A closer look at how grade 9 technology teachers incorporate critical thinking in their teaching of the design process: A case study in KwaSanti cluster.

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ABSTRACT

The Technology Curriculum Assessment Policy Statement (DBE, 2011, p.11) states that Technology should promote critical thinking skills via the specific aims using the design process. The design process is regarded as the backbone of Technology (Ohemeng-Appiah, 2014; Mabaso, 2015) and should be used to structure all learning in the Technology classroom in order to promote critical thinking, problem solving and creativity (DBE, 2011).

The purpose of this interpretivist study was to explore grade 9 Technology teachers' understanding of the design process and critical thinking and establish how these teachers promote critical thinking during their teaching of the design process with two critical questions to be answered; 1. What are grade 9 Technology teachers' understanding of the design process and critical thinking; 2. Do grade 9 Technology teachers promote critical thinking during their teaching of the design process? If so how and? If not, why?. The study sampled conveniently and purposively 5 Technology teachers in the area of KwaSanti as participants with questionnaires, focus group discussions, lesson observation, post-observation interview and document analysis were used to generate data from the participants.

The findings of the study were that Technology teachers in KwaSanti understand the design process to be iterative and the process being more essential than the end product. Teachers' understanding of critical thinking was different from that of the literature. However, it was found that the three teachers whose lessons were observed do promote critical thinking in their teaching of the design process. However, it is important for technology teachers to have a deeper understanding of critical thinking and its associated skills. This could enable learners to develop critical thinking skills that could be useful outside the classroom

Keywords: Critical Thinking; Design Process; Technology Education; Problem-solving

DECLARATION

I, Khethokuthula Chilliba, declare that "**A closer look at how grade 9 technology teachers incorporate critical thinking in their teaching of the design process: A case study in KwaSanti cluster**" is my own original work and that all the sources I have used or quoted, have been indicated and acknowledged by means of complete references.

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Researcher

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Supervisor: Dr Asheena Singh-Pillay

DEDICATION

This thesis is dedicated to my daughters **Simthandile Flawless** and **Mukelwa Lycoline**. You are the reason I keep moving forward on a daily basis. My love and commitment to you will always be unconditional and genuine. May you grow and pursue a life worth being proud of and remember that no star is out of reach.

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"Now therefore, our God, we thank you, and praise Your glorious name."

1 Chronicles 29:13

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CHAPTER 1

CONTEXTUALIZING THE STUDY

1.1 BACKGROUND

Technology Education was introduced in the South African school curriculum in response to the critical shortage of engineers, technicians and artisans (DBE, 2011, JIPSA, 2008). It is envisaged that the introduction of Technology in the school curriculum ought to provide opportunities for learners to engage in tasks that promote critical and creative thinking, teamwork and solve problems using the design process (DBE, 2011; Sotsaka, 2016). Critical thinking, according to Costa and Kallick (2009, p.15) involves the development of dispositions which, include probing, inquisitiveness and keenness of mind, zealous dedication to reason, and hunger or eagerness for reliable information. Secondly, critical thinking refers to the development and application of interrelated cognitive and meta-cognitive skills involved in solving problems, understanding and expressing meaning, identifying relationships, assessing credibility of statements, identifying elements needed to draw reasonable conclusions, presenting the results of one's own reasoning coherently and self-consciously monitoring one's own cognitive actions. Thirdly, critical thinking comprises the development of habits of mind. The Technology Curriculum Assessment Policy Statement (DBE, 2011, p.11) states that technology should promote critical thinking skills via the specific aims using the design process. The design process is regarded as the backbone of Technology (Ohemeng-Appiah, 2014; Mabaso, 2015) and should be used to structure all learning in the technology classroom in order to promote critical thinking, problem solving and creativity (DBE, 2011). The aim of teaching the design process is to promote cognitive skills, such as investigating, analyzing information and reflecting, that are needed for solving technological problems (Mioduser & Degan, 2007; Duran & Sendag, 2012).

This means that, critical thinking is not an innate quality, nor does it develop on its own as it must be nurtured (Ku, 2009). Therefore, it is important for teachers to provide opportunities for learners to think critically during teaching as critical thinking is a key skill needed in a workplace for decision-making, leadership, scientific judgement, professional success and reflective participation in society (Yang & Chou, 2008). Critical thinking skills allows learners to review information, evaluate alternative evidence, demonstrate the ability to justify their choices as well as solve problems they are confronted with in their social context (Jeevantham, 2005). Despite

the reformed curriculum terrain, post 1994 within the South African context, learners still perform poorly in numeracy, science and mathematics (Rademeyer, 2007); deficiencies with regard to higher-order thinking abilities, including *inter alia* critical thinking skills are evident (Howie, 2007). Teachers are at the coalface of curriculum implementation and are the brokers of critical thinking in learners. Thus, it becomes quintessential to question whether South African learners at school are exposed to teaching practices that stimulate them to new and critical thinking.

1.2 RATIONALE FOR THE STUDY

I am passionate about teaching Technology Education and see the Technology curriculum, in particular the teaching of the design process as an avenue to develop critical thinking and creativity in learners. When I was a pre-service teacher of Technology, the interconnectedness between design process, critical thinking, problem-solving and creativity was always emphasized by the various Technology lecturers on campus. I carried this ideology of the design process with me when I was appointed as a teacher of Technology at Hill Top High (pseudonym). This is my second year of teaching at Hill Top High. My enthusiasm to introduce new ideas into the teaching of Technology is always met with resistance by senior (older) teachers of Technology both at school level and at the ward level. At our Technology cluster meeting when I suggest we need to plan how to use the design process to develop critical thinking in our learners my suggestions are always snubbed or shot down. Having studied for an honours degree in Technology Education, I am aware that literature is replete with studies on the nature of the design process, (Lawson, 2006; Williams, 2000; Mawson, 2003; Hill, 1998; Rowel, 2004; Flowers, 2010) teacher challenges with the implementation of the Technology curriculum (Pudi, 2007; Rauscher, 2010; Mapotse, 2012) and teachers conceptions of the design process (Ohemeng-Appiah, 2014; Mabaso, 2015; Singh-Pillay & Ohemeng-Appiah, 2016). Furthermore, research by Mathumbu, Rauscher & Braun (2014) elucidate that teaching in the Technology classroom is restricted to engage only lower order thinking. I am also cognizant of the need to explore the link between teachers' views of the design process and critical thinking and their teaching of the design process. Therefore, I am eager to explore how teachers of Technology within the KwaSanti ward incorporate critical thinking in the teaching of DP.

1.3 SIGNIFICANCE OF THE STUDY

The findings of this study will illuminate how the design process is used (or not) to promote critical thinking among learners. It will bring to the fore factors that enable and or inhibit the promotion of critical thinking during the teaching of the design process. The findings will benefit teachers of Technology to teach the design process in a more nuanced way thereby contributing to the development of critical thinking amongst learners. It will also inform school management teams and the subject advisors of the kinds or types of support teachers need to incorporate critical thinking in the teaching of design process. The teachers in this study are representative of many other dedicated Technology teachers in South Africa, and their respective schools are just a few of many similar schools. Although this case study cannot be generalized to all classrooms, there are commonalities between this case and many similar classrooms in South Africa and the findings will reflect the case in many schools.

1.4. PURPOSE OF THE STUDY

The purpose of this study is to explore grade 9 Technology teachers' understanding of the design process and critical thinking and establish how these teachers promote critical thinking during their teaching of the design process.

1.5. OBJECTIVES OF THE STUDY

The objectives of this study are to:

1. Explore grade 9 Technology teachers' understanding of the design process and critical thinking.
2. Determine if grade 9 Technology teachers promote critical thinking during their teaching of the design process, if so how if not, why?

1.6 CRITICAL QUESTIONS

The critical research questions guiding the study are:

1. What are grade 9 Technology teachers' understandings of:
   1.1. The design process and
   1.2. Critical thinking?

2. Do grade 9 Technology teachers promote critical thinking during their teaching of the design process?
   2.1. If so how and
   2.2. If not, why?

1.7 CLARIFICATION OF TERMS

Critical thinking: Critical thinking is the art of analyzing and evaluating ideas with a view to improving them (Paul & Elder, 2008). Evans (1993) describes critical thinking as thinking that is reasonable and reflective and is focused on deciding what to believe or do. According to Paul, Binker, Martin & Adamson (1989), critical thinking is skilled thinking, characterized by empathy, into diverse opposing points of view and devotion to truth as against self-interest.

Facione (1990) describes critical thinking as: -
"Purposeful, self-regulatory judgement which results in interpretation, analysis, evaluation and inference as well as explanation of the evidential, conceptual, methodological, critiological or contextual considerations upon which that judgement is based". Critical thinking is essential as a tool of inquiry. As such, critical thinking is a liberating force in education and a powerful resource in one's personal and civic life. The definition of critical thinking was used as a conceptual framework of this study. The skills of Interpretation, Evaluation, Inference, Explanation and Self-regulation are of particular importance as they are considered as essential critical thinking skills (Facione, 1990)

Design process: The design-make appraise approach to Technology Education is based on a model of a concept of a design process. There have been many attempts to model the design process (e.g. Lawson, *et al*., 2003; Ministry of Education 2001; Walker & Cross 1983). All describe a common thread from the inception of an idea to a reflection stage evaluating the success of the outcome (Flowers, 2010; Lawson, 1970). While these models moved from a very linear to a very complex iterative pattern during this period, the basic elements were essentially the same. Mabaso (2015) cited Department of Basic Education (2002, 2011) describing the design process as "a creative and interactive approach used to develop solutions to identified problems or human needs". The

process incorporates a range of skills such as investigative, designing, making, evaluating and communication skills (DBE, 2011)

Technology Education: is the study of Technology, in which students learn about the processes and knowledge related to Technology. As a field of study, it covers the human ability to shape and change the physical world to meet needs, by manipulating materials and tools with techniques (ITEA, 2000). Technology Education is one of the eight compulsory subjects in the GET band. The areas of knowledge contained in this subject are: processing, structures, mechanical systems and control, and electrical systems and control. (deJager, 2012: p.10)

Problem-solving: is the process of finding solutions for difficult or complex issues. Sutton (2003, p. 56) stated that "the problem-solving process involves several aspects from which three major facets tend to emerge: the solver's representation of the problem, the solver's background experiences, and the solver's understanding of the problem." The problem-solving process begins as soon as the problem solver generates enough information about the problem space to gain an understanding of the problem. Often, the problem solver can associate concepts from previous experience to solving a similar problem.

1.8 OUTLINE OF THE THESIS

This dissertation comprises five chapters.

Chapter 1 is an introduction to the study to give an overview of the background of the study. It outlines the focus, purpose, and objectives of the study, states the key research questions guiding the research, the rationale of the study and its significance. Chapter one also incorporates clarification of terms used in the study and lastly gives an overview of all the dissertation chapters.

Chapter 2 focuses on the literature review and conceptual framework. Several related studies will be cited on the design process and critical thinking. The chapter delineates the conceptual framework, which comprises of Facione's (1990) theory of critical thinking and the CAPS - IDMEC, (DBE, 2011).

Chapter 3 addresses the research methodology. It explains the choice of qualitative case study as the research design, and outlines the underpinning research paradigm, methods of data generation,

sampling method, the process of data analysis, reporting and presentation of findings, and considers ethical issues.

Chapter 4 will address the data analysis and presentation of research finding, to deduce answers to the main research questions and sub research questions of research question one

Chapter 5 will address the data analysis and presentation of research finding, to deduce answers to the main research questions and sub research questions of research question two

Finally, **Chapter 6** will include the discussion of the findings, recommendations and conclusion.

1.9. CONCLUSION

This chapter highlighted the background to the study, the rationale, significance, objectives, research questions and clarifies important terminology. The next chapter pays attention to the literature review and conceptual framework.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

This chapter presents a review of literature regarding the design process and the theoretical framework pertinent to the purpose of this study. The literature surveyed focuses firstly, on the design process as scholars have different views about the enactment of the design process which should occur. Some scholars envisage the design process as linear whilst other scholars see the design process as iterative (Ohemeng-Appiah, 2014). Secondly, the perspective of CAPS curriculum on the design process followed by scholars' view on teaching the design process is reviewed to support my argument that how scholars perceive Technology teaching can unfold in the classroom. The literature further explores teachers' perspective of the design and the benefits of teaching the design process as the backbone of Technology Education. In this regard, it is worth noting that there is limited research on the development of critical thinking skills in the design process in their teaching of Technology Education. Therefore, literature on what is critical thinking, the dispositions and skills required for critical thinking are explored. Furthermore, we extend on how critical thinking in the design process can be developed through teachers as agents of change. Lastly, this study adopted Facione (1990); CAPS – IDMEC model (2011) and Argyris and Schon's (1974) the espoused theory and theory in use. Using a qualitative method approach, this study explores how grade 9 Technology teachers incorporate critical thinking skills in their teaching of the design process.

2.2 WHAT IS THE 'DESIGN PROCESS'?

Lawson (2006) as cited in Ohemeng- Appiah (2014) and Mabaso (2015) regard the design process as a complex process which stems from its cyclical and iterative nature. Furthermore Lawson (2006) states that the process is not linear, possible solutions come from a complex interaction between parallel refinements of the design problem and ever-changing design ideas. Ohemeng-Appiah (2014) further concurs with Mawson (2003) in considering the design process to be the concept/model that undergirds Technology Education. Jones, Buntting, & De Vries (2011) concur with Mawson and maintain that the design process forms the core of the South African Technology Education curriculum just as it is in many other countries. It is proffered by some scholars that the

design process is a model that comprises various activities or stages one must go through in order to find solutions to achieve the aims of Technology.

2.2.1 Design process: CAPS curriculum perspective

The design process in Technology Education can be the key pedagogic principle of the subject and helps to distinguish it from other subjects in the curriculum. In this regard Nováková (1999) suggests that within general education TE should create a "bridge" between school and real life and that it should form an important part of acquiring technological literacy for lifelong learning. TE in general can thus be used as a vehicle to teach knowledge, skills and attitudes in which technological information can be manipulated and processed by creating a learning environment that enhances motivation and positive attitudes (Starko, 1995).

The curriculum determines what learners should experience in schools to prepare them for the real world. It is therefore necessary for the school curriculum to change in-keeping with changes outside the school. The TE curriculum must be in a "real life" context for the learners as this will give them knowledge which will serve as a foundation from which they can draw to build on over their lifetime and thus become lifelong learners (Norman & Schmidt, 2000). TE can help learners to engage in the development of new skills from an early age in schools. Not only does TE teach basic skills needed in our daily lives, but it allows learners opportunities to engage with critical, creative, and thinking skills, an example of which is the design process. The design process is a basic skill used in many careers, such as engineering, architecture and product design to mention a few. As in any learning situation, the role of the teacher is vital in the teaching of TE. The purpose of this study therefore is to investigate how grade 9 Technology teachers incorporate critical thinking skills in their teaching of the design process.

The South African Curriculum and Assessment Policy Statement (CAPS) for Technology Grades 7-9 (DBE, 2011) describes the design process as a non-linear process. The description of the design process in CAPS concurs with the Revised National Curriculum Statement (RNCS) (DoE, 2002, p. 6) which conceptualizes the design process as:

"A creative and interactive approach used to develop solutions to identified problems or human needs".

The application of the design process: At the heart of the process is the identification of everyday problems, needs and wants of people, and the selection and application of appropriate resources, knowledge, skills and values to develop practical solutions. The design process encourages the development of critical and creative thinking skills. It is worth noting that both curriculum statements identify the following five elements as constitutive of the design process: investigate (seek information, conduct relevant investigation, grasp concepts, gain insights, determine new techniques) design (design brief, come up with possible solutions, draw ideas, graphics 2/3D,make decisions, choose best solution and justify choice) make (use tools/equipment, build , test and modify to suit safety and health) , evaluate(evaluate actions/decisions/results, evaluate solution/s and processes followed, suggest necessary improvements and evaluate constraints) and communicate (presentation and record of communication) (DBE, 2002; 2011). A common thread throughout these definitions is the use of knowledge and skills to solve real life problems within an environmental and social context.

2.2.2 Design process: scholars' perspective

Whilst the Oxford Dictionary defines design in Technology as a plan or drawing that represents how an object functions before it is manufactured, Stewart (2011) regards design as a cognitive plan of action to solve a problem. Mitcham (2001) considers design in Technology to embrace all the processes involved in constructing an artefact such as considering scientific information/skills and applying technical skills. Moiduser (2009) adds that design in Technology involves cognitive steps such as intensive analysis of the problem, identifying the links between the elements of the problem, seeking a solution and combining the elements of the problem. From the above definitions of DP, it can be seen that DP embraces cognitive processes involved in constructing an artifact as well as reflection and refinement of the different steps involved (Hill, 1998). Design is a process used in Technology to solve problem and provide learners with opportunities to think critically while going through the steps of the design process (William, 2000; Potter, 2013). This means that for learners to establish the feasibility of their artifact they have to engage in critical thinking.

The design process used in most educational systems is linear; however this contradicts the reasoning behind why one designs (Davis *et al.,* 2002). Fiell & Feill (2005) assert that the design process is not linear, rather it is a complex activity similar to a game strategy but strangely, it is a

game where the rules are continuously changing and that is what makes it so fascinating and mysterious. According to Davis *et al.* (2002) literature does not support the idea of linear approaches which may be referred to by some researchers as "design, make, appraise" when referring to the design process. Leahy & Gaughran (2007); and Williams (2000) concur that the design process which is the predominant system implemented by teachers in Engineering and TE should not be linear. Williams (2000) adds that the process cannot be linear as the learners do not always start from a human need; neither do they always proceed in an orderly way.

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

The approach by Bosworth & Savage (1994) of the design process suggests that the learner should start with the statement of the problem and follow the steps towards the end where the production of the prototype, observation of how the product works and give feedback as to whether the problem stated in the beginning was solved. The linear models above focus more on the end product than on the process. In contrast to the linear process is the cyclical model, the second model identified by Dagan *et al.* (2003).

However, Ohemeng-Appiah (2014) further explains that the representation of the design process differs in the two policies. The RNCS has no diagram which has only stages that lead to a linear presentation of the design process whilst the CAPS document has a cyclic diagrammatic (re)presentation of it (Ohemeng-Appiah, 2014). With the diagram in the CAPS document, it emphasizes the iterative aspect that the design process is iterative and interactive. Irrespective of the diagrammatic (re)presentation of the design process it must be emphasized from the preceding discussion that both statements emphasize the iterative nature of this process. Both policies leave no room for the design process to be misconstrued by readers or implementers of the policy to be linear in nature, where the 5 stages must occur sequentially (Ohemeng-Appiah, 2014). A technological problem requires the learner to search for a method to solve the problem rather than following a set procedure (Fredrik & Sonneveld, 2009).

Teachers often prefer a linear process which emphasizes the stages of planning and drawing, then construction and finally, testing. Lee & Todd (2004); and Moreland & Jones (2000) agree that teachers still structure design activities as sequential rather than iterative processes. The reason for trying to find a suitable model for the design process is mainly to make the teaching and assessment in TE easier for the teacher (Mawson, 2003). Mawson (2003) continues to caution teachers to see the design process as a helpful guide and not to see it as prescriptive stages to be followed as this can turn the design process and TE into a series, ending in a product rather than a process to solve a problem. Van Dyk (1998) urges teachers to guard against putting too much emphasis on the end product, as it is the process that is more important.

2.2.3 Teachers' perception of the design process

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

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

In a study conducted by de Jager (2012) on the identification of the design process by Technology teachers, the study concluded that although teachers can identify the different stages in the design process, they do not see the design process holistically but focus more on the end product which indicates their lack of procedural and conceptual knowledge. This study also found that the teachers cannot identify all the different activities that need to be done in each stage of the process. The different activities in each stage are contained in the assessment standards of the learning outcome but because the teachers do not know the assessment standards, they do not know which skills and knowledge the learners need to achieve during the design process.

Mabaso, conducted a study in (2015) that explored ACE technology lecturers' and in-service teachers' understandings of the design process, and what informs and influences these understandings. The findings of the study attest that Technology teachers hold different perceptions regarding the design process. Only three participants out of seven held the idea of the design process being iterative. *DP is not linear but usually cyclical in finding a solution whereby evaluation takes place throughout the process. A solution has room for improvement as Technology is ever-changing* (Mabaso, 2015: p.60). The views of the participants indicate that actions taken during the design process are not systematic and structured. The complexity of the design process foregrounds the idea that the design process should not be prescribed for learners. This sentiment is echoed in Kimbel's argument (as cited in Mawson, 2003) where he cautions against the presentation of the design process as a simple, linear, systematic process (Mabaso, 2015).

In a study conducted by Ohemeng-Appiah (2014) on Technology teachers' perceptions of the design process, 7 out of 10 Technology Education teachers view the design process as an activity that can be used to solve problems. The analysis highlights that these teachers do not differentiate between the design process and problem-solving. In other words, the design process is construed to be identical to problem-solving. Furthermore, the design process is seen as a "method or structure or plan" that can be used to solve problems, needs or wants (Ohemeng-Appiah, 2014).

In contrast, 3 out of 10 teachers construe the design process as being related to critical thinking and creativity. Put simply this means, for these teachers the design process is not reduced to a mere problem-solving activity. It is an activity that promotes critical thinking as well as creativity. In other words, for these teachers there are multiple solutions to any problem as well as multiple ways

to work towards solutions for the identified problem. The implications are that learners are free to make choices. These teachers' views of the design process indicate that they encourage problem-solving in diverse and creative ways *(solutions which I as a teacher would not have thought about*) as far as design-related problems are concerned. Furthermore, they allow learners to take control of the "learning" during the design process (*they are doing the project on their own; create your own design*). This finding concurs with what Asik (2010) refers to as learner autonomy. Asik (2010) (cited in Ohemeng-Appiah (2014)) maintains that learner autonomy is the independence from the control of others during learning and it can only occur in a learner-centred classroom. Therefore, an assumption can be deduced that these three teachers have learner-centred classrooms.

2.2.4 Benefits of teaching the design process

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

Fredrik and Sonneveld (2009) suggest that in each stage of the design process, which they call "cyclical zooming", the learners practice each part of the process by doing short capability tasks where they combine procedural and context knowledge. Once the learner is confident in one activity they move to the next. The learners can at any time return to the previous stages. It is both a means of developing learners' knowledge of Technology and a critical outcome of a good Technology Education.

During the design process learners must be continuously assessed (DBE, 2002). Neuman (2003) states that assessment may be done by the learner and teacher through reflecting, testing, modification, re-testing and re-evaluating as the learner progresses through the design cycle of the

design process. He adds that if continuous assessment does not take place, the focus will wholly be on the end product and not on the process, and learners will not analyze the advantages and shortcomings of their product. This could result in learners not understanding the design process especially during the designing and making process.

McGregor (2008) carried out a study in which she examined the impact of task structure on students' learning processes in the context of several case studies on secondary school science practicals. The findings of the case study indicate that task structure can influence the naturalness and level of social interaction when students work collaboratively (McGregor, 2008). This shows that to develop creativity and critical thinking among students, teachers should be conscious of how they structure problem-solving tasks. In addition, McGregor's (2008) study revealed that scaffolding tends to occupy students more deeply with the ways of thinking about the task, and enabled development of both creative and critical thinking. Creative thinking was developed in a way that students were able to use a variety of problem-solving strategies, while critical thinking was developed in a way that students effectively evaluated procedures that influenced their findings (Mabaso, 2015).

Mawson (2007) suggests that learners should also be helped to discover their own ability in reaching decisions and to state and visualize their ideas and that "lateral thoughts built on the recognition of their own existing knowledge and ability" should be encouraged. This is supported by Lewis (2006) who thinks children should rather be helped to achieve creativity.

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

Nováková (1999) agrees that the importance of TE lies in the fact that this subject develops competencies, knowledge and skills through problem-solving which enriches each learner and prepares them for the world of work. She states further that TE taught at school should enable the

learner to be able to participate as a problem solver, decision maker, engineer, fabricator, evaluator and consumer in the real world.

2.3 WHAT IS CRITICAL THINKING?

Paul (1992, p. 11) describes critical thinking as the "art of thinking about your thinking while you are thinking in order to make your thinking better; more clear, more accurate and more defensible." According to Paul (1992, p. 20), critical thinking is "disciplined, comprehensive, based on intellectual standards, and, as a result, well-reasoned." Lipman (1985) defines critical thinking as skillful, responsible thinking that is conducive to good judgment because it is sensitive to context, relies on criteria, and is self-correcting. The words *critical* and *criteria* come from the same root, meaning "judgment." For thinking to be *critical* thinking, it must make judgments that meet criteria of reasonableness.

Critical thinking, at its heart, is thinking about real problems. Although you can reason out puzzles and brain-teasers, the essence of critical thinking comes into play only when you address real problems and questions rather than artificial ones. Critical thinking is far more about what you believe or do. It is about good judgment.

Paul & Elder (2008) describe critical thinking as an act of analyzing and evaluate thinking with the intention of developing it further. Critical thinking is a self-examination activity that entails exceptional standards, appropriate use, sound communication and the ability to solve problems encountered in society. Ennis (1998) views critical thinking as the capacity to reason and reflect with conviction. Paul *et al*. (1989) see critical thinking as skillful thinking that fits into the nature of knowledge requirements and is keen to seek authenticity. Critical thinking is considered as consistent thinking in the application of exceptional standards that seek a solution to a particular problem. Moreover, critical thinking is a skill used to constructively put to rest uncertainly, and to develop an open-minded approach which enables learners to seek alternative solutions to technological problems (DBE, 2011). Furthermore, an open-minded approach allows learners to share ideas and perhaps change their viewpoints when persuasive argument emerges.

Paul & Elder (2008) and Paul *et al*. (1989) concur that critical thinking involves the aptitude to analyze, evaluate, reason, reflect, judge, interpret and manipulate information. These features of critical thinking are fundamental and thus justify the selection of the framework adopted for this

study, which includes analyzing, evaluating and interpreting critical thinking skills. Being able to observe, interpret, analyze and manipulate information to solve problems exhibits competence in critical thinking. Critical thinking involves problem solving, looking for alternatives and being able to analyze findings (Adams & Hamm, 2005)

Moore (2010) asserts that critical thinking provides a structure for problem solving. Critical thinkers can reflect on their own ideas and justify their decision, intentionally focusing on a particular goal (Crawford, Saul, Matthew & Makinster, 2005). Critical thinking is a collaborative process that calls for active involvement and interaction between learners and teachers (Hooks, 2010). Dunn *et al*. (2008) argue that critical thinking is a far-reaching process. One of the characteristics of critical thinking is the capability to analyze information. Furthermore, critical thinkers ask vital questions and solve complex problems by applying open-mindedness and using the ability to communicate effectively with others (Duron, Limbarch & Waugh, 2006).

2.3.1 Dispositions of critical thinking

Paul (1992), Facione *et al*. (1994), and Norris (1995) believe that the education of good critical thinkers includes the fostering of critical thinking dispositions (CTD), as well as the development of critical thinking skills. Dispositions or habits of mind are crucial to critical thinking and many experts assert that without positive dispositions toward critical thinking, it does not happen or may be substandard (McGrath, 2013: p.575)

The list below outlines the dispositions of critical thinking that Technology teachers ought to be familiar with in order to promote and incorporate critical thinking skills while supporting learners to solve technological problems.

Dispositions of critical thinking

- Inquisitiveness on a broad range of matters
- Keen to be well-informed
- Cautious for likelihood to apply critical thinking
- Belief in the procedures that stem from the rational investigation
- Confident in personal aptitude to reason
- Open-mindedness to different views, and flexible to consider alternative views
- Perceptive to others standpoint

- Reasoning fairly without prejudice
- Forethoughts before taking a decision
- Keen to review personal stance where new evidence emerges

The above listed dispositions of critical thinking are those that Facione (1990) (cited in Kola, 2016) considers as fundamental to develop critical thinking skills. Kola (2016) asserts that inquisitiveness as a character of critical thinking skills emanates from the desire to seek dependable and valid information. In addition, learners should be well informed about way technological problems are solved using the design process. Therefore, it is important that learners engage different views expressed by their fellow learners with an open-minded attitude without being biased (Kola, 2016).

2.3.2 The skills required for critical thinking

This study exploits the fundamental and vital critical thinking skills identified by Facione (1990). These skills as cited in Kola (2016) are used in this study to explore how grade 9 Technology teachers incorporate critical thinking skills in their teaching of the design process. The list below is a summary of skills required for critical thinking

Figure 1: Skills and sub-skills for critical thinking

Skills	Sub skills
Interpretation	Categorization Decoding significance Clarifying meaning
Analysis	Examining ideas Identifying arguments Analyzing arguments
Evaluation	Assessing claims Assessing arguments
Inference	Querying evidence Conjuring alternatives Drawing conclusions
Explanation	Stating results Justifying the procedure

	Presenting arguments
Self – regulation	Self-examination
	Self-correction

In order to develop critical thinking skills, teachers ought to develop and support learners through the design process by instilling these skills and subskills proposed by Facione (1990) in their teaching of the design process. Technological problems require cognitive abilities and abstract skills that are high order thinking and Technology teachers are burdened with this incredible task to incorporate and actualize these skills into their teaching of the design process in their classroom.

2.4 CRITICAL THINKING IN THE DESIGN PROCESS

In Technology Education, the design process is fundamental to the teaching, learning and assessment (Ohemeng-Appiah, 2014; Mabaso, 2015). Therefore, learners ought to be encouraged to investigate technological problems with the quest to pursue authentic Technology-based solutions. Before learners engage with the design process, the Technology teacher is required to set out the scenario within the need or problem that needs to be solved. For instance, when teaching about structures, the Technology teacher should describe the context in which the structure could be used to meet a need or solve a problem or create possible opportunities. This enables learners to seek clarification and subsequently draw their own conclusion about the problem to be solved. Mostly importantly, learners can structure their own thoughts to seek the most suitable technological solution. Oxman (2004) affirms that teaching learners how to obtain, systematically arrange and apply both conceptual and procedural knowledge relies greatly on the teacher's cognitive skills and the instruction strategies the teacher enacts.

Duran and Sendag (2012) assert that it is essential that learners are taught skills such as investigating, analyzing, information and reflecting which are vital for the development of critical thinking. Ku (2009) avows that it is important to teach critical thinking skills since learners should develop reasoning capacities that are essential in a rapidly changing world. Similarly, critical thinking skills enable learners to review information, evaluate alternative evidence and demonstrate the ability to justify their arguments as this is correspondence and aligned with the standards of skills to be developed through the design process in a Technology classroom.

However, although it is important to develop learners' critical thinking skills, teachers rarely teach or support learners in developing critical thinking skills. Reed and Kromrey (2001) claim that most learners, after spending so many years in the education system and yet still lack critical thinking skills. The literature shows that the development of critical thinking is often not considered by Technology teachers and that they rather focus on the recall of facts and knowledge using repetitive strategies that are not stimulating (Viera, Tenrerio-Viera & Martins, 2011). As a result, fewer citizens are admitted into the fields of engineering, artisans and technicians that the curriculum aims to produce as a demand from society (DBE, 2011).

2.4.1 Teachers as agents of change

The RNCS states that all teachers and other educators are key contributors to the transformation of education in South Africa. The Norms and Standards for Educators document (1995) describes the role of educators as being mediators of learning, interpreters and designers of learning programmes and materials, leaders, administrators and managers, scholars, researchers, lifelong learners and assessors. The Committee on Teacher Education Policy (COTEP) of 1995 states that effective teaching requires knowledge of the learning process and the acquisition of appropriate knowledge, skills, values, attitudes and dispositions which take cognizance of the political, economic, environmental and social context in which the teaching and learning occur. To be effective in Technology, Reddy (2001) states that teachers must develop three dimensions of knowledge:

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

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

Research by Bailey (2012) and Atkinson (2011) has shown that teachers of Design and Technology (D&T) do not have what it takes to help pupils in this regard. This is due to lack of confidence on the part of teachers in their own D&T abilities (Bailey, 2012) and that teachers do not really

understand the complex nature of the activity involved in design (Atkinson, 2011). In a study on design in the UK, Atkinson (2011) found that “there were many teachers who were not taught to design during their training”. This has had a knock-on effect over the years as a result of the cyclical movement of knowledge from teachers to pupils who in turn become teachers and lecturers who train the next generation of teachers to design. There is a feeling that it is of utmost importance that educators must be trained and re-trained to make Technology Education work in schools. Banks (1994) suggests that the Technology teacher who is currently a "wood expert" or a "metal expert" should be re-trained to develop Science and Engineering knowledge.

According to Sadeck (2001) teachers have a lack of understanding of Technology, they have low literacy levels in Technology, they know what Technology is, but they do not understand it. For teachers to successfully guide students in the design process to generate creative output, it is imperative that they themselves understand the creative nature of the design process (Wong & Siu, 2012). Kola (2016) conducted a study on how Technology teachers actualize critical thinking in their classrooms. The findings of that study suggested that teachers seem to neglect the actualization of the critical thinking skills in the classroom. By implications, the aims of NCS “to identify and solve and make decisions using critical and creative thinking” (DBE, 2011, p.5) may not be realized. Kola (2016) further states that it is vital that Technology teachers have a sound understanding of critical thinking in order to align their teaching strategies towards developing critical thinking skills.

2.5 CONCEPTUAL FRAMEWORK

In this study, the aim is to explore how grade 9 Technology teachers incorporate critical thinking in their teaching of the design process. Therefore, to achieve this, the conceptual framework adopted for this study is adopted from Facione (1990); the CAPS IDMEC model of the design process and the espoused theory and theory in use by Argyris and Schon (1974).

2.5.1 Facione (1990) and IDMEC design process (DBE, 2011)

Facione (1990) believes that critical thinking skills could be developed through Interpretation, Analayzing, Evaluation, Inference, Explanation and Self-regulation. According to Facione (1990)

each skill entails subskills that need to be developed to promote critical thinking as follows: Interpretation (categorize, decoding significance and clarifying meaning); Analyzing (examine ideas, identify arguments, analyze arguments); Evaluation (assessing claims , assessing arguments); Inference (querying evidence, finding alternatives, drawing conclusions); Explanation (sharing results, justifying procedure, presenting arguments) and Self-regulation (self-examination and self-correction). I considered Facione's (1990) framework and the CAPS IDMEC model to be aligned to establish which critical thinking skills and sub skills are developed during the teaching of DP (during content analysis). Facione's framework is used to construct the interview questions and to develop an observation schedule. The interview questions were structured using critical thinking skills and sub-skills to allow the participants to verify their abilities to promote critical thinking skills. This framework is further used in this study to analyze and interpret the data.

The design process IDMEC model presented in the CAPS document is used as a conceptual framework as it involves investigation, designing, making, evaluation, and communication. The conceptual framework of Facione (1990) and IDMEC (2011) are delineated in the table below as it shows the critical thinking skills and incorporates the subskills included in the IDMEC design process as prescribed by the DBE (2011).

Critical thinking skills (Facione, 1990)					
Interpretation	**Analysis**	**Evaluation**	**Inference**	**Explanation**	**Self-regulation**
Categorization Decoding significance Clarifying meaning	Examining ideas Identifying arguments Analyzing arguments	Assessing claims Assessing arguments	Querying evidence Conjuring alternatives Drawing conclusions	Stating results Justifying procedures Presenting arguments	Self-examination Self-correction
Design process (IDMEC) (DBE, 2011)					
Investigation	**Design**	**Make**	**Evaluate**	**Communicate**	
Seek information Conduct relevant research Determine new techniques	Design brief Generate possible solutions Draw ideas Graphics (2/3D)	Use tools and equipment Building, testing and modifying product Safety and healthy atmosphere	Evaluating actions, decision and results Evaluate solutions and processes followed Suggest necessary improvements	Presentation Record of process	

Figure 2: Link between Facione (1990) and IDMEC- CAPS (DBE, 2011)

2.5.2 Espoused theory and theory in use

Argyris and Schön (1974) have indicated that people hold mental maps about how to plan, implement and review their actions. They assert that few people are aware that the maps they use to take action are not the theories they explicitly espouse. In addition, Argyris (1980) contends that even fewer people are aware of the maps or theories they use. In other words, this is not just the difference between what people say and do. According to Argyris and Schön, there is a theory consistent with what people say and a theory consistent with what they do. Therefore, the distinction is not between "theory and action but between two different "theories of action" (Argyris, Putnam & McLain Smith, 1985, p. 82). Hence, the concepts of espoused theory and theory in use.

Espoused theory is the theory used for explaining the action to others, but not necessarily for conducting the action. Espoused theories are explicit. Theory-in-use is embedded in the logic of the action: it is the theory that commands the thinking of the action. Theories-in-use are tacit. Human action may or may not be consistent with a person's espoused theory; therefore, it is never accidental or theoretical. To achieve congruence between espoused theory and theory in use, one must engage in reflective practice. The goal of reflective practice, according to Argyris and Schön (1974) is to create a world that more faithfully reflects the values and beliefs of the people in it through the revision of people's action theories.

2.6 CONCLUSION

This chapter has focused on the literature concerns to the design process and critical thinking by exploring the scholars'; teachers' and the CAPS curriculum perspective on the DP and CT. The chapter furthers discussed the conceptual framework adopted and employed in this study. The next chapter highlights the methodology of the study.

CHAPTER 3
METHODOLOGY

3.1. INTRODUCTION

In this chapter I discuss the research methodology. I justify the philosophical assumption underpinning this research, namely interpretive paradigm and qualitative research approach. Further I explain why this study embraces a case study design. Subsequently the method of data generation, sampling, location of the study, research instruments and data analysis used in this study are highlighted. Attention is also paid to ethical issues, research rigour, strategies used to ensure trustworthiness in the study and finally the limitations encountered in the study.

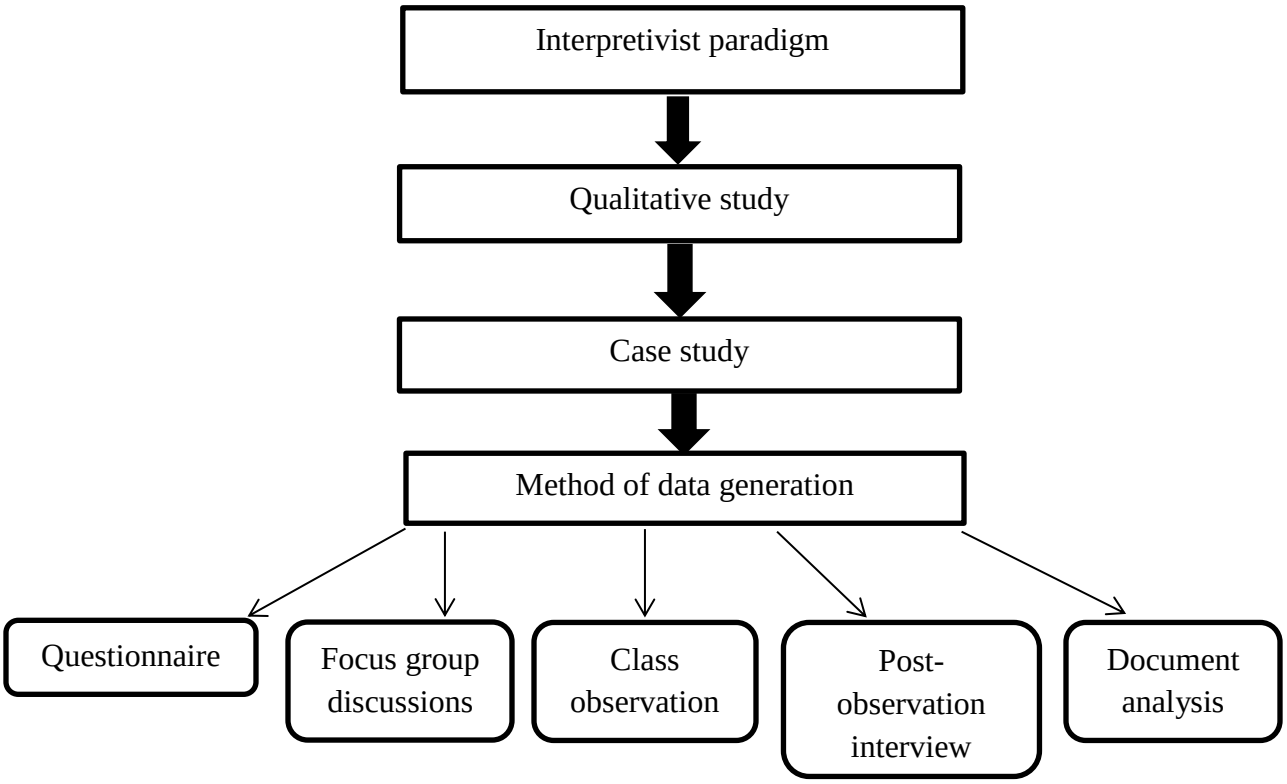

Figure 3: Diagrammatic representation of research methods and approach to this study

3.2. RESEARCH PARADIGM

A paradigm is regarded as one of the frames of references we use to organize our observations and reasoning (Babbie, 2011). This study is underpinned by an interpretive paradigm. According to Cohen, Manion and Morrison (2018) the main concern of the interpretive paradigm is to

understand the subjective world of human experience, in order to derive meaning from shared experience. Similarly, Bertram and Christiansen (2014) state that the purpose of an interpretive paradigm is to develop a better understanding of how people make sense of contexts in which they live, work and learn. This means that researchers employing an interpretive paradigm aim to describe and make sense of social phenomena, such as peoples' opinions and experiences, in order to develop a greater understanding of how people make sense of the contexts in which they live and work. The interpretive paradigm has the following characteristics as given by Cohen *et al*. (2018). It focuses on the individual, is small- scale research, acknowledges subjectivity, is qualitative in nature, has multiple directions of causality and seeks understanding of actions or reasons rather than cause and effect. Researchers using this paradigm thus focus on the specific context in which people live and work (Creswell, 2013). This study is concerned with exploring grade 9 Technology teachers' understanding of the design process and how they incorporate critical thinking skills in their teaching of the design process within the KwaSanti ward. Within this framework the teacher is seen as a social being situated within a particular social background. The social background within which the teacher works is influenced by contextual factors. These factors such as resources and types of training are considered when we examine teacher practices in terms of the design process.

The ontological assumptions of the interpretative paradigm required me to take into consideration that multiple realities exist. I understood the multifaceted reality of how grade 9 Technology teachers understand design process and how they incorporate critical thinking into their teaching of DP, and that I could only understand this reality from the meaning the participants attach to it. Cohen, Manion and Morrison (2018, p.16) state that the role of the researcher in the interpretive paradigm is to understand, explain, and demystify social reality through the eyes of the participants. For that reason, as the data for this study, I will use the descriptions given by the participants of their experiences and opinions of DP and how they incorporate critical thinking in their teaching of DP.

3.3. QUALITATIVE RESEARCH APPROACH.

The choice to adapt a qualitative approach for this study was guided by the ontological position of the interpretative paradigm. The notion of constructing multiple social realities is fundamental in a qualitative approach and it is recommended by Johnson and Onwuegbuzie (2004, p.20) for

furnishing comprehensive descriptions of human experiences of a phenomenon. Qualitative research offers suitable approaches when seeking to know or interpret in-depth understanding of a real-life phenomenon, such as human subjective experiences, contexts or conditions of living, social behaviours, understanding or conceptions, views and perspectives on social issues (Yin, 2014). Creswell and Creswell (2017) agree that qualitative research is concerned with understanding participants' views, experiences, beliefs, ideals, thoughts and actions of social or human problems.

Qualitative research is an advantage when investigating a completely unknown or unpredictable situation. It allows participants to express their opinions without bias, thereby providing uncut data for the researcher. Furthermore, qualitative research involving human subjects makes use of audio, visual or textual data which enable the researcher to deduce meaning from active social context (Henning, Van Rensburg, & Smit, 2004). Accordingly, qualitative data analysis involves the researcher being able to develop a pattern or theme which best describes the phenomenon observed (Creswell, 2013). In this study, grade 9 Technology teachers' understanding of the design process and critical thinking was explored with a view of gaining in-depth knowledge of how they incorporate critical thinking in their teaching of DP.

3.4. CASE STUDY RESEARCH DESIGN

A case study design was embraced to qualitatively explore grade 9 Technology teachers understanding of design process, critical thinking and how they incorporate critical thinking in the teaching of DP. According to Yin (2014), a case study is an approach to research that facilitates exploring a phenomenon within its context using a variety of data sources. Resonating with Yin's (2014) idea of case study, Creswell & Creswell (2017, p. 462) defined a case study as "an in-depth exploration of a bound system which could be an activity, event, process or individuals." The case study design allows participants to freely share their ideas, views, perceptions and experiences in their natural settings, making it possible for the participants to provide in-depth information/data (Cohen, Manion & Morrison, 2013). This means that a case study is very suitable and useful when a researcher is seeking in-depth understanding of a specific event, process, organization or particular group/groups of people in a particular place. In case study research methodology, the context (real-life context) is a major factor as it gives the researcher the opportunity of interacting with the participants in their natural setting, thereby leading to in-depth understanding and

interpretation of the phenomenon under investigation. Scholars such as Lapan *et al*. (2011, p. 245) and Cohen *et al*. (2013), assert that the hallmark of the case study approach, is that the methodology provides thick descriptions of participants' lived experiences of, or thoughts about and feelings for, a situation, using multiple data sources. These authors further contend that the strength of the case study approach lies firstly in its being concerned with rich and explicit descriptions of events relevant to the case; its focus on individual actors or groups of actors, seeking deep understanding of their views; and secondly that the researcher is involved in the case, because the case study may be linked to the researcher on a personal or professional level. In this case I am a teacher of Technology.

Case studies may be categorized with regard to their outcomes, which include exploratory, descriptive and explanatory case studies (Yin, 2014).

- *Exploratory case study*: This serves as a suitable means of eliciting information in order to seek new insights and clarify one's understanding of process or a problem. This approach also serves as a pilot to other studies or research questions. This implies that the exploratory approach provides new and detailed information or insight about a problem or a process (the phenomenon) through the research findings, which can perhaps inform policy or serve as the background for further research.
- *Descriptive case study*: This type of case study focuses on providing narrative accounts.
- *Explanatory case study*: This deals with hypothesis testing.

Bearing Yin's classification in mind, this study embraces an exploratory case study approach based on the purpose of the study; to explore grade 9 Technology teachers' understanding of the design process and critical thinking was explored with a view of gaining in-depth knowledge of how they incorporate critical thinking in their teaching of DP

3.5. STUDY CONTEXT AND LOCATION

This study is located within the context of the Technology learning area at the grade 9 level. The study is in KwaZulu Natal, in KwaSanti cluster which forms part of the Pinetown District of Education. KwaSanti cluster has public government schools that are accessible to learners from

the surrounding areas of KwaSanti, Dassenhoek, Nazareth, Nagina and Marrianridge. Most of these schools are poorly resourced.

3.6. SAMPLING AND SAMPLING METHOD

Sampling involves making decisions about what people, settings and behaviours to observe (Creswell & Creswell, 2017). According to Cohen *et al*. (2018) the quality of a research study is not only determined by appropriate use of methodology and instruments but also by the suitability of the sampling strategy chosen. Tashakkori and Teddlie (2010) further define sampling as "a process of selecting a subset or sample unit from a larger group or population of interest", as determined by the purpose of answering the research questions. Accordingly, Cohen *et al*. (2018), refer to sampling as a process of decision-making about the population (community), settings, events or deeds that have been chosen for observation. Convenience sampling as well as purposive sampling will be used for the study.

Convenience sampling according to (Maree, 2013) refers to "situations when population elements are selected based on the fact that they are easily and conveniently available". In this study, convenience sampling is chosen on the grounds of proximity and affordability. I am a teacher within the KwaSanti ward and therefore have access to schools in the KwaSanti ward.

Purposive sampling, according to Johnson and Christensen (2008, p. 239) happens when the researcher specifies the characteristics of a population of interest. It therefore allows a sample to be chosen because it illustrates some feature or process that is of interest in the study (De Vos, Strydom, Fouche, & Delport, 2005). The participants in this study are also purposively selected as they are grade 9 Technology teachers from schools with quintile rankings 1-4 and varied learner performance. The teachers were therefore chosen as they had a variety of experiences, to offer a potentially rich and valuable source of information that would provide a deep insight into teachers' understanding of and practice in Technology, thereby answering the research questions of the study.

To achieve the purpose of this study, it was important to select the participants who had appropriate qualifications and or experience in teaching Technology. Five grade 9 teachers of Technology were selected from the 5 high schools within the KwaSanti ward. Each school has one grade 9 Technology teacher.

These five grade 9 teachers of Technology agreed to participate in the study.

3.7. RESEARCH INSTRUMENTS USED TO GENERATE DATA

Several instruments, namely, a questionnaire, focus group interviews, observation of lesson and post-observation interviews were used to generate data to answer the two research questions posed: I will elaborate on each instrument next.

3.7.1. Questionnaire

Questionnaires have several advantages over other research instruments. According to McMillan and Schumacher (2006) they are relatively economical in terms of both time and money and they provide identical questions to a sample of participants, unlike other techniques such as interviews or observations where these may vary. Finally, they allow adequate time for the participants to think about their responses.

The reason for using the questionnaire as the first instrument of data generation was: it allowed participants the opportunity to answer the questions privately, with the information written down by the participants in their own words. These aspects reduce the possibility of the researcher misunderstanding information and then misrepresenting it in field notes.

An open-ended questionnaire was designed with the assistance of a technology teacher educator from a university in KZN. An open-ended questionnaire was deemed suitable to collect data for this study because it could capture the specificity of the situation. Furthermore, it facilitates respondents giving answers without any restrictions which make it suitable for enquiry into complex issues, which by their very nature demand more than simple, prescribed choices (Cohen *et al*., 2018). I was seeking to gain a deeper insight into grade 9 Technology teachers' understanding of design process, critical thinking and how critical thinking skills are incorporated in the teaching of the design process thus an open-ended questionnaire was the instrument of choice to generate data. Open-ended questions, according to Cohen *et al*. (2018), make it possible and easy for the respondents to answer without any restrictions on what they wish to say. This makes it suitable for enquiring into complex issues, which demand more than just simple yes/no answers.

The questionnaire was piloted with senior phase pre-service Technology teachers at the university from which the technology teacher educators hailed. The questionnaire was piloted to check the clarity of the questionnaire items, and to eliminate ambiguities or difficult wording. According to Cohen *et al*. (2018) a pilot study serves to increase the reliability, validity and practicability of the questionnaire. The outcome of the piloting was that the questionnaire items had good construct validity. Changes were made to two questions to avoid ambiguity. The 21 questions contained in the questionnaire were closely linked to the research questions posed, in order to generate data to answer the research questions posed.

Copies of the questionnaire were delivered personally to five grade 9 Technology teachers at their respective schools in the KwaSanti circuit. Teachers were given one week in which to complete the questionnaires in their own time, after which they would be collected. As a follow-up measure, telephone calls were made to respondents after four days to remind them to complete the questionnaire timeously, as suggested by Kerruish, Settle, Campbell-Stokes, & Taylor (2005).

3.7.2 Focus group interview

I opted to use a focus group interview as it allowed the researcher to probe and gain insight into the participants' questionnaire responses about their understanding of design process and critical thinking skills. Furthermore, a focus group interview will generate debates amongst the participants when they present their understanding and incorporation of critical thinking skills in their teaching of the design process and this in turn will provide the researcher with a deeper insight on participants' understanding and practices in their classrooms. All participants, who completed the questionnaire, were invited to participate in a focus group interview. Five grade 9 Technology teachers participated in the focus group interview which was video recorded to capture both verbal and non-verbal information. Longhurst (2010) quotes the explanation given by Krueger and Casey (2000) that interviewing is about talking, but it is also "about listening. It is about paying attention. It is about being open to hear what people have to say. It is about being non-judgmental. It is about creating a comfortable environment for people to share". The purpose of the focus group interview was to sample the respondents' responses by asking each of them questions in the same order thereby increasing comparability of responses (Cohen *et al*., 2007).

3.7.3 Observation schedule

Observations entail being present in a situation and recording impressions of what takes place, then interpreting the meaning of the observed behaviour (Somekh, 2011; Sotsaka, 2016). Observations take place in real-world settings, where programmes are subject to change and redirection. With fieldwork observations, researchers are in direct contact with the setting and the people they are observing (Sotsaka, 2016). Sotsaka further emphasized that direct observation gives researchers first-hand experience and thus enables them to generate detailed descriptions of the setting, the activities, interactions and participants' experiences. Observation also allows the researcher to compare what is written in official programmes, what teachers espouse in practice to what actually occurs in practice. First-hand experience on site is also important in providing insights that might be missed if the researcher relied only on other people's descriptions of the setting (Patton, 2002). Good inquiry through observation thus documents what is actually happening. Through direct observation, a researcher sets out to document, accept and understand the complexities of a changing situation, including what may be unanticipated but emerges as important in understanding the participants' experiences.

Observation provides 'a form of '*primary data*" (Yin, 2011, p.27) because researchers use their own senses to generate data, instead of relying on what has been previously reported by someone else. Similarly, Cohen, *et al*. (2018), note that observation "offers a researcher the opportunity to gather 'live' data from naturally occurring social situations", specifically, by looking directly at what is happening, instead of relying on second-hand accounts. Cohen *et al*. (2018) point out that observation potentially produces more valid or authentic data than that obtained through reading a second-hand account. Similarly, the strength of observations is that it gives direct access to social interaction. Thus, observation data enriches, and supplements data gathered by other techniques and so enables triangulation (Simpson & Tuson, 2003). An observation schedule was designed with the assistance of university researchers. Its role was to facilitate recording data gathered when observing teaching of design process in the grade 9 technology classroom (see appendix 5 for observation schedule). The purpose of the lesson observations was to gain insight into the teachers' practice and to capture any possible disjuncture between teachers' understanding of the design process and critical thinking skills and their practice which incorporate these critical thinking skills. The semi-structured observation schedule enabled the researcher to gather data on the

physical, human, interactional and programme settings. The physical setting involved the physical environment and its organization.

The observation schedule was structured so that the critical thinking skills (and sub skills) were linked to the steps of the design process. This enabled me to observe how the participants used the design process to develop critical thinking. During the lesson the appropriate blocks were ticked when the link between the design process and critical thinking was observed.

Three out of five grade 9 Technology teachers who were purposively selected availed themselves to have their lessons observed. The two teachers who had responded to the questionnaire and focus group interview were transferred to schools closer to their home towns of Ladysmith and Ulundi.

3.7.4 Post-observation interview

Post-observation interviews were conducted with the three teachers whose lessons had been observed. The purpose of the interview was to enquiry further, and so gain more insight into, what had been observed during their lesson on electronic circuits. Post-observation interviews provide more flexible opportunities to probe for greater depth than do a video recording or observation notes. The research focus was not only to explore how teachers' understanding of critical thinking skills and how these skills are incorporated in the teaching of the design process, but further gain perceptions into their thinking and reasoning in the process of knowledge transformation, and their reflection in and on action (Park & Chen, 2012; Schön, 1983, 1987). The post-observation interviews were thus used in the study to clarify, supplement and support what had been observed in the classroom and to provide further information that could not be captured by observation alone (Cohen *et al*. 2018).

3.8. DATA GENERATION PLAN

The table below reflects the data generation plan for the study. Data was generated in two stages.

Table 1: Data generation plan

Phase	Research question	Instrument	Data source	Analysis
1	What are grade 9 technology teachers' understanding of: ✓ the design process and ✓ critical thinking	Questionnaire, Focus group interview	Gr 9 technology teachers	Content analysis using construct of conceptual framework
2	Do grade 9 technology teachers promote critical thinking during their teaching of the design process? ✓ If so when and how? and ✓ If not, why?	Observation Document analysis (lesson plan, assessments-learners portfolio) Post observation interviews	Gr 9 technology teacher	Content analysis using construct of conceptual framework

Stage one:

In the first stage, an open-ended questionnaire was used to generate data followed by a focus group interview. The focus group interview was video-recorded. Video recordings can capture non-verbal data (body gestures, facial expression, and tone), which audio recordings cannot or that an observer may miss. Another advantage of using video recordings is that they are an accurate image of what occurs and allow for repeated viewing and checking. The repeated viewing and checking of the video recording thus serve as a means of data validation. The audio portion of the video recordings was transcribed and sent to participants for member checking, (see section 3.11.1 for more details).

Stage 2

During stage 2, an observation schedule (see Appendix 5) was used to frame observations of how teachers incorporate critical thinking skills in their teaching of the design process. Three of the participants (T1, T3 and T5) from phase 1 agreed to have their lessons observed. Observation of lessons was video-recorded. A post-observation interview was then conducted to follow up on the practice observed and all pre- and post-observation interviews were video-recorded. Each of the three teacher's teaching portfolio, comprising tests, assignments, homework and class exercises,

were also subjected to document analysis to establish their practices in respect of incorporating critical thinking skills in their teaching of the design process.

3.9. DATA ANALYSIS

Following the data generation phases, were two stages of data analysis. According to Cohen *et al*. (2018), analysis of qualitative data involves organizing, accounting for and explaining the data in terms of the participants' conception of the phenomenon being explored, noting patterns, themes and categories and regularities. Data from the two stages was analyzed by a deductive approach. Deductive analysis involves a systematic procedure for analyzing qualitative data where the analysis is guided by specific objectives (Cohen *et al*. 2018). Using this approach, all the relevant data from different sources (questionnaire, focus group interview, and observation schedule) are collated to provide a collective answer to a research question. In this study, grade 9 Technology teachers' promotion of critical thinking skills in their teaching of the design process is focal. The conceptual framework developed (see chapter 2, section 2.5) was used during the analysis. The two research questions posed in this study will inform the organization of data for analysis.

Content analysis of data

The analysis commenced after the questionnaires had been returned. For research question 1 (What are grade 9 Technology teachers' understanding of critical thinking and the design process?) I engage in content analysis of the questionnaire and focus group interview transcripts. Content analysis, according to Cohen *et al*. (2018), is a systematic set of procedures for rigorous analysis, explanation and verification of the content of written data. It is a technique for making replicable and valid inferences from text to the contexts of their use. The transcripts were read several times before coding could begin. Codes sharing the same characteristics were grouped together and categories emerged from the data.

3.10 ETHICS AND GAINING ACCESS

According to Durrheim and Wassenaar (2002), the code of ethics for research is concerned with the researcher's attempt to value human rights. There are several ethical considerations that must be observed when doing research among humans, because it may be invasive and complex (de

Vos *et al*., 2005). One ethical aspect is gaining access to a site and/or participant, which means dealing with various gatekeepers at each research stage, as is explained next.

Prior to conducting this study, formal permission to conduct research was first obtained from UKZN's research office, which included the ethics committee, and the school principals in the KwaSanti ward. I realized that gaining permission was an iterative process. I experienced difficulty in trying to contact the principals of certain schools as they were attending a series of meetings in preparation for a looming strike by the teacher unions. After many fruitless visits, some of the principals were finally contacted and formal permission was granted for the study to be conducted in those schools. In one instance, when I arrived at a school, my supervisor was telephoned to confirm that I was her student before I could be granted permission to conduct research at that school. Eventually permission to conduct research was obtained from the five school principals in KwaSanti ward. Once I had gained the principals' consent to conduct research at their schools, I finally sought permission from individual grade 9 Technology teachers to include them in this study. Whilst requesting the teachers' permission, I informed them verbally about the background and purpose for the study. Participants were also made aware that they could choose to withdraw from the study at any time, and they would also be guaranteed confidentiality and anonymity.

3.11 CREDIBILITY AND TRUSTWORTHINESS

3.11.1 Member checking during the research

Member checking is a research procedure used to ensure credibility and validity of the research. According to Carlson (2010), member checking involves taking back the interview transcript or observation transcripts and asking participants to check their accuracy. In this process, participants are given the opportunity to elaborate, clarify or confirm aspects of the interview in order to ensure that their views, experiences and perceptions were captured accurately during the interview. Thus, member checking was adopted to guarantee the credibility of the research. Some participants were reluctant to participate in the quality assurance activity, blaming their unwillingness on their tight work schedules.

3.11.2 Triangulation during the research

Triangulation was used as a measure to ensure credibility and trustworthiness of this study. It is a process used to ensure validity in research. According to Creswell and Miller (2000), triangulation is used to increase credibility and check dependability by sourcing information from different sources to form themes for the study. This was done by collecting data using questionnaires, interviews and observation to ensure the authenticity (validity and reliability) of the data. This is to say data collated via a questionnaire, observation and interviews were triangulated. Triangulation assisted in identifying and adjusting inconsistencies encountered in the three phases of data collection.

3.11.3 Rigour

Like all other studies my research was subjected to open critique and evaluation from other researchers to improve the value of the study, soundness of the methods used, accuracy of findings as well as the quality of assumptions made, or conclusions reached as proffered by Long and Johhnson (2000). This was done in close and frequent consultations with my supervisor.

3.11.4 Anonymity

For ethical reasons all participants in the study were assured of the anonymity of their identity before and after the data collection to enable them to partake willingly and freely in the research. To that effect, the anonymity of the respondents was fully ensured. Their identities were known only to the researcher and the supervisor of this research. Again, ensuring anonymity also guaranteed strict adherence to the university's research ethical standards.

3.12 LIMITATION

A possible limitation of the study that was anticipated was if participants wished to withdraw from participating for any reason. However, most of the participants withdrew towards the end of data collection. Furthermore, some participants behaved differently from normal, for participants who would not participate well in discussions, to normalize the situation, the researcher also gave participants an opportunity to write their responses on paper.

3.13 CONCLUSION

This chapter has described the research methodology and the rationale for the choice of methods adopted in the study. The method of choosing a sample as well as description of the sample has

been presented. A brief statement of what a research design is together with the instruments used for data collection was explained. The method used to analyze data was discussed. Issues of validity and reliability have been addressed. In the following chapter the data will be analyzed and interpreted.

CHAPTER 4

PRESENTATION OF DATA AND ANALYSIS: RQ1

4.1. INTRODUCTION

This chapter aims to answer the research question one, namely, What are grade 9 Technology teachers' understanding of:

1.1. The design process and

1.2. Critical thinking?

As mentioned in the previous chapter in order to answer research question one, data was generated using a questionnaire and a focus group interview. Data was subjected to content analysis. I first present data from the biographical section of the questionnaire follow by data from the opened ended questions. The chapter ends with a conclusion.

4.2. BIOGRAPHICAL DATA

The data acquired from the biographical section of the questionnaire was to create a context for grade 9 Technology education within KwaSanti region. This section of the questionnaire focused on teacher qualification, teacher age, gender, teaching experience, years teaching Technology Education as well as whether they had attended any training for technology education to assist with implementation of the curriculum. Three female and two male teachers formed the sample in this study. Table 2 below reflects the qualifications, teaching experience and number of hours spent teaching technology per week.

Table 2: Reflecting qualification, teaching experience of technology teachers in KwaSanti ward

Number	Gender	Qualification	Teaching experience	Attended technology training workshop	Hours spent per week teaching tech
1	Female	PGCE(Tech)	7	Yes	8
2	Male	PGCE(Tech)	8	Yes	4
3	Male	BED hons (no tech)	2	No	6
4	Female	PGCE	9	No	8
5	Female	BED (tech)	3	No	16

From table two, it is visible that two out of 5 teachers (T3 & T4) do not have a qualification in Technology and that these two teachers did not attend the Technology training workshop, conducted by subject advisors, to assist them with curriculum implementation. For T3 and T4 Technology is a "filler" subject, this means they are teaching out of field. Two (T1 & T2) of the three qualified teachers of Technology attended the Technology training workshop for curriculum implementation. Technology makes up 40% (16 hours) of T5's teaching workload. This means that T5 also teaches other learning areas to make up her workload of 40 hours.

4.3. TEACHERS' UNDERSTANDING OF DESIGN PROCESS

Two key themes emerged from the data, namely design as a process and design as a product. Each of the themes will be explained. For each theme, firstly data from the questionnaire is shown, which is then supported by data from the focus group interview, thereafter I present relevant literature findings.

4.3.1. Design as process

In the notion of design as process the following 2 categories emerged:

- Process of solving problems
- Iterative process involving critical and creative thinking

Process of solving problems

Four teachers (T1,T2, T4, T5) view the design process as an activity that is used to solve problem as reflected in the excerpts below:

> *The design process is the same as problem-solving, you identify and define the problem, also solve the problem. T1 (*questionnaire response)
>
> *it's a successful solution to a problem. T2 (*questionnaire response*)*

The excerpt from the focus group supports the idea that design is a process embracing problem solving.

> *Design is the same as problem solving .T4 (*focus group interview*)*

The analysis highlights that these teachers construed the design process to be identical to problem solving.

Iterative process involving critical and creative thinking

Three teachers (T5, T1, T4) construe the design process as being iterative and related to critical thinking and creativity. Put simply this means, for these teachers the design process is not reduced to a process that occurs in a sequential way, where one step must follow the next. In other words, the design process is not construed to be linear in nature. Rather these teachers (T5, T1 and T4) view the design process as an opportunity for learners to think independently, where learners have the freedom to use their own ideas. It is a learner driven process where learners can skip stages, move back and forth between stages and adjust their plans as they explore by trial and error. In other words, for these teachers these are multiple solutions to any problem as well as multiple ways to work towards solutions for the identified problem.

The implications are that learners are free to make choices as reflected in the excerpts below:

> *It is a series of steps, the steps do not occur in a fixed order, each step involves a lot of thinking, planning, researching, rethinking to come up with creative, original solution to a problem identified, learner are free to design as they feel*. T5 (Questionnaire).

The excerpt from the focus group interview validates the notion that design is an iterative process involving critical thinking and creativity.

> *Learners must have the freedom to come up with their own original solution-, they must think innovatively, be creative. Teacher must not force learners to follow the IDMEC steps. Learner can skip stages when their thinking is advanced. They must be creative and yet achieve its purpose.T1- (*Focus group interview*).*

The above excerpts illuminate that these teachers encourage problem solving in diverse and creative ways during the design process. Additionally, they do not force learners to rigidly follow the steps involved in the design process. Learners have the freedom to skip stages and take control of the "learning" during the design process. Learners can be creative during the design process. Creativity is regarded as important in designing products (Jagtap, 2019, Cross, 2011; Gerber & Martin, 2012; Verhaegen, Vandevenne, Peeters, & Duflou, 2013). The above finding resonates with Soobik's (2011) study which reports that in Technology Education lessons, learners' honein their analytical thinking and technical wit through performing problem-solving tasks during the design process. Soobik (2011) further contends that students improve their creativity when they have freedom to express their ideas during the designing of their projects. The above finding concurs with what Asik (2010) refers to as learner autonomy. Asik (2010) maintains that learner autonomy is the independence from the control of others during learning and it can only occur in a learner-centred classroom. Therefore, an assumption can be deduced that these three teachers have learner-centred classrooms. The above finding is aligned with the Basic Department of Education's (DoE, 2011) vision that the design process as a non-linear iterative process ought to be used to structure all learning in a technology classroom (Mabaso, 2015; Ohemeng-Appiah, 2014; DoE, 2011: p.11). The notion that design is an iterative process that fosters learners' creativity is also embraced by scholars such as Mawson (2003); Jones, Bunting and de Vries (2013) who attest to the link between the flexibility of the design process and learner creativity.

4.3.2. Design as production of a product

One teacher (T3) sees design as the production of a product as is visible from the excerpt below:

> *I mark the product; I'm interested in the product only, not the steps involved in designing the product. The product is evidence for the mark given to the learner, when parents query marks I bring out the product so they can see at a glance why their child did well or badly*. T3 (questionnaire)

T3 maintained the above view of design as the production of a product in the focus group interview as is evident in the excerpt below:

> *I still focus on the product, I can't agree with my colleagues about giving marks for problem solving, the learners do not do their projects in class, they get help at home, some even pay other to turn out the product for them, the learners do not do the thinking anyway, so why must I give marks for thinking, their parents do their projects for them, in mot assessing the parents thinking - so I just mark the end product*. T3 (focus group interview)

The above excerpts bring to the fore the contextual realities and turmoil Technology teachers encounter when they must assess a Technology project. The teacher is in a dilemma as s/he is aware that parents help their children to produce a product that looks attractive. The dilemma encountered by the above teacher with assessing the stages of the design process is consistent with the findings of Oivallus, (2011) as well as Rasinen, Ikonen and Rissanen's (2008) studies that reported Finnish teachers often assess only pupil's product at the end of the design process . These scholars argue that assessment should support pupil's self-directed and process-oriented learning throughout the design process.

A closer look at the biographical data indicates that T3 has no qualification to teach Technology, neither has he attended any of the training workshops for the implementation of the Technology curriculum and has just recently started teaching Technology (2 years) and that Technology is a filler subject to assist T3 (teaches 6 hours per week) meet the workload requirement. It can be reasoned that in the absence of proper training for curriculum implementation and proper criteria for assessment of the design process teachers are confronted with dilemmas on how to assess the stages /thinking involved in the design process and hence prefer to assess the end product.

4.4. TEACHERS' UNDERSTANDING OF CRITICAL THINKING

Critical thinking is a self-regulatory ability to make rational conclusions from skills such as, interpret, analyse, evaluate and provide explanations (Facione, 1990). These critical skills formed the backdrop to evaluate participants' understanding of critical thinking. Teachers understanding of critical thinking from the questionnaire are reflected in the excerpts below:

It is the ability to compare, criticise and analyse deeply. T1

It's when learners think outside of a box. T3

Critical thinking occurs when learners are given a chance to think when designing. T4

The above views are confirmed by responses from the focus group interview:

When learners can think unaided and understand. T2

When they use their imagination. T3

The excerpts above highlight that teachers have a very naïve understanding of what critical thinking entails. For example, the ability to compare and contrast are subskills of analysis, which is a major critical thinking skill in Facione's framework of critical thinking. However, it must be noted that these teachers do involve learners in (thinking and understanding/ or interpreting). Interpretation is a form of critical thinking that entails categorization, decoding information and deriving meaning (Facione, 1990). It is worth noting that novice teachers considered the design process as involving critical thinking and creativity and they could link the processes /skills of critical thinking to design (*thinking, planning, researching, rethinking to come up with creative, original solution to a problem identified).*

It would be interesting to see how teachers' understanding of critical thinking unfolds in their classrooms when engaging learners in design.

4.5. CONCLUSION

In this chapter, I attempted to answer research question one using data generated from the questionnaire and focus group discussion. My finding indicates that teachers have two major understandings of design, namely as an iterative process involving problem-solving, critical thinking and creativity as well as a production of a product. In terms of understanding critical thinking teachers seem to have a limited understanding- they did not link critical thinking to the processes involved in design. In the next chapter, chapter 5 I present the analysis for research question two.

CHAPTER 5

PRESENTATION OF DATA AND ANALYSIS: RQ2

5.1. INTRODUCTION

This chapter aims to answer the research questions one, namely Do grade 9 Technology teachers promote critical thinking during their teaching of the design process?

If so how and

If not, why?

To answer research question two data generated via a focus group interview, observations and post observation interviews was used. As mentioned previously in chapter 3 only three teachers (T1, T3 and T5) availed themselves for stage two of data generation. I present the data from the observations and post observation in order to establish grade 9 Technology teachers' practice in terms of the promotion of critical thinking during the teaching of design and use the data generated from the focus group interview for the espoused practice. All three teachers were teaching different sections after the mid-year examination (T1 taught gears, T3 electric circuits and T5 food processing). A brief description of each teacher's lesson is presented.

5.2. Presentation of data for T1, T3 and T5)

Observation of T1's lesson on gears

Duration of lesson: 60 minutes

School context: The area around the school is neat and free of litter with a fence around the school. The principal walks around the school and learners are clad in their school uniform and are in the classroom during lesson time. The building is old but well maintained and the classroom is neat, with a box that serves as a bin. There are about 60 learners in the class, each learner has a desk and chair, the furniture is old. There is a teachers table in the classroom and each learner has a desks and chairs, although the furniture is old. The learners' desks and chairs are arranged in groups to allow 6 learners per group and there is a table the teacher

The lesson: T1 brings to class 6 hand drills, 6 egg beaters, 6 steering racks and 10 mechanical kits. The hand drills, egg beaters and steering racks are distributed among the learners. Learners are asked to observe this equipment and notice how they "rotate". After a few minutes T1 asks one learner from each group to explain how a piece of equipment functions. Learners were asked to identify the driver and driven gear, and the direction of rotation and learners were asked to present their identifications with a justification. The mechanical kits were passed out to each group and learners were instructed to use the mechanisms kit to complete the activity on gears. Learners were required to build at least 3 examples of gears, draw exactly what they had done and use a block diagram to indicate the Input and Output directions in each of their examples. They were also required to provide 2 or 3 examples of gears used in children's toys. Learners were given a project to research a sliding door and consider the impact of gears on society.

The lesson plan: The lesson plan was in detail. Learners were required to identify gears in everyday life, build examples of gears and consider the impact of gears on society.

CT/design	Interpretation	Categorises	Translate significance	Clarify meaning	Analysis	Examines ideas	Identify arguments	Analyse argument	Evaluate	Access credibility	Assess quality	Analyse argument	Inference	Query evidence	Find alternatives	Draw conclusions	Explanation	State results	Justify procedure	Present argument	Self-regulation	Reflection & correction
Investigate	x	X	x		x	x	x		x		x		x			x	x	x				x
Design	x	x	x		x	x	x		x		x		x			x	x					x
Make	x	x	x		x	x	x		x				x				x					x
Communicate	X				X				X				X				X				X	

From the above table 3.1 it is evident that T1's lesson foregrounded the investigate, design, make, evaluate and communicate steps of the design process. Learners were involved in all stages of the design process. T1 embraced 5 critical thinking skills in the teaching of gears in the grade 9 Technology classroom. T1's teaching strategy promoted and allowed for critical thinking among the learners.

Post observation interview

T1 stated that in the teaching of technology critical thinking was embraced by engaging learners in hands on activities, teacher demonstration followed by learners discussing their observations, tasks, application of content to context and projects linked to real life.

Observation of T3's lesson on electrical circuits

Duration of lesson: 45 minutes

School context: the school has no fence, many learners are sitting or standing around the school area (they are outside the classroom) while lessons are being conducted. The classroom where the observed lesson occurred is untidy, with litter everywhere and no electricity. There are many learners in the classroom (65), not all sit at a desk but all have chairs. Learners share textbooks (about 3 per textbook) are rowdy.

The lesson: The question and answer technique was used in the lesson. T3 posed a series of questions at the start of the lesson but before learners could respond to the questions posed he gave the answers to the learners. Learners were referred to a task in the textbook (on circuit diagrams-connecting components in series) and 5 learners were called to the board to draw diagrams. Thereafter the learners were asked to check if the diagrams were correct. Learners answered in chorus (that is, they all answered together) - T3 did not ask learners to justify their answer.

T3 then set up a simple circuit and asked learners what would happen if more bulbs were added. Learners were asked to justify their responses. T3 connected an ammeter and voltmeter in the circuit and learners were given the reading on both meters as the number of cells increased. As a

conclusion to the lesson, learners were asked to plot a graph of potential different vs current strength.

Lesson plan: the specific aim was for learners to investigate the relationship between current strength, potential difference and resistance.

The table 3.2 below reflects the observation schedule for T3's lesson

CT/design	Interpretation	Categorises	Translate significance	Clarify meaning	Analysis	Examines ideas	Identify arguments	Analyse argument	Evaluate	Access credibility	Assess quality	Analyse argument	Inference	Query evidence	Find alternatives	Draw conclusions	Explanation	State results	Justify procedure	Present argument	Self-regulation	Reflection & correction
Investigate	x	x															x	x				
Design																						
Make																						
Communicate																						

From the above table it is evident that T3's lesson foregrounded the investigation step of the design process, learners were not involved in designing, making or evaluating but were involved in the communication stage (graphical communication) as they had to plot a graph to establish the relationship between potential difference and current strength while keeping resistance constant. T3 embraced two critical thinking skills (translate meaning/clarify meaning and state results). T3 missed many opportunities to encourage critical thinking among the learners in his lesson when

he gave answers before learners could respond as well as when he did not ask learner to justify their responses.

Post observation interview:

T3 claimed that he actualized critical thinking skills by using scenarios, case studies, projects and problem-solving of community issues.

Observation of T5's lesson on food processing

Duration of lesson: 30 minutes

School context: The area surrounding the school is unkempt- it is surrounded by overgrown grass and shrubs. The fence is falling down and learners are escaping from school through the dilapidated fence. Many teachers are sitting in the staff room. The classroom is untidy with much graffiti on the wall and desks and windows are broken. There are only 15 learners in class (the other 45 have absconded the lesson according to the learners).

The lesson: the lesson focuses on ways of preserving food (western and indigenous) and extending the life span of food. T5 asks learners to share ideas on how their parents extend the life span of cooked and raw food, as well as how food is stored. Learners eagerly share information as they are very familiar with the methods their parents use to preserve food. T5 then produces a sample of Indian pickles to the class and explains the processes involved in making pickles. Learners are actively engaged as they are questioned about the science involved in each stage of pickling. As a follow-up activity leaners were asked to work in groups to preserve food by either drying /salting, to bring the product and communicate their results to the class.

Lesson plan: The lesson plan was not in great detail; however the focus of the lesson was clear. Learners were required to list western and indigenous ways of preserving food, compare indigenous ways of preserving food with modern methods used to preserve food, make and evaluate dried/salted food as a means of food preservation.

CT/design	Interpretation	Categorises	Translate significance	Clarify meaning	Analysis	Examines ideas	Identify arguments	Analyse argument	Evaluate	Access credibility	Assess quality	Analyse argument	inference	Query evidence	Find alternatives	Draw conclusions	Explanation	State results	Justify procedure	Present argument	Self-regulation	Reflection & correction
Investigate	x	x	x		x	x	x		x		x		x			x	x	x				x
Design	x	x	x		x	x	x		x		x		x			x	x					x
Make	x	x	x		x	x	x		x				x				x					x
Communicate	X				X				X				X				X				X	

From the above table 3.3 it is evident that T5's lesson foregrounded the investigate, design, make, evaluate and communicate steps of the design process. Learners were involved in all stages of the design process. T5 embraced 5 critical thinking skills in the teaching of food processing in the grade 9 Technology classroom. T5's teaching strategy promoted and allowed for critical thinking among the learners.

Post observation interview: T5 stated that in the teaching of technology critical thinking was embraced by engaging linking Technology to the learners' daily life, involving learners in hands on activities and, application of content to context and projects linked to real life.

5.3.1. Do grade 9 Technology teachers promote critical thinking during their teaching of the design process?

The data from the observation of lessons (See tables 3.1; 3.2 & 3.3), post observation interviews and focus group discussion illuminate that all three grade 9 Technology teachers do embrace and promote critical thinking during their teaching of technology and the design process. The excerpts below confirm that they do promote critical thinking during their teaching of design process.

> " *I use design process for all my lessons- even if learners are not making a produce , they will be involve in at least one stage of DP and they will engage in some form of critical thinking*" T1 focus group interview.

Similar ideas were expressed during the post observation interview.

> "*in my lesson on food processing I engaged learners in all the stages of the design process, the CAPS policy is clear about the critical thinking skills linked to DP- so critical thinking is involved in each step of DP*" T5- post observation interview

> *" I'm trying to include DP in all my teaching as suggested at our technology ward meeting- so in my lesson on electric circuits- learner observed an investigation and were expected to inferences as a follow up activity*" T3 post observation interview

The table 4 below reflects the stages of DP and critical thinking embraced by T1, T3 andT5 in their lesson.

Table 4: showing stages of DP and critical thinking skills embraced in lesson

Teacher	Stages of DP in lesson	Critical thinking skills
T1	Investigate, design, make, evaluate, communicate	Interpretation, analysis, evaluation, inference, explanation, self-regulation
T3	Investigate	Categorizes , state results
T5	Investigate, design, make, evaluate, communicate	Interpretation, analysis, evaluation, inference, explanation, self-regulation

As is visible from the above table the depth at which critical thinking is promoted differs. T1 and T5 embraced all stages of the design process in their lesson and thus provided many opportunities for their learners to engage in various critical thinking skills (see the observation schedule for critical thinking skills promoted during the lesson). T3 devoted attention to the investigation stage of the design process and promoted the development to two critical thinking skills.

Tracing the data from the lesson observations back to the biographical data of the teachers reveals that T1 and T5 are qualified teachers of technology while T3 lacks a formal qualification in technology Furthermore T3 only spends 6 hours a week teaching Technology as part of his workload at his school. This means that technology is a "filler subject" to make up his workload (of 40 hours per week). The except below attests to the aforementioned point:

> "*This is a filler subject for me. So I don't devote much attention to it".* T3 focus group interview

5.3.2. How do grade 9 Technology teachers promote critical thinking during their teaching of the design process?

Sadeck (2001) claims that the approach to teaching technology is different from other disciplines because the primary focus of Technology is not only the development of knowledge but also the development of practical skills and values. For Technology teachers to successfully guide learners to generate critical thinking skills, it is imperative that they themselves understand the creative design process and its routines. In this section I elaborate how T3, T1, andT5 promote critical thinking in their actual classroom practice and their espoused practice.

T3

From the lesson observation it is evident that T3 promotes critical thinking by engaging learners in an investigation of Ohm's law. In his engagement with learners, T3 adopts a top down approach. No opportunities were afforded to learners to ask question, share their views or express their concerns. T3's teaching strategy becomes a hindrance to the learners' development of critical thinking as they are not allowed think time and answers are given by T3. In instances when learners do respond to questions posed T3 does not ask learners to justify their answers or explanations.

According to Facione (1990) the ability to justify teaches learner to present evidence and evaluate contextual factors thereby enabling them to interpret, analyze and evaluate,

Excerpts from the focus group interview and post observation interview bring T3's espoused practice to promote critical thinking during the teaching of technology to the fore

> *"I involve learners in discussion, research, application."* T3 Focus group interview

> *"Learners apply content to solve contextual problems, projects, group work investigations."* T3 post observation interview

From the above presentation of data, it is obvious that there is a disjuncture between T3's classroom practice of promoting critical thinking with his espoused theory of promoting critical thinking in the grade 9 technology classroom.

Data from the observation of T3's lesson and document analysis of his lesson plans confirm that very little modeling of critical thinking occurs when T3 teaches. Scholars such as Brookfield (2012); Snyder and Snyder (2008); Liu (2011) and Van Gelder (2001) assert that it is important for the teacher to model critical thinking in the classroom in order to teach learners how to think critically and to create opportunities for learners to engage in critical thinking. Further, it is worth noting that critical thinking skills are not developed automatically, they should be nurtured.

T1 andT5

T1 and T5 employ similar teaching strategies to promote critical thinking during the design process in the grade 9 Technology classroom. For both T1 and T5 design process is used to structure all teaching and learning as is visible in the excerpts below:

> *"The design process is used to structure every lesson that I teach, it just makes teaching Technology easier."* T5 focus group interview

> *"you would have observed in all my lesson plans- the various stages DP is linked to it and each stage promotes specific critical thinking skills in learners"* T1 post observation interview.

As is visible from the above excerpts the design process is used by T1 and T5 to structure the teaching and learning in their grade 9 Technology classrooms. T1 and T5's practice resonates with Mapotse's (2014) study, which indicates that the Design Process (Investigating, Designing, Making, Evaluating and Communicating - IDMEC) forms the backbone of the subject and should be used to structure the delivery of all the learning aims.

When T1 and T5 use DP to structure their lessons they also employ the, following teaching strategies, group work, research/hands-on activities, application, feedback and discussion as is confirmed by the excerpts below:

> "*I link what I have to teach to their communities, ask them to research, explore , report on an indigenous issues, I provide feedback to them*" T1 post observation interview

> *''I use a community based problem, it is explored, learners work in small groups, they communicate their ideas, they are critiqued to extend their thinking*"T5 focus group interview

Through T1 and T5's classroom practice learners are exposed to problems, conduct research and apply ideas to their context, hence they engage in a systematic process that allows them to develop solutions that solve problems, rectify design issues and satisfy needs. The teaching strategies used by T1 and T5 to promote critical thinking in their class is aligned with DBE CAPS (2011), which emphasizes that design comprises project-centered teaching as well as planning the process, including hands on everyday activities and problem-centered solutions for phenomena. Furthermore, learners in these classes were actively engaged in the various stages of the design process and had the opportunity to be involved in problem solving of interest to them (indigenous methods used to preserve food), research and application. The finding of this study concurs with that of Järvinen (2011), which emphasizes that approaches used to teach Technology should also give students the opportunity to design, develop, apply Technology, investigate and solve problems related to them (Nieman & Monyai, 2006) in order to promote critical thinking. Halpern (2010) found that approaches such as group work, research, projects, investigation, and discussions

support the development of critical thinking skills. These teaching approaches allow learners to encounter several different perspectives to describe a certain topic (Brookfield, 2012).

T1 used group work (during the lesson observation) which is also referred to as collaborative learning as it allows individuals to work together on a given task collaboratively and to produce desired outcomes. Group work promotes communication among learners, and they learn to value different perspectives and respect for each other and their ideas. Critical thinking skills are actualized through group work as learners create multiple and unique ideas, as a team they often discuss them and analyze, evaluate and make sound conclusions that are desired for a certain task.

Both T1 andT5 allow for discussions in their Technology classroom as is evident in the excerpts below:

> *"I often play devil's advocate during learners' presentations and discussion, it is important for learner to know that are different views and ways to solve a problem*"T1, post observation interview

> *"The learners love the discussions and presentation segments of their tasks; they are not shy to express their views or to challenge their friends on what is presented"*T5, post observation interview

The above excerpts show the role that T1 and T5 play in modeling critical analysis and getting different perspectives in their classrooms. Discussions and explanations are essential in promoting critical thinking skills in a technology classroom. Even when activities are given, it is vital for teachers to explain further to simplify for learners what is expected. T1 and T5 made use of class discussions to create meaning of concepts during their observations. Learners would share their ideas and the ideas are discussed as a class to reach a fair and appropriate meaning that is accepted by all the learners. However, for critical thinking skills to be promoted via discussions, it requires

active participation from all the learners to argue and examine ideas with the class which was evident in the two classrooms that I observed.

Table 5: Reflecting strategies used to promote critical thinking

HOW IS CT PROMOTED?			
Group work • Share ideas • Develop each other • Communication	**Challenge learners** • Activities • Presentations • Skeptical learners • Research	**Discussion/Explanation** • More time explaining • Class discussions • Active participation • Space for learners • Relevant examples/scenarios	**Feedback** • Positive/Negative feedback • Marking/Corrections • Right support

5.4. Why are critical thinking skills not promoted?

There are numerous factors that hinder the promotion of critical thinking skills in the teaching of the design process in South African schools. Some of these factors affect teachers directly and others indirectly yet they all play a major role in the ineffectiveness and the unsuccessful promotion of critical thinking skills. Table 6 highlight factors that impede the promotion of critical thinking in the teaching of grade 9 Technology in KwaSanti ward.

Table 6: Reflecting factors leading to Critical thinking not being promoted

WHY IS CT NOT PROMOTED	
Questionnaire & Post observation interviews	**Document analysis & Class observation**
• Overcrowding • Lack of resources • Social issues • Learners • Policy • School politics	• Less resources • Lesson outcomes • No proper planning • Content-based teaching plans • Levels of questioning techniques

5.4.1. Overcrowding

The schools in which research participants teach are all governmental public schools which means they are no-fee paying schools. The enrollment rates hit maximum high whereby in one classroom

there are huge numbers. The large numbers in the classroom hinder critical thinking skills as teachers cannot attend to learners to provide adequate support needed to promote critical thinking skills. Overcrowding also shadows the learners who are brighter as they are often shy to speak in front of many people. Teachers are challenged by the fact that it is even difficult to collect and correct so many workbooks and activities in order to give timeous feedback since the numbers are huge. Therefore, due to overcrowding teachers end up teaching the content and focus on the end results (product based teaching) without learners receiving support.

5.4.2 Lack of resources

It is evidently undisputable that lack of resources is one of the major issues that hinders the promotion of critical thinking skills when teaching the design process. Learners learn better with visuals and what they can feel and touch. The absence of resources leaves teachers without options but to only use a textbook to facilitate and set activities. The absence of resources hinders the promotion of critical thinking as teachers cannot provide support in a manner that is accurate and effective. Schools do not have workshops and tools for teachers and learners to even construct their capability tasks, let alone resource tasks whereby the design process has reached a stage of making. These Technology teachers are exposed and doomed to fail to promote critical thinking skills as lack of resources cripples their attitude towards the subject. Learners are left stranded to gather their own resources and tools to create their work. Furthermore, this limits teachers in monitoring the progress of the learners and providing adequate support. This ends up with one approach where teachers focus on the end product and assessing the final product without the iterative process promoting critical thinking skills in all relevant stages of the design process.

5.4.3 Social issues

The social issues may affect teachers indirectly as most teachers are not aware that they are affected yet it is worth noting that these schools are found in the heart of Black African townships where the rates of poverty, drug abuse and crime is rapidly rising. Most learners in the participants' classrooms are drug users and have no interest in critical thinking skills. These types of learners waste their time coming to school as they spend most of their time in corners and toilets smoking during teaching hours. Therefore, it is difficult for teachers in a classroom to help a learner who is on drugs as it often has undesired outcomes.

Learners from poor homes often have problems but prove to love education. However, the circumstances hinder their promotion of critical thinking skills instilled in them. Usually they come to school hungry and it becomes impossible for teachers to actualize critical thinking skills when a child is hungry. In correspondence, some female learners are mothers and therefore frequently absent themselves from school to attend family responsibilities. It becomes difficult for teachers to promote critical thinking whereby a learner is erratic in attendance. This is proof that learners themselves are not motivated enough to be in school as they are affected by these social issues that hinder their development to become responsible citizens. However, there are those slow learners who lack the ability to think critically and require additional support, yet they do not receive that support due to issues that have been discussed.

5.4.4. School politics

Research participants have complained that school politics plays a major role into why critical thinking skills are not promoted. In schools, we see politics (internal and external) have a fundamental role in the running of the school. The presence of teacher unions and community affiliated programmes such as COSAS and ANC Youth League will disturb normal school days for their own programmes which end up taking away teaching and learning times. Teachers end up left behind on their Annual Teaching Plans (ATP), when teaching resumes, teachers are rushing to make up and cover the content with the remaining time. Teachers then spend no time in supporting learners or creating space for learners to share their experiences and provide adequate skills needed by the learners.

T1 further explained that in her school, technology is placed in the last two periods after break. This action hinders teachers to promote critical thinking skills as learners after the break are often tired and exhausted. It becomes a problematic exercise to teach during the last periods in these schools with the factors discussed above where learners are on drugs and overcrowded in the classrooms. During these times learners are uncontrollable and eager for the bell to ring and for them to go home. Therefore, it becomes difficult for teachers to teach and promote critical thinking skills in their teaching of the design process.

5.4.5. Policy

The policy document as a guide to teaching, learning and assessing is a crucial document that all technology teachers ought to possess and follow no matter what. However, research participants have mentioned that even policy itself has a negative impact on the promotion of critical thinking skills in the teaching of the design process. One of the major issues with the policy is that it does not cater for all types of learners. The kind of activities that it offers is irrelevant to other areas of the country for instance grade 8 term 3 Practical Assessment Task (PAT) which employs learners to create an alarm system. Learners in rural areas who have not been exposed to such components are unfamiliar with the situation.

The policy further does not address which critical thinking skills technology teachers must promote in their teaching but rather emphasizes addressing practical skills such as designing and making.

5.4.6. Teacher planning

The administration process for teachers has always been a challenge, to prepare to teach in the form of lesson planning to be filed which is seen by teachers to be time consuming and strenuous over the time spent on actual teaching. Most teachers fail to keep up with this demand and teach more lessons without proper planning. Due to lack of resources, social issues and politics in our public schools, the lessons become the same with teachers using the same approach relevant to the resources at their disposal. The promotion and actualization of critical thinking skills is not planned for by technology teachers as they often complained about factors that hinders the actualization of critical thinking skills.

In teacher portfolio files analyzed, the lesson outcomes (objectives) make no reference to critical thinking skills to be achieved by teachers at the end of the lesson. Therefore, this emphasizes that the lessons that teachers conduct are content-based. However, Technology is a more practical subject with skills to be promoted yet with schools' lack of resources and workshops learners suffer because these skills are inadequately promoted. Critical thinking skills are not evident from teachers' planning processes which is are factors why critical thinking skills are not promoted by Technology teachers in their teaching of the design process. Due to teachers forced into content-driven teaching which is teacher centered, learners are chosen for what they learn, when to learn it and the pace to learn it. This further addresses why critical thinking skills are not being actualized in a Technology classroom.

In addition, with teachers overwhelmed by factors discussed, the learners end up not being challenged and in fact, the level of questioning in activities and tests, is too low and weak to foster the promotion of critical thinking skills. This means teachers set easier tasks so that learners can pass and for teachers to record a passing situation which keeps a good image for schools with the Department of Education. This further explains why critical thinking skills are not actualized in the classroom and with the number of factors as such, it is still going to be difficult for teachers to promote critical thinking skills in their teaching of the design process.

5.5. CONCLUSION

This chapter presented data to answer research question two, namely: Do grade 9 Technology teachers promote critical thinking during their teaching of the design process?

If so how and

If not, why?

My findings reveal that all three teachers whose lessons were observed do promote critical thinking in their classrooms to varying degrees. The following strategies were used to promote critical thinking investigations, research, discussions, presentations, projects and application of content to context. In the next chapter, I present a summary of this study and make recommendations.

CHAPTER SIX

REVIEW OF FINDINGS; RECOMMENDATIONS AND CONCLUSION

6.1. INTRODUCTION

The focus of this chapter is to provide a review of findings and recommendations from and conclusions to the qualitative study. The analysis of the findings was produced using diverse data generation methods such as questionnaire, focus group interview, observation of lessons and post observation interviews. The study, which aimed to explore whether grade 9 Technology teachers' promote critical thinking in their teaching of design process was underpinned by the following two research question: .

1. What are grade 9 Technology teachers' understanding of:
    1.1. The design process and
    1.2. Critical thinking?
2. Do grade 9 Technology teachers promote critical thinking during their teaching of the design process?
    2.1. If so how and
    2.2. If not, why?

6.2. SUMMARY OF KEY FINDINGS

6.2.1. Findings for research question one

Table 7.1: Reflects the key findings for research question one.

Research question	Findings
What are grade 9 Technology teachers' understanding of design process?	• Design as a process: Process of solving problems Iterative process involving critical and creative thinking Design as a product.
What are grade 9 Technology teachers' understanding of critical thinking?	It is the ability to compare, criticise and analyse deeply.

Grade 9 Technology teachers in KwaSanti ward think of design as a process that is iterative and involves problem solving and critical thinking. A link is established between design process and critical thinking.

Teachers' understanding of critical thinking is limited as it embraces only a few of the sub skills associated with critical thinking. Teachers' understanding of critical thinking differs from the definitions of critical thinking in the literature.

6.2.2. Findings for research question two

Table7.2: Reflecting key findings for RQ2

Research question	Finding
Do grade 9 technology teachers promote critical thinking during their teaching of the design process?	Yes
If so how?	Investigations, all stages of design process, research, group work, discussions.

All three teachers whose lessons were observed do promote critical thinking in their teaching of the design process. The teachers used different strategies to promote critical thinking during the design process as listed in the table above. The investigate stage of the design process provides many opportunities for Technology teachers to connect investigative activities to critical thinking as, stipulated in CAPS (DBE, 2011). Learners are required to conduct research, draw conclusions using inductive reasoning and make inferences. The results indicate that T3 supported his learners poorly when they were involved in investigations. Consequently few critical thinking skills were developed among T3 learners.

T1 and T5 espouse all stages of the design process in their lessons and allow their learners to explore things on their own.

6.3. LIMITATIONS OF THE STUDY

The first limitation in this study was that learners were not given an opportunity to present their views on how they were engaged or encouraged to develop critical thinking skills. This limitation could provide an opportunity for further research. Additionally, time constrains also have been a limitation to this study.

6.4. RECOMMENDATIONS

It is important for Technology teachers to have a deeper understanding of critical thinking and its associated skills. This could enable learners to develop critical thinking skills that could be useful outside the classroom. To this end it is vital to provide continuous teacher professional development for Technology teachers within the KwaSanti ward in terms of critical thinking and to promote professional learning communities among the teachers so that teachers like T3 could benefit from teachers like T1 and T5.

6.5. CONCLUSION

The findings of this study clearly show that grade 9 Technology teachers in KwaSanti cluster do promote critical thinking skills in their teaching of the design process. They use numerous strategies to actualize critical thinking skills, yet there are other factors that hinder Technology teachers to promote critical thinking skills. This chapter has reviewed the findings of the study and discussed its limitations and further made recommendations for future promotion of critical thinking in a Technology classroom.

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ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

21 August 2018

Mr Khethokuthula David Chilliba 212528998
School of Education
Edgewood Campus

Dear Mr Chilliba

Protocol Reference Number : HSS/1116/018D
Project title: A closer look at how Grade 9 Technology teachers incorporate critical thinking in their teaching of the design process: A case study in KwaSanti cluster

Full Approval – Expedited Application

In response to your application received 3 August 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Professor Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committe

/pm

Cc Supervisor: Dr A Singh-Pillay
cc Academic Leader Research: Dr SS Khoza
cc School Administrator: Ms Sheryl Leonardin

Humanities & Social Sciences Research Ethics Committee
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EDITORS CERTIFICATE

Angela Bryan & Associates

6 La Vigna

Plantations

47 Shongweni Road

Hillcrest

Date: 28 March 2019

To whom it may concern

This is to certify that the Master's Dissertation: A Closer Look at How Grade 9 Technology Teachers Incorporate Critical Thinking in their Teaching of the Design Process: A Case Study in the KwaSanti Cluster written by Khethokuthula Chilliba has been edited by me for language.

Please contact me should you require any further information.

Kind Regards

Angela Bryan

angelakirbybryan@gmail.com

0832983312

Appendix 2A: Participant informed consent

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,

Dear Participant

INFORMED CONSENT LETTER

My name is, K.D. Chilliba I am a Masters candidate studying at the University of KwaZulu-Natal,

Edgewood campus, South Africa.

I am interested in exploring **how grade 9 technology teachers incorporate critical thinking in their teaching of the design process: A case study in Kwa-Santi cluster**.

To gather the information, I will be asking you some questions via a questionnaire, lesson observation and individual interview. In addition I also require permission to audio record and observe you teach the design process in a grade 9 technology class.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The questionnaire will take 20 minutes to answer and interview may last for about 10 minutes and may be split depending on your preference.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at understanding grade 9 Technology teachers perception of the design process and its impact on their teaching style. .
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to have your lesson observed and audio recorded and possibly interviewed please indicate (by ticking as applicable) whether or not you are willing to allow the recording by the following equipment:

	willing	Not willing
Audio equipment		

I can be contacted at:0722331573
Email: 212528996@stu.ukzn.ac.za

My supervisor is Dr. A. Singh-Pillay who is located at the School of Education, Science and Technology cluster, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: pillaya5@ukzn.ac.za Phone number: 031-26053672

You may also contact the Research Office through:
P. Mohun
HSSREC Research Office,
Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION OF INFORMED CONSENT

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

Appendix 2B

Permission letters from principals to conduct research in their schools

School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,
April 2018

The Principal,
……..Secondary School

Sir,

Permission to conduct research

My name is, K.D. Chilliba I am a Masters candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am conducting research on **how grade 9 technology teachers incorporate critical thinking in their teaching of the design process: A case study in KwaSanti cluster**.

To gather the information, I will need access to grade 9 technology teachers' class in your school to observe the teaching of the design process. Permission will also be sought from the individual teacher. Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at understanding how grade 9 Technology teachers incorporate critical thinking in their teaching of the design process in the Kwasanti cluster.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to grant me access to your school please indicate (by ticking as applicable)

	Granted	Not granted
Access		

I can be contacted at: 0722331573

Email: 212528996@stu.ukzn.ac.za

My supervisor is Dr. A. Singh-Pillay who is located at the School of Education, Science and Technology cluster, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: pillaya5@ukzn.ac.za Phone number: 031-26053672

To whom it may concern:

Permission is hereby granted for KD Chilliba, a Masters candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa to conduct research at my school.

Yours faithfully,

Sign: ----------

_____

(Name of Principal)

School stamp:

Appendix 3: Survey Questionnaire

A. Please complete the information needed below:

Age	
Gender	
Number of years teaching in general	
Number of years teaching technology education	
Qualification/s	
Qualification in technology education (Please specify)	
Have you attended any training in technology education? Please elaborate about the training and its duration	
Have you attend any conferences seminars in technology education- Please specify	
How many periods of technology education do you teach per week?	
How many periods of technology education makes up your workload?	
Do you teach other learning areas? - Please list them	
Please indicate the number of period's these other learning areas contribute to your workload.	
Level on which you are employed e.g. L1, L2	Level:
Nature of appointment: Permanent/ temporary	

Section B:

1. What is your understanding of :
   design process:_____
   _____
   _____
   critical thinking:_____
   _____
   _____

2. In your opinion is there a link between design process and critical thinking ?, please elaborate .

_____
_____
_____
_____

3. How do you actualize critical thinking skills in your teaching of DP? Please explain.

4. What enables you to teach critical thinking skill in your technology classroom. ? p[lease elaborate.
5. What do you do , when teaching DP to encourage learners to interpret information? Please explain.
6. Do you create the space in your teaching to allow learner to describe their experience to understanding the meaning of a concept? Elaborate.
7. How do you support learners to recognize the importance of interpreting the learning experience?
8. Do you provide opportunities for learners to clarify meaning/ideas during the DP? Please elaborate.
9. How do you motivate learners to analyses statements in you technology class? Please explain.
10. How do you support learners to examine ideas when solving design problems? Elaborate.
11. How do you assist learners to recognize/identify arguments within a claim or opinion? Please explain
12. How do you encourage a learner to analyze an argument? Elaborate.
13. How do you get learners to evaluate the credibility of a statement given? Please explain.

14. Do you think that learners are able to recognize the factors that contribute to the credibility of a given statement? Please explain
_____
_____
_____
15. How do you support learners in drawing their own conclusions when solving design problems? Please elaborate._____
_____
_____
16. Do you think that learner question evidence in order to develop reliable arguments? Please explain._____
_____
_____
17. Can learners formulate alternative solutions when solving design problems? Please explain._____
_____
_____
18. What do you do to support learners in justifying their reasoning? Please elaborate._____
_____
_____
19. Do you allow learners to produce a clear description of their results when solving design problems? Elaborate.
_____
_____
_____
20. Do you create the space for learner reflection on their reasoning during the DP. Please elaborate._____
21. How do you encourage learner o rectify their errors/mistakes? Please explain_____
_____
_____

Appendix 3A: Questionnaire responses

1. What is your understanding of?	
a) Design process	
T1	The design process is the same as problem-solving, you identify and define the problem, also solve the problem
T2	A series of steps which helps learners identify a problem and follow steps to solve the problem. It's a successful solution to a problem
T3	I mark the product; I'm interested in the product only, not the steps involved in designing the product. The product is evidence for the mark given to the learner, when parents query marks I bring out the product so they can see at a glance why their child did well or badly
T4	Critical thinking occurs when learners are given a chance to think when designing
T5	It is a series of steps, the steps do not occur in a fixed order, each step involves a lot of thinking, planning, researching, rethinking to come up with creative, original solution to a problem identified, learner are free to design as they feel
b) Critical thinking	
T1	To think refers to the ability be creative, thinking of something unique and different. It is the ability to compare, criticise and analyse deeply
T2	Critical thinking is thinking abstractly, being able to think high order thinking'
T3	I have less knowledge of critical thinking when it comes to Technology Education but to think critically simply means thinking out of the box
T4	Critical thinking can be the ability evaluate a problem or solution by keeping an open mind as one must evaluate all possible solutions and review all angles of approaching a problem'
T5	Critical thinking refers to high order thinking which involves skills to analyze, interpret, evaluate and make sound conclusions'
2. In your opinion, is there a link between design process and critical thinking?	
T1	'Yes, there is a link because learners are able to come up with solutions to problems that are creative and unique
T2	Yes, there is a link definitely between the DP and CT. The design process helps learners to think critically while engaging in problem solving'
T3	Yes, there is a link definitely between the DP and CT. The design process helps learners to think critically while engaging in problem solving'
T4	Yes, a link does exist because one must design with enough information. Furthermore, the information must be accurate and to address the issue at hand. Critical thinking must be employed to ensure that proper research is done before delivering a required solution'
T5	Undoubtedly, there will always be a link between DP and CT. The skills that learners acquire in critical thinking are essential when engaging with the design process
3. How do you actualize critical thinking skills in your teaching of DP?	
T1	Learners in groups come with different prior background knowledge, critical thinking skills emanates when they are allowed to work with others'

T2	Group work allows learners to engage and share ideas on how a technological problem may be solved. Their skills to be different and creative thinkers is tested when they work with others in solving challenges at hand'
T3	In order for me to actualize or be able to foster critical thinking skills during the design process, I challenge my learners by making them present their ideas in a class discussion and allow others to criticize, reason, analyze and to offer feedback to others. By doing so, I stimulate these skills for learners to be able to understand other views and how they can make better their own ideas.
T4	Group work or teamwork allows learners to come up with a solution that best solves the problem at hand. Critical thinking facilitated by teamwork produces desired results
T5	For me, I would say that due to the high numbers in our classrooms, it is very difficult to effective assess all the learners whether these critical thinking skills are being actualized but with activities that stimulate and challenges learners to question and think of alternatives is how a teacher in the environment that I am in would rather do in order to adhere to time.
4. What enables you to teach critical thinking skills in your technology classroom?	
T1	It is very difficult to teach these skills in our schools because of the numbers in our rooms but we try by all means to foster them by encouraging learners to evaluate each scenario presented to them and not to jump to conclusions but to always have reasons how they came up with the solutions that they have.
T2	This is one of the difficult questions to respond to because not only does it speaks to how critical thinking is but how do we actually teach it. To be honest with you, it is very difficult for teachers in quantile 3 schools to teach critical thinking skills due to less resources and more social factors to be concerned about. However, I usually encourage my learners to be more open-minded in their approach of the design process.
T3	Encouraging learners to research and consult more sources before reaching the final solutions'
T4	in a classroom our sizes and with limited resources, it is never an easy aspect to teach critical thinking skills in a technology classroom. What usually works/ or what I usually do is to provide activities that would challenge my learners; then we would discuss them as a class; further I explain and ask for more options with reasons on how we can make the solution better'
T5	It is very difficult to teach critical thinking skills as there is no textbook and no procedure on how to teach it but as teachers are forced to make a plan I would I say. As Technology teachers we are trained to be critical thinkers in order to be able to instill and pass these skills on to our learners. Yet in reality, it is difficult since you cannot attend a learner individually due to large numbers in our classrooms
5. What do you do, when teaching DP to encourage learners to interpret information?	
T1	I prefer providing more examples that are relevant to what we working with. By doing so, we work through different scenarios and this provide the opportunity for learners to interpret information during the design process'

T2	Learners' experiences are very essential in my classroom as often I sit my learners in small groups in order to be able to attend them effectively. Therefore, they share different experiences and interpret information as a team
T3	I doubt that I have seen it this way but I encourage my learners to question everything
T4	In my classroom, I prefer discussion and brainstorming as a method because by doing so I can tap to a child even in the corner of the room. Sharing those ideas does help learners interpret information
T5	The type of learners we work with or the system we work under is not doing justice. Our learners are just not as active as we may want them to be. My learners want to be spoon-fed and they do not want to do anything. Therefore, now I identify key words, make sure I explain them and to make sure what is expected of them to do'
6. Do you create the space in your teaching to allow learners to describe their experience to understanding the meaning of a concept?	
T1	'I do create the space for learners to share their experiences as this is very important because all the learners come into class with prior background knowledge'
T2	T2 'It is vital as a teacher to create this space in your classroom as you need to allow your learners to contribute to their learning and it makes it easier for the teacher to understand what learners know by giving them the opportunity to share their experiences
T3	Yes I do create this space and often take their experiences to create a definition or understanding of the concept the easy that is easier for them to understand'
T4	Yes I do create this space in my classroom. However, discussions and brainstorming are often methods that work for as my learners share their experiences; as a class we discuss and analyse them in order to define or identify concepts.
T5	I create this space all the time, fortunately I try by all means to facilitate a learner-centred classroom where learners are responsible for what they learn. As Vygotsky states that learners must construct and reconstruct their own knowledge. Therefore, I do allow my learners to share their understanding of concepts based on their prior knowledge and if this knowledge must be reconstructed to fit in the context of my classroom, so be it'
7. How do you support learners to recognize the importance of interpreting the learning experiences?	
T1	Feedback is very important to our learners. Therefore I make sure that I provide feedback to them and then how to solve poor performances'
T2	Making use of more tasks to fill the gap between their learning experiences and application helps me support my learners and I make sure they understand what is happening all the time'
T3	I doubt that I support my learners in this regard'
T4	Learners love it when they succeed, so it important to give positive and negative feedback

T5	My learners enjoy their books being marked and with a lot of ticks. I mark their books regularly and put a star sign to those who done well and encourage those who did not
8. Dou you provide opportunities for learners to clarify meaning/ideas during DP?	
T1	Yes, most certainly. It is easier to assist learners' once you understand what and how they think. In this case when learners clarify their own meanings and ideas during the design process, you are then able to provide the right support that learners require'
T2	Sure, I do provide the opportunity yet I am not sure that my learners do see it that way because when you provide learners with tasks, their aim is to finish it and submit without any eager to have new knowledge
T3	Yes, I do provide my learners with the opportunity to define/clarify their ideas especially when they done something unique. I encourage them to share with the class on how they came about to reach that stage or a certain solution'
T4	I believe so, usually, I group my learners in small groups or in pairs in order to work efficiently and faster to reach our deadlines. However, learners do clarify their ideas and define their own meanings through collaborative learning and teamwork. I usually have discussions and class presentations when we reach certain stages of the design process.
T5	Yes, there is opportunity for my learners to clarify their meanings and to express their ideas while they engage with the design process. In most cases, allowing learners to question and provide them with the space to free (not fearful) to ask for support helps and enables the teacher to understand learners ideas and how to guide them towards a fruitful outcome
9. How do you motivate learners to analyse statements in your Technology classroom?	
T1	I provide them with more challenging scenarios/case studies to help them be able to analyse statements. Usually I sit them around in smaller pairs to make them share ideas and benefit from each other'
T2	When engaging with these learners, you need to be more explicit and make sure you decode every bit, key points and key words in order for them to analyse better.
T3	I would appreciate if you can allow me to skip this question'
T4	My learners are so incorrigible, when provided opportunities they waste them. However, I try by all means to facilitate and motivate them by giving them tasks.
T5	Learners are easily motivated in a classroom where they can feel and touch the world they live in. By saying so, I mean that as a teacher you need to bring the outside world into the classroom. When making examples, use what learners know and what they can relate to. By doing so, it becomes easier for learners to participate and be part of the classroom'
10. How do you support your learners to examine ideas when solving design problems?	
T1	I do provide my learners with support by ensuring that when they have some problems, I am nearby to assist and guide them towards a better understanding of the problem they are facing'

T2	The type of kids that we have today I mostly lazy and do not want to do the work the way we want them to. So in order to provide support; you are forced to be more transparent and have patience. In my classroom I support my learners by providing hints, I give them tips when necessary and examples to help them examine ideas.
T3	I personally prefer brainstorming and discussions to support learners examine ideas. This because I take control of the supporting system by taking different ideas and we explore them together as a class; discuss each idea and how individual views can be used to make better or discreet the idea'
T4	The learners in my classroom examine ideas on their own in form of tasks and small class activities that I often mark and provide feedback in form of classroom discussions to enable them to understand where and how they were incorrect and where to be corrected'
T5	'In my classroom, group work /collaborative learning is the most adequate support I can provide since learners are able to share their ideas and rectify together as a group. As a facilitator I am there to guide them when they encounter issues yet most of the work is done by the learners as a group'
11. How do assist learners to recognize/identify arguments with a claim or opinion?	
T1	I am not sure whether these learners do recognize arguments made not to mention claims and opinions. However, there are incidents whereby as a class engaged in discussions that learners fail to recognize arguments or even fail to accept a different opinion even from their peers'
T2	To assist learners is one of the most difficult jobs to execute because our learners look like they do not need assistance. But for learners to recognize claims, it is more relevant to make them share their experiences with the class and then we discuss and have other views as well
T3	NO ANSWER
T4	NO ANSWER
T5	'In my classroom, no stone is left unturned, my learners are assisted but they all know that when you have a view/opinion it is up for discussion. By doing, the class is open for debate as most learners will participate with contradicting views to challenge a certain claim made or point of view. By this, learners learn differently on how to recognize a claim and what opinions can lead to. This further addresses that learners need to be able to respect other people's views and freedom of speech'
12. How do you encourage a learner to analyse an argument?	
T1	Brainstorming is usually helpful in this regard as learners fail to analyse arguments on their own. I end up brainstorming with them and further engage into a discussion on the arguments'
T2	As I have pointed out before that my learners are so different, I have to break down every material I present to them to bits and pieces in order for them to understand. I can try and encourage them but still I end up providing hints and tips for them'
T3	My learners are yet to be able to recognize and identify arguments, therefore it is very difficult for them to analyse arguments. Maybe this is because we have not dealt with arguments before.

T4	Unfortunately, my learners are unable to analyse arguments'
T5	Most of the learners are unable to analyse arguments which makes the teachers' job very difficult. Yet in my classroom I try by all means to make sure that my learners understand before making decisions and that they are able to differentiate between claims and opinions'
13. How do you get learners to evaluate the credibility of a statement given?	
T1	By allowing learners to evaluate their own work, this allows them to evaluate the credibility of their work
T2	It is very difficult to get learners to evaluate, it a skill that is not fostered upon them. My learners cannot evaluate even if I try to provide tasks that will challenge them
T3	it is very problematic for learners to evaluate the credibility of statements as they cannot differentiate between statements, claims and opinions
T4	My learners are not good with skills of evaluating as this often is challenging to design activities to try and equip learners with these skills
T5	Learners often lack these skills of evaluation and analysis which limits teacher's option to foster activities as such or you end up with time wasted and no work done. Therefore, I usually provide formal and informal activities and those informal I allow learners to exchange workbooks and mark for each other and that helps learners evaluate for each other'
14. Dou you think that learners are able to recognize the factors that contribute to the credibility of a given statement?	
T1	No, the learners do not have these critical thinking skills'
T2	Not at all. The type of learners that we have in these schools are not equipped with these skills that enables them to think critically and creatively'
T3	No
T4	No, our learners are not able to recognize the factors because of the type of environment we teach in'
T5	Not at all, my learners are not convincing at all. However, this I believe is due to the fact that our education system does not provide room for teachers to be flexible and it has a rigid curriculum to teach as assess learners. Learners are taught critical thinking skills at a late stage of their schooling career'
15. How do you support learners in drawing their own conclusions when solving design problems?	
T1	It is easier to support learners when you understand how they think and what is on their minds. Therefore, I usually brainstorm ideas with my learners and support them on their ideas by giving them extra information and tips when it is necessary but allow them to modify their ideas'
T2	Supporting learners is not as easy as we may think because learners appreciate when they do things themselves and succeed. Therefore, I provide feedback regularly with evaluations and modifications to be done on conclusions drawn by the learner'
T3	I allow my learners to draw their own conclusions without my interferences but I guide them as to how this conclusion will affect the solution and how it can be made better'

T4	I prefer brainstorming and discussions, this gives rise to certain levels of ideas and conclusions that learners can draw from. This also helps learners gather certain ideas on how to clarify and modify their original idea or conclusions made
T5	Learners shall always be given freedom to construct their own learning environment and space. Therefore, in my classroom, there is support yet learners are allowed to draw conclusions from their own ideas or solutions. Ads a facilitator, I provide guidance at the ZPD to how we overcome matters that arise when drawing conclusions and making solutions'
16. Do you think that learner question evidence in order to develop reliable arguments?	
T1	Nope, learners always take what teachers say and do not question'
T2	'No, the type of learners I have are not active, they take what I tell them to be true at all times. Yet no one can dispute that learners shall look up to their teachers as teachers are trained and the ones doing the teaching. So learners take what teachers say to be true at all times'
T3	No, the learners cannot question the evidence. This is because the kids we teach are not responsible for their own learning'
T4	Not a chance; our learners do not question the evidence in order to develop reliable arguments. However, it usually depends on what an individual learner is made of. If the learner is more aware and intelligent, then that learner can question the evidence.
T5	No, the learners we have are usually scared to speak out especially in their classroom where they have to defend their arguments. The learners prefer keeping quite even if they see something wrong. They are often scared but you find that when you give them the opportunity to speak they actually know what is going on'
17. Can learners formulate alternative solutions when solving design problems?	
T1 & T3	Learners do not always provide alternative solutions when working on their own. They need assistance and support from their teachers to guide them towards other alternative solutions'
T2, T4 & T5	Group work and team work is often the better method for learners to formulate alternative solutions when solving design problems. This happens as learners come together with different ideas and personalities; then have to formulate a solution together. Their solution can be evaluated and rectified if the solution does not serve the purpose of the entire group. In group effort, alternative solutions emanates as learners come with different ideas
18. What do you do to support learners in justifying their reasoning?	
T1 & T2	I provide a platform for my learners always to always back what they say. This is done in most classes as learners may explain and reason to the whole class as to what he/she is reasoning in that manner
T3	My learners know that they have to explain always, to defend their ideas no matter what. I encourage them to first be able to defend your reasoning in order for it to be accepted'
T4 & T5	'I provide my learners with learners with class activities to enable them to back and justify their reasoning. I prefer this method as my learners are often shy to speak in class discussions and presentations. Yet when I provide feedback, it

	becomes easier to understand the reasoning of the learners rather than in discussions as it may be time consuming in discussions whereby all learners may not be given enough opportunities to justify their reasoning'
19. Do you allow learners to produce a clear description of their results when solving design problems?	
T1	Yes, I use class discussions for learners to produce a clear description of their results
T2	Yes
T3	Yes
T4	Class activities and discussions of the results with the class to offer evaluations and alternative solutions'
T5	Learners are usually responsible for producing a clear description of their results as they shall engage in class presentations and demonstrations when needed to in a class. This helps the learners to understand other solutions there is when others present. To communicate the product with class is helpful for evaluation in technology Education'
20. Do you create the space for learner reflection on their reasoning during the DP?	
T1	Yes, I always create the space
T2	Yes, there is always space created for reflection
T3	Yes, I do
T4	Yes, the space created for learner reflection is very important to the learner for growing purposes as the learner is conscious of their reasoning in the future'
T5	Reflection is very important especially when dealing with the design process. Learners must be able given the space to reflect on their reasoning during the design process. Reflections helps learners to review their reasoning and see whether it will provide a fruitful conclusion or even a solution that is required. Therefore, reflection is very fundamental in the DP as learners will be aware of the impacts of their reasoning.
21. How do you encourage learner to rectify their errors/mistakes?	
T1 & T2	When learners engaged in activities, I make sure that I mark regularly and provide corrections often to ensure that learners know their errors and how to fix them'
T3	We do corrections as a class in order to allow others to be able to fix their errors/mistakes'
T4	I provide the class with power to correct other by each other. In most cases when learners were engaged in activities, they swap workbooks in order to correct each
T5	Learners feel bad when they fail. So as teacher we must encourage them to rectify their mistakes/errors when engaged with the design process. I often give activities that I promise them to mark and when I see they have failed many, I call them to take their work back and to go and re-do it. That space to allow them to rectify and reflect on their own work gives them a chance to make their errors better than they were before'

Appendix 4: Focus group transcript

Teachers understanding of

a) Design process

T1 – Learners must have the freedom to come up with their own original solution-, they must think innovatively, be creative. Teacher must not force learners to follow the IDMEC steps. Learner can skip stages when their thinking is advanced. They must be creative and yet achieve its purpose.

T3 – I still focus on the product, I can't agree with my colleagues about giving marks for problem solving, the learners do not do their projects in class, they get help at home, some even pay other to turn out the product for them, the learners do not do the thinking anyway, so why must I give marks for thinking, their parents do their projects for them, in mot assessing the parents thinking - so I just mark the end product.

T4 – Design is the same as problem solving.

T5 – The design process is used to structure every lesson that I teach, it just makes teaching technology easier.

b) Critical thinking

T2 – When learners can think unaided and understand.

CT/design	Interpretation	Categorises	Translate significance	Clarify meaning	Analysis		Examines ideas	Identify arguments	Analyse argument	Evaluate	Access credibility	Assess quality	Analyse argument	inference	Query evidence	Find alternatives	Draw conclusions	Explanation	State results	Justify procedure	Present argument	Self-regulation	Reflection & correction
Investigate																							
Investigate solutions																							
Investigate nature of the problem																							
Incorporates electronic circuits into design																							

T3 – This is a filler subject for me. So I don't devote much attention to it yet it is when they use their imagination.

Appendix 5: Observation schedule

Appendix 6: Post-observation transcript

How do you promote critical thinking during the teaching of the design process?

T1 – I use design process for all my lessons- even if learners are not making a produce, they will be involve in at least one stage of DP and they will engage in some form of critical thinking. You would have observed in all my lesson plans- the various stages DP is linked to it and each stage promotes specific critical thinking skills in learners. I link what I have to teach to their communities, ask them to research, explore, and report on indigenous issues, I provide feedback to them.

I often play devil's advocate during learners' presentations and discussion, it is important for learner to know that are different views and ways to solve a problem

T3 - I'm trying to include DP in all my teaching as suggested at our technology ward meeting- so in my lesson on electric circuits- learner observed an investigation and were expected to inferences as a follow up activity"

T5 – In my lesson on food processing I engaged learners in all the stages of the design process, the CAPS policy is clear about the critical thinking skills linked to DP- so critical thinking is involved in each step of DP. I use a community based problem, it is explored, learners work in small groups, they communicate their ideas; they are critiqued to extend their thinking. The learners love the discussions and presentation segments of their tasks; they are not shy to express their views or to challenge their friends on what is presented

Appendix 7: Turnitin Originality Report

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