the acquisition of higher order thinking skills.

When I was doing my research proposal I felt confused when I received feedback from my supervisor that I had to correct my many errors. I finally made an appointment with my supervisor to have a face-to-face meeting so that he could coach me about how I would write my research proposal in accordance with academic writing standards. The meeting I had with my supervisor was a breakthrough for this study as I gained insight required for writing an acceptable research proposal, which would be the foundation of my mini dissertation.

I experienced problems in formulating the sub-questions which were directly linked to the research problem of this study. But due to the expert advice from my supervisor I finally understood how to construct the researchable questions related to the research problem. I would however be frustrated every time I received feedback regarding my many errors from my supervisor. However, every time following feedback that was supposed to be improved, I would give myself more time to deal with errors identified. I would be relieved every time after submission of a chapter to the supervisor.

5.6.2 What did I learn in this study?

This study was a journey of personal transformation which changed my life for the good. The main areas of my learning are as follows:

5.6.2.1 Time management skills

I have learnt that time is like a gold; it is very precious and that if you waste time by procrastinating, the work will pile up and it will be difficult to catch up. I have also learnt that postgraduate studies can take toll on one's health and relationships, therefore postgraduate students must plan their time in order to avoid burnout. This had led me to balance my family, personal and work responsibilities. I have therefore learnt that there is a time that is very suitable for me to concentrate on my studies and be productive, namely, studying was early morning and mid-night when my family were asleep.

All of this has culminated in me creating a schedule with firm deadlines that I would always abide by. Whenever I received feedback from my supervisor I would have a set time to improve it and return it to him.

5.6.2.2 Independent learning skills

I have leant to work independently as most of my work I had to do without relying completely on my supervisor. However, my supervisor was always available to assist me whenever I was not progressing. He was always asking provoking questions, which demanded a lot of thinking in order to train me to utilize my thinking skills. I also learnt to collect information related to my research topic from different sources like internet websites. Because of this study, I can easily locate data that I need without any assistance. I also learnt to sift information and that I must not rely solely on old sources of information as knowledge keeps on developing. Therefore, the old sources of information must be supplemented by the recent ones to demonstrate your own understanding as a researcher of the trends within your field of study.

5.6.2.3 Academic writing skills

I have learnt to describe and critically analyse the data that I collect from primary and secondary sources. I have become more knowledgeable about the use of consistent referencing throughout the dissertation chapters. I have learnt to use a plain language that can be understood by the potential readers of this mini dissertation. I however had a problem in using transitional expressions in argumentation and my supervisor kept on emphasizing this until I realised how valuable the application is in academic writing.

5.6.2.4 Personal growth

This study has further developed my unquenchable thirst for learning and discovering new knowledge. Before I commenced with this study I believed that the knowledge and the skills I had acquired in my BEd Honours degree were sufficient to understand how learning takes place, but as I engaged with this study I realised that there is a lot to be learnt in this life.

I really understood that the sky is the limit. As I conclude this study I am hooked to studying. I have realised that what started as a burden, has now changed into something that I enjoy. The experience of conducting this research and writing my mini dissertation has been an unforgettable life experience and I believe that the skills and knowledge I have acquired will benefit humankind. The findings of this study will help many Technology teachers and officials in the Department of Basic Education in planning better ways to improve the teaching and learning of Technology, particularly in improving the learners' acquisition of higher order thinking skills.

REFERENCES

Adams, K. (2006). The sources of innovation and creativity: A paper commissioned by the National Centre on Education and the Economy for the New Commission on the Skills of the American Workforce. Washington D.C: National Centre on Education and the Economy.

Ankiewicz, P.J. & De Swardt, A.E. (2001). Technology Education: Principles, methods and techniques of Technology Education II. Johannesburg: University of Johannesburg.

Ankiewicz, P.J., De Swardt, A.E. & De Vries, M. (2006). Some implications of the philosophy of Technology for Science, Technology and Society (STS) Studies. *International Journal of Technology and Design Education*, 16: 117-141.

Ankiewcz, P.J.; De Swardt, A.E. & Engelbrecht, W. (2005). Technology Education in South Africa Since 1998: Shift from traditional teaching to outcomes-based education Unit 2. Johannesburg: University of Johannesburg.

Ankiewics, P.J., De Swardt, A.E. & Stark, R. (2000). Principles, methods and techniques of Technology Education Module 1. Johannesburg: RAU Centre for Distance Education.

Babbie, E. & Mouton, J. (2001). The practice of social research. Cape Town. Oxford University Press.

Baer, J. & Garrettt, T. (2010). Teaching for creativity in an era of content standards and accountability. New York: Cambridge University.

Baldwin, A.Y. (2010). Creativity: A look outside the box in classrooms. New York: Cambridge University.

Barak, M. & Williams, P. (2007). Learning elemental structures and dynamic processes in technological systems: A cognitive framework. *International Journal of Technology and Design Education*, 17: 323-340.

Barbara, L. & Wendy, W. (2010). Developing higher level thinking. *Journal of Instructional Pedagogies*, 3: 1-9.

Barlex, D. (2007). Creativity in schools design and technology in England: A discussion of influences. *International Journal in Technology Design and Education*, 17: 149-162.

Barlex, D. (2012). Possibilities for research in Technology Education. Available at: http://www.project2061.org/events/meetings/technology/tech2/barlex.htm. Accessed 05 August 2012.

Barlex, D. & Rutland. (2008). DEPTH2: Design and Technology trainee teacher's use of a subject construct model to enable reflective critique of school experience. *International Journal of Technology and Design Education*, 18: 231-246.

Bartel, M. (2008). Teaching creativity. Available at: http://www.goshen.edu/. Accessed 30 July 2012.

Bell, B. & Cowie, B. (2001). The characteristics of formative assessment in Science Education. Hamilton: University of Waikato.

Best, J.W. & Kahn, J.V. (1998). Research in education. Boston: Allyn and Bacon.

Beyer, B.K. (1987). Practical strategies for the teaching of thinking. Boston: Allyn and Bacon.

Black, P.J. (1998). An international Overview of Curricular Approaches and Models in Technology Education. The journal of Technology Studies, 24(1): 1-9.

Black, P. & William, D. (1998). Inside the black box: Standard through classroom assessment. London: Phi Delta Kappa International.

Bryman, A. (2004). Social research methods. Oxford: University of London.

Butt, G. (2010). Making assessment matter. London: Continuum International Publishing Group.

Chapman, A. (2009). Bloom's taxonomy of learning domains. Available at www.businessballs.com. Accessed 19 May 2013.

Chubinski, S. (1996). Creative critical-thinking strategies. *Nurse Educator*, 21(6): 23-27.

City Press. (2011). We are failing our kids, 25 April.

Cohen, L., Manion, L. & Morrison, K. (2000). Research methods in education. New York: Routledge-Falmer.

Coll, K. & Chapman, R. (2000). Choices of methodology for cooperative education researchers. *Asia-Pacific Journal of Cooperative Education*, 1(1): 1-8.

Compton, V. (2004). Technological knowledge: A developing framework for technology education in New Zealand. Available at: www.tki.org.nzcurriculum/whats happening. Accessed on 30 May 2011.

Compton, V.J. (2007). A new technological literacy. Available at: www.iteaconnect.org/PATT/PATT18/fullprog-21a. Accessed 05 August 2012.

Cotton, K. (1991). Teaching thinking skills: School improvement research series. Available at: http://www.nwrel.org/scpd/sirs. Accessed 30 July 2012.

Cox, S. (2008). A conceptual analysis of technological pedagogical content knowledge. Brigham: Brigham Young University.

Craft, A., Jeffrey, B. & Leibling M. (2004). Creativity in education. New York: Continum.

Department of Basic Education. (2011). CAPS: Curriculum Assessment Policy Statement First Additional Language Grades R-3 (Foundation Phase). Pretoria. Government Printers.

Department of Education. (2004). C2005: Revised National Curriculum Statement Grade 7-9 (Senior Phase). Pretoria: Government Printers.

De Vries, M.J. (2002). Integration of knowledge in technological developments: Philosophical reflections on an empirical case study. Paper presented at Technological Knowledge: Philosophical Reflections Conference, Boxmeer, The Netherlands.

De Swardt, A.E. (1998). Technology Education and the development of thinking skills: A case study. Johannesburg: Rand Afrikaans University.

De Swardt, A.E., Ankiewicz, P. & Engelbrecht, E. (2005). Technology in South Africa since 1988: A shift traditional teaching to outcomes based education. Paper presented at PATT15 Conference. Harlem, Netherlands.

Engelbrecht, W. (2008). Technology teachers' experience of an industry-sponsored, school-focused model for continuing professional teacher development. Johannesburg: University of Johannesburg.

Ertmer, P. & Ottenbreit-Leftwich, A. (2009). Teacher technology change: How knowledge, beliefs and culture intersect. Available at: www.edci.purdue.edu/.../AERA01.Ertmer-Leftwich. Accessed 30 August 2011.

Evans, D. (2007). Developing mathematical proficiency in the Australian context: Implications for students with learning disabilities. *Journal of Learning Disabilities*, 50(5): 421-426.

Facione, P.A. (1990). The California Critical Thinking Skills Test: College Level technical report. Millbrae: The California Academic Press.

Financial Mail (2009). What's right with schooling, 23 January.

Fogarty, R. & McTighe, J. (1993). Educating teachers for higher order thinking: The three-story intellect. *Theory into Practice*, 32(3): 161-169).

Forrester, J.C. (2008). Thinking creatively and thinking critically. *Asian Social Science,* 4 (5): 100-105.

Fox-Turnbull, W. (2006). The influences of teacher knowledge and authentic formative assessment on student learning in Technology Education. *International Journal of Technology and Design Education*, 16: 53-77.

Fox-Turnbull, W. (2007). Teacher education in Technology through a constructivist approach. Paper presented in Technology Education Conference, Auckland, New Zealand.

Frank, M., Lavy, I. & Elata, D. (2003). Implementing the project based learning approach in an academic engineering course. *International Journal of Technology and Design Education*, 13: 273-288.

Gall, P.J., Gall, M.D. & Borg, W.R. (2005). Applying educational research: A practical guide. Boston: Pearson.

Gauteng Department of Education. (2010). Gauteng, Science & Technology Education improvement strategy 2009-2014. Johannesburg: Government Printers.

Gauteng Department of Education & Gauteng Institute for Curriculum Development. (1999). Technology draft progress map: Foundation, Intermediate and Senior Phases Levels 1 to 6 (Grades 1 to 9). Norwood: Gauteng Institute for Curriculum Development.

Gelven, D.R. & Stewart, B.R. (2001). Developing critical thinking skills of Tech Prep students using applied communications. Available at: http://scholar.lib.vt.edu/ejournals/JOTS/Summer-Fall-2001. Accessed 30 August 2011.

Ginns, I.J, Norton, S.J., McRobbie, C.J. & Davis, R.S. (2007). Can twenty years of Technology assist 'grass roots' syllabus implementation. *International Journal in Technology Design and Education*, 17:197-215.

Golafshini, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4): 597-607.

Gredo, M.A. (1997). A study of the relationship between teacher performance and student acquisition of subject content and higher order thinking skills. South Florida. University of South Florida.

Hammer, D. 1997. Discovery learning and discovery teaching: Cognition and instruction, 15(4):485-529. Available at: dhammer@tufts.edu. Accessed 07 October 2011.

Haapasalo, L. (2003). The conflict between conceptual and procedural knowledge: Should we need to understand in order to be able to, or vice versa. Joensuu: University of Joensuu.

Hoadley, U. & Jansen, J. (2010). Curriculum: Organising knowledge for the classroom. Cape Town: Oxford University Press.

Hoepfl, M.C. (1997). Choosing qualitative research: A premier for Technology Education researchers. Journal of Technology Education, 9(1): 1-16. Available at: http://scholar.lib.vt.edu/ejournals/JTE/v9n1/hoepfl.html. Accessed 02 December 2011.

Hofmeyr, J. (2010). Is this a new curriculum I see before me. *Naptosa Insight*, 4(2): 15-17.

Howell, M.T. (2005). Students' perceived learning and anticipated future behaviors as a result of participation in the student judicial process. *Journal of College Student Development,* 46(4): 374-392.

Hughes, M. (1999). Rigour in usability testing. *Technical Communications,* 46(4): 488-494.

Hunter, B.E. (1993). Fostering creativity: Ensuring quality in education. Austin: St Edward University.

Jacobs, M. Vakalisa, N.C.G. & Gawe, N. (2011). Teaching-learning dynamics. Cape Town: Heinemann.

James, V.; Lederman, R.G. & Vagt-Traore, B. (2004). Creativity. Athens: University of Georgia.

Jimoyiannis, A. (2010). Developing a technological pedagogical content knowledge framework for Science Education: Implications of a teachers' preparation program. Korinthos: University of Peloponnese.

Johnson, S.D. (1992). A framework for Technology Education curricula which emphasises intellectual processes. *Journal of Technology Education,* 3(2): 1-9.

Johnson, S.D. (1997). Learning technological concept and developing intellectual skills. *International Journal of Technology and Design Education,* 7(1): 161-180.

Johnson, B. & Christensen, L. (2008). Educational research: Quantitative, qualitative, and mixed approaches. California: Sage.

Jones, A. & Moreland, J. (2004). Enhancing practicing primary school teachers' pedagogical content knowledge in technology. *International Journal of Technology and Design Education,* 14: 121-140.

Kanselaar, G. (2002). Constructivism and socio-constructivism. Available at: http://pdts.uh.edu/~ichen. Accessed 30 September 2012.

Karagiorgi, Y. & Symeou, L. (2005). Translating constructivism into instructional design: Potential and limitations. *Educational Technology and Society,* 8(1): 17- 27.

King, F.J.; Goodson, L. & Rohani, F. (1998). Higher order thinking skills: Teaching, teaching strategies and assessment. Available at: www.cala.fsu.edu. Accessed 18 July 2012.

Klimoviene, G.; Urboniene, J. & Barzdziukiene, R. (2006). Developing critical thinking through cooperative learning. *Studies About Languages,* 9: 77-85.

Krathwohl, D.R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice,* 41(4): 212-218.

Ku, W.A. (2007). Using concept maps to explore the conceptual knowledge of Technology students: An exploration study. Ohio: The Ohio State University.

LaVerne, S. & Gene, R. (2011). Downsings, mergers, and acquisitions: Perspectives of human resource development practitioners. *European Journal of Training and Development,* 35(2): 135-153.

Leedy, P & Ormrod, J.E. (2005). Practical research. New Jersey: Research Educational International.

Lewis, J. (2009). Redefining qualitative methods: Believability in the fifth moment. *International Journal of Qualitative Methods,* 8(2): 1-14.

Leydens, J.A.; Moskal, B.M. & Pavelich, M.J. (2004). Qualitative methods used in the assessment of engineering education. *Journal of Engineering Education,* 93(1): 65-72.

Lise, M.Y. (2007). Evaluating of an ethnographic research: Learning to labour by Paul Willis. London: University of London.

Lunenburg, F.C. (2011). Critical thinking and constructivism techniques for improving student achievement. *National Forum of Teacher Education Journal,* 21(3): 1-9.

Mahfoodh, O.H. (2011). A qualitative study of EFL students' affective reactions to and perceptions of their teachers' written feedback. *English Language Teaching,* 4(3): 14-25.

Maldonado, R.R. (2012). Sample qualitative research proposal published by permission of the author. Available at: www.chapterpdfcom/...sample-qualitative-research-proposal. Accessed 27 June 2012.

Marrapodi, J. (2003). Critical thinking and creativity: An overview and comparison of the theories. Providence: Critical Thinking and Adult Education.

Mason J. (2010). Qualitative researching. Los Angeles: Sage.

Mathumba, V.R. (2002). Multilingual approach to the teaching of human and social sciences subjects in the Senior Phase. Johannesburg: Rand Afrikaans University.

Mawson, B. (2003). Beyond 'The design process': An alternative pedagogy for Technology Education. *International Journal of Technology and Design Education,* 13: 117-128.

Mawson, B. (2007). Factors affecting learning in Technology in the early years at school. *International Journal of Technology and Design Education,* 17: 253-269.

Mayer, R.E. (2002). Rote versus meaningful learning. Theory into practice, 41 (4): 226-232.

McCormic. R. (1997). Conceptual and Procedural Knowledge. *International Journal of Technology and Design Education,* 7: 141-159.

McGuire, L.A. (2010). Improving student critical thinking and perceptions of critical thinking through direct instruction in rhetorical analysis. Mineapolis: Capella University.

McMillan, J.H. & Schumacher, S. (2010). Research in education: Evidence-based inquiry. Boston: Pearson.

Merriam, S.B. (1995). What can you tell from an N of 1? Issues of validity and reliability in qualitative research. *PAACE Journal of Lifelong Learning,* 4: 51-60.

Miyata, H. & Kai, I. (2009). Reconsidering evaluation criteria for scientific adequacy in Health Care Research: An integrative framework of quantitative and qualitative criteria. *International Journal of Qualitative Methods,* 8(1): 64-75.

Montgomery, K. (2009). Using a historical controversy to teach critical thinking, the meaning of theory and the status of scientific knowledge. *Journal of Geoscience Education,* 57(3): 214-221.

Moore, B. & Stanley, T. (2010). Critical and formative thinking assessments: Increasing the rigor in your classroom. Larchmont: Eye on Education.

Morris, W. (2006): Creativity: Its place in education. New Plymouth: JPB.

Murphy, E. (1997). Characteristics of constructivist learning & teaching. Available at: http://www.ucs.mun.ca/~emurphy/stemnent. Accessed 12 October 2012.

Nayagar, Y. (2002). Learners' view of the concept of community service within the curriculum of the Vaal Triangle Technikon. Johannesburg: Rand Afrikaans University.

Nordsdrom, A. (2008). Wisdom 101. Available at: www.wisadompage.com. Accessed 12 October 2012.

Nosich, G.M. (2005). Learning to think things through: A guide to critical thinking across the curriculum. New Jersey: Pearson Prentice Hall.

Orr, J.B. & Klein, M.F. (1991). Instruction in critical thinking as a form of character education. *Journal of Curriculum and Supervision,* 6 (2): 130-144.

Pesonen, M.E. (2004). Solving mathematical problems with dynamical sketches: A study of binary operations. Joensuu: University of Joensuu.

Phillips, K.R.; De Miranda, A.M. & Shin, J.T. (2009). Pedagogical content knowledge and industrial design education. *The Journal of Technology Studies,* 35(2): 47-55.

Pinder,G.(2012). Eight barriers to critical thinking. Available at: http://EnzineArticles.com/?expert=Gene. Accessed 28 July 2012.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education,* 93(3): 223-231.

Prince, M. & Felder, R. (2007). The many faces of inductive teaching and learning. *Journal of College Science Teaching,* 36(5): 14-20.

Pudi, I.T. (2007). Understanding Technology Education from a South African perspective. Pretoria: Van Schaik Publishers.

Purvis, C.A. (2009). Factors which can influence the development of critical thinking skills in Associate Degree Nursing Students. Athens: University of Georgia.

Ramirez, R.P. & Ganaden, .M.S. (2008). Creative activities and students' higher order thinking skills. *Education Quarterly,* 66 (1): 22-33.

Rauscher, W. (2009). The technological knowledge used by Technology Education students in capability tasks. Pretoria: University of Pretoria.

Ricketts, J.C. & Rudd, R. (2004). The Relationship between critical thinking dispositions and critical thinking skills of selected youth leaders in the National FFA Organisation. *Journal of Southern Agricultural Education Research,* 54(1): 21-33.

Robert, P.; Priest, H. & Traynor, M. (2006). Reliability and validity in research. *Nursing Standard,* 20(44): 41-45.

Rohaan, E.J.; Taconis, R. & Jochems, W.M.G. (2010). Reviewing the relations between teachers' knowledge and pupils' attitude in the field of primary Technology Education. *International Journal of Technology and Design Education,* 20: 15-26.

Rohaan, E.J.; Taconis, R. & Jochems, W.M.G. (2009). Analysing teacher knowledge of Technology Education and its effects on pupils' concept and attitude. Available at: www.iteaconnect.org/conference/PATT/PATT22/Rohaan.pdf- . Accessed 15 June 2011.

Rohaan, E.J. (2009). Testing Teacher Knowledge for Technology Teaching in Primary Schools. Eindhoven: Eindhoven University of Technology.

Ryan, F.; Coughhlan, M. & Cronin, P. (2007). Step-by-step guide to critiquing research. Part 2: Qualitative research. *British Journal of Nursing,* 16: 738-744.

Schlichter, C.L. (1991). Teaching content and process: Integrating thinking skills instruction with the curriculum. Virginia: Baldwin College.

Scott,S. & Koch, D. (2010). Teaching university-level Technology students via the learning preferences and problem-solving approach. Available at: http://scholar.lib.vt.edu/ejournal/JOTS/V36/V36n1/. Accessed 15 June 2011.

Shenton, A.K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information,* 22: 63-75.

Spooner, M. (2004). Generating integration and complex understanding: Exploring the use of creative thinking tools within interdisciplinary studies. *Issues in Integrative Studies,* 22: 85-111.

Starko, A.J. (2010). Creativity in the classroom. New York: Routledge.

Sternberg, R.J. (2010). Teaching for creativity. New York: Cambridge University.

Strauss, J. & Myburgh, C.P.H. (2005). Research methodology. Johannesburg: University of Johannesburg.

Strong, A.B. (2006). How do you think? Creative or logical. Brigham: Brigham Young University.

Tapper, J. (2009). Making meaning: Successful Mathematics teaching practices with students in higher poverty schools. New York: New York University.

The Southern African Development Community. (2001). Module 1: Teaching Technology in the Primary School. Pretoria: The Commonwealth of Learning.

Van Niekerk, E.; Ankiewicz, P.J. & De Swardt, E. (2005): Technology Education in South Africa since 1998: A shift from traditional evaluation to a process-based assessment framework. PATT-15 Conference, Harlem, The Netherlands.

Van Niekerk, E.; Ankiewicz, P.J. & De Swardt, E. (2010). A process assessment framework for Technology Education: A case study. *International Journal of Technology and Design Education,* 20: 191-215.

Wallen, N. E.& Fraenkel J.R.(1991). Educational research: A guide to the process. New York: McGraw-Hill.

Webster, A.; Compbell, C. & Jane, B. (2006). Enhancing the creative process for learning in Primary Technology Education. *International Journal of Technology and Design Education,* 16: 221-235.

Welman, C.; Kruger, F. & Mitchell, B. (2010). Research methodology. Cape Town: Oxford University Press.

Williams, P.J. (2000). Design: The only methodology of Technology. *Journal of Technology Education,* 11(2): 1-10.

Wise, V.L. (2011). Quality research: Determining the quality of data. Portland: Portland State University.

Woolfalk, A. (2010). Educational Psychology. New Jersey: Pearson.

Appendix A: Interview guides for Technology teachers

The issues and anticipated questions which were covered during the interview:

- Pedagogical knowledge.
- Subject matter knowledge.
- Knowledge of assessment.
- Knowledge of nature and purpose of Technology.
- Concerns of Technology teachers.

Pedagogical knowledge

- How can Technology teachers' pedagogical knowledge capture and contribute to learners' higher order thinking skills?
- How can the knowledge of teaching approaches and strategies play a role in promoting higher order thinking skills?
- How do the teaching strategies benefit learners with regard to higher order thinking skills?
- How can the link between pedagogical and content knowledge help learners in acquiring higher order thinking skills?
- How can the knowledge of the National Curriculum Statement help Technology teachers in acquiring higher order thinking skills?

Subject matter knowledge

- How is the importance of the teachers' knowledge of Technology subject matter for promoting higher order thinking skills in learners?
- How can the knowledge of different strands of Technology help teachers in promoting learners' higher order thinking skills?
- In which way does the knowledge of construction and manufacture help Technology teachers in promoting learners' higher order thinking skills?
- What do you see as the role of the practical expertise of Technology teachers in helping learners to acquire higher order thinking skills?

Knowledge of assessment

- What is your understanding of assessment?
- How can Technology teachers' knowledge of assessment help learners in acquiring higher order thinking skills?
- Which questions are most suitable for enhancing higher order thinking skills?
- How do you evaluate the process and results of a technological learning activity which involves higher order thinking skills?

Knowledge of nature and purpose of Technology

- How can the teachers' knowledge of the nature and purpose of Technology help learners in acquiring higher order thinking skills?
- What is your understanding of Technology as a learning area and how can that understanding make you help learners in acquiring higher order thinking skills?
- How can the Technology teachers' knowledge of the similarities and differences between Technology and other learning areas help learners in acquiring higher order thinking skills?
- How can the Technology teachers' knowledge of the relationship between conceptual and procedural knowledge help learners in acquiring higher order thinking skills?

Concerns

- Do you get adequate support from your seniors in your school which can help you to teach higher order thinking skills as a Technology teacher?
- What is the impact of the development you get from your seniors and how do you feel about the support you get from them?
- What are your barriers for teaching higher order thinking skills?

Appendix B: Classroom observation checklist

Teacher:……………………………………………….

School:………………………………………………….

Number of learners:………………………………….

Learning area:………………………………………..

Date of observation:………………………………….

Time of observation:………………………………….

PHENOMENON OBSERVED	RESEARCHER'S COMMENT
Technology strands: Learning outcomes: Assessment standards: Resources:	
Teaching approaches	
Teaching strategies	
Integration of other learning areas	
Integration of different strands	
Use of practical examples	
Assessment methods	
Types of questions	

Appendix C: Principal's consent letter for interview and observation

Nkone Maruping Primary School
11062 Mine Road
Braamfischerville
1725

11 January 2013

The Principal

I am a Master's student under the supervision of Professor MT Gumbo in the College of Education at the University of South Africa. I am doing a research to determine the role of Technology teachers' knowledge in the learners' acquisition of higher order thinking skills.

I thus, request your permission to conduct interviews with three Grade 7 Technology teachers and observe their lessons in class over three days at your school. The results of the interview will be used solely for the purpose of this study, and the name of your school and the teachers who will participate in this study will be kept confidential.

Please, indicate your response by signing the reply part below. If you have any query please do not hesitate to consult me at the number indicated below.

Yours faithfully

…………………………………..

Mr Maluleke Richard (Researcher) Cell no. 0722915582

<u>REPLY</u>

PERMISION GRANTED YES….. or NO…..

Principal's name: …………………………………………….

Signature…………………………Date……………………..

Appendix D: Teachers' consent letter for interview and observation

Nkone Maruping Primary School
11062 Mine Road
Braamfischerville
1725

11 January 2013

Technology teacher

I am a Master's student under the supervision of Professor MT Gumbo in the College of Education at the University of South Africa. I am doing a research to determine the role of Technology teachers' knowledge in the learners' acquisition of higher order thinking skills.

I thus request to have an interview with you and observe one of your lessons in class. The results of the interview will be used solely for purposes of this study, and your name and that of your school will be kept confidential.

Please, indicate your consent in the reply part below. If you have any query please do not hesitate to consult me at the number indicated below.

Yours faithfully

…………………………………..

Mr. Maluleke Richard (Researcher) Cell no. 0722915582

REPLY

CONSENT GIVEN YES….. or NO……

Technology teacher's name: ……………………………….

Signature…………………………Date……………………..