TEACHING THE DESIGN PROCESS IN THE GRADE 9 TECHNOLOGY CLASS

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DECLARATION

I hereby declare that "Teaching the design process in the grade 9 technology class", is my own 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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ABSTRACT

The design process undergirds technology education and therefore it is quintessential to the teaching, learning and assessment of technology education. Since the introduction of technology education into the South African curriculum, there has been a series of changes that teachers have had to contend with: C2005, RNCS and now the NCS-CAPS. In the CAPS technology policy there has been a (re)-presentation of the design process from a linear to nonlinear. This (re)presentation of the design process has led to uncertainties amongst teachers of technology in terms of how the teaching of the design process should unfold.

This study therefore explores grade 9 technology teachers' views of the design process and how these views influence their teaching of the design process. Shulman's Pedagogical Content Knowledge (PCK) model (1986), the Argyris and Schön (1974) notion of "espoused theory" and "theory in use", and Singh-Pillay's (2010) notion of interface have been used to frame the research. A qualitative case study approach was used. Purposive and convenience sampling were used to obtain the respondents for this study. An open ended questionnaire, semi-structured interviews, observation of lessons and post-observation interviews were used to collect data.

The study occurs in the Chatsworth West ward in Durban, KwaZulu Natal. The findings indicate that grade 9 technology teachers hold two core views of the design process, namely: design process as problem-solving and design process as a step-by-step process that provides "comfort" to learners during problem-solving. The findings indicate that teachers' views of the design process are an amalgam of their diverse qualification in technology education, their pedagogical content knowledge, their previous teaching experience, their training and (re)training and

existing support in the school ecosystem. Thus, it is concluded that the PCK of the technology teacher influences how they teach the design process to their learners. It is recommended that if the non-linear approach of problem-solving in the design process is to be adhered to then there is the need for the retraining and reskilling of technology teachers and that teacher education should also focus more on the development of the PCK of future teachers.

Key words: design process; non-linear model; teacher development; technology education

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ABBREVIATIONS

C2005   Curriculum 2005

CAPS   Curriculum Assessment and Policy Statement

DBE   Department of Basic Education

DoE   Department of Education

DP   Design Process

FET   Further Education and Training

NCS   National Curriculum Statement

PCK   Pedagogical Content Knowledge

RNCS   Revised National Curriculum Statement

TLA   Technology Learning Area

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CHAPTER 1

BACKGROUND AND EDUCATIONAL CONTEXT

1.1 INTRODUCTION AND BACKGROUND

The main reason technology education was introduced in the South African national curriculum, in 1998, was the recognition of the need to produce engineers, technicians and artisans needed in modern society as well as the need to develop a technologically literate society for the modern world (Lewis, 2006). The design process is the backbone of technology education and is used as a structure to deliver all the learning aims of technology education. The subject stimulates learners to be innovative and develops their creative and critical thinking skills. It teaches learners to manage time and material resources effectively, provide opportunities for collaborative learning and nurtures teamwork. These skills provide a solid foundation for several Further Education and Training (FET) subjects as well as for the world of work. According to the CAPS policy document (D.O.E., 2011) Technology as a subject contributes towards learners' technological literacy by giving them opportunities to:

- Develop and apply specific design skills to solve technological problems,
- Understand the concepts and knowledge used in Technology education and use them responsibly and purposefully,
- Appreciate the interaction between people's values and attitudes, technology, society and the environment,

The intention is to introduce learners to the basics needed in Civil Technology, Mechanical Technology, Electrical Technology and Engineering Graphics and Design. Additionally, learners gain an idea of the way engineers apply scientific principles to practical problems. In addition, evaluation skills will be fostered and the introduction of product design and production will be useful in other FET subjects that use these skills.

Technology will teach learners the opportunity to learn:

- To solve problems in creative ways;
- To use authentic contexts rooted in real situations outside the classroom;

- To combine thinking and doing in a way that links abstract concepts to concrete understanding;
- To evaluate existing products and processes; and to evaluate their own products;
- To use and engage with knowledge in a purposeful way;
- To deal with inclusivity, human rights, social and environmental issues in their tasks;
- To use a variety of life skills in authentic contexts (such as decision making, critical and creative thinking, cooperation, problem-solving and needs identification);
- While creating positive attitudes, perceptions and aspirations towards technology-based careers; and
- To work collaboratively with others:

It is obvious that if technology education is introduced as a completely new learning area (subject) in the curriculum of any country, it will engender the need for extensive in-service teacher training (Potgieter, 2004). The implementation of Technology Education within the school curriculum has been a hurdle for both teachers and learners (Pudi, 2007). With regard to the foregoing discussion, it is important to remember there were no teachers qualified to teach technology at the time of its implementation in 1998. Teachers qualified in other subjects were asked to volunteer to teach technology. The advent of technology education, nationally and internationally, has posed challenges different from those experienced in regard to other learning areas, contends (Rauscher, 2010). The successful implementation of the technology curriculum is dependent on teachers having a solidly established personal construct of technology equivalent to that of the curriculum (Tholo, Monobe, & Lumadi, 2011). Studies by Singh-Pillay (2010) and Carrim (2004) elucidate the uncertainties teachers encounter during policy reform in terms of their pedagogical practice. Ever since the introduction of technology education, the teachers are still grappling with its pedagogy and didactics. The Technology Learning Area (TLA) needs skilled teachers. It is poignant to disclose that 99% of the teachers teaching technology had little or no qualification to teach the subject before the year 2010 (Lovington, 2009; Nkosi, 2008)

In respect of teacher training, it is significant to note that only few technology teachers have received formal training thus far. This being the case, it should equally be noted, that technology teacher training has not been easy or clear (DoE, 2009). Teachers were asked to volunteer to teach technology for the first time. According to Reitsma and Mentz (2009), short workshops by the DoE

do not offer teachers the opportunity to study and reflect on the new information. The difficult situation seems compounded by the under-qualified and inexperienced educational officials who also give the training as (Reitsma & Mentz) found out: "Only few of the subject advisors themselves, who acted as trainers, had training in technology education". However, it is not even clear from the Curriculum Review Report (DoE, 2009) as to who will now be expected to teach Technology – will it be Science teachers, Technology teachers, or a team of Science and Technology teachers? In a recently completed doctoral study, Mapotse (2012) conducted an action research with 18 technology teachers from selected secondary schools in Limpopo Province. Through observations and fact-finding, he discovered that some teachers in whose schools his student teachers were placed for practice teaching, could not teach technology to the point that student teachers changed roles with them, i.e. student teachers ended up mentoring their mentor/senior teachers. In the sampled schools, Mapotse found that 11 teachers had less than 6 years' experience teaching technology, 11 teachers had no qualification in technology education, and 8 teachers could not plan a technology lesson at all. This means, these teachers had no idea of the design process which is fundamental to technology nor did they use it to structure their technology lessons.

1.2 PURPOSE OF THIS STUDY

The purpose of this study is to explore grade 9 technology teachers' views of the design process and its influence on their teaching of the design process. This purpose can be achieved by:

• Ascertaining teachers' views of the design process in technology education; and
• Establishing if any relationships exists between teachers' views of the design process, and their teaching style.

There are two critical questions guiding the study. These are:

• What are Gr 9 technology teachers' views of the design process?
• How do these views influence their teaching of the design process?

1.3 RATIONALE

I am and have been a technology teacher for the past 8 years in the Umlazi District. Since the introduction of technology education into the curriculum teachers have been bombarded with the following policies namely: Curriculum 2005 (C2005), Revised National Curriculum Statement (RNCS) and now the National Curriculum Statement –Continuous Assessment Policy Statement (NCS-CAPS). As a teacher of technology education in preparation for implementation of the NCS-CAPS policy, I received training from subject advisors via the once-off cascade model which lasted 4 days. I am intrigued by first, the change in the (re)-presentation of the design process from a linear to nonlinear representation in the CAPS document and second by the policy's vision for the teachers. Hence I want to explore Grade 9 technology teachers' views of the design process in Chatsworth West ward within the Chatsworth circuit and its influence on their teaching of the design process. Research by Richmond and Anderson (2003) show how important the views of teachers are when it comes to reform in education whilst a study by Zipf and Harrison (2003) indicates that teachers' views can act as filters through which new knowledge and experiences are screened for meaning. Furthermore, a literature survey revealed that only 8.6 per cent of the 199 research studies conducted in technology education were design-related (Johnson & Daughterty, 2008). It stands to reason that not much is known about the link between teachers' views of the design process and how these views influence their teaching of the design process. Therefore it becomes imperative to embark on this study in order to understand the relationship between teachers' views of the design process and their teaching style.

1.4 SIGNIFICANCE OF THE STUDY

This study will be beneficial to technology subject advisors and technology curriculum developers because it will provide a deeper insight into teachers' views of the design process and its impact on their teaching style. The findings for this study will help technology teachers to engage in reflective practice in respect of their enactment of and engagement with the design process, and this could contribute to a more nuanced practice. 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: the training that

teachers received for the implementation of the technology curriculum is similar to that of many teachers in South Africa; the contextual constraints that they experienced are not unique to their schools, and the pressure of the examination is the same in all public schools in this country.

1.5 LIMITATIONS

Major limiting factors of the study were participant drop-out, and time constraints leading to the observation of insufficient number of lessons. The findings of this case study cannot be generalized to all classrooms.

1.6 OVERVIEW OF THE STUDY

This research report is presented in five chapters.

Chapter 1 describes the background and the educational context within which the research was conducted. Also outlined in chapter one is the purpose of the study, the critical questions guiding the study, rationale as well as the significance. This chapter is closed with a brief description of the delimitations of the study and a conclusion.

Chapter 2 presents a detailed review of relevant literature on the design process. In chapter two the conceptual framework of this study is presented. The conceptual framework is an synthesis of Shulman's (1986) model of Pedagogical Content Knowledge (PCK), Argyris and Schön's (1974) idea of espoused theory and theory in use and Singh-Pillay's (2010) notion of interface.

Chapter 3 explores the philosophical assumptions underpinning this study and explains why this study adopts a qualitative approach as well as why a case study approach is used. The research site and the data collection method employed in the study are also described. The chapter also gives an account of how various gatekeepers at each stage of the research were approached in order to gain access and also outlines the hustle encountered by the researcher during the data collection phase of the research. The data collection instruments as well as the sampling procedure used in the study are described. This is followed by the description of data collection procedure and the method of data analysis. The chapter ends with the description of the validity and reliability of the instruments.

Chapter 4 aims to present the finding and analysis of data to answer the two research questions that guide the study, namely, "What are Gr 9 technology teachers' views of the design process?"

and "How do these views influence their teaching of the design process?". This chapter is divided into two parts (part A and part B). Part A aims to answer the first research question whilst part B attempts to answer the second research question. In answering research question 1, two core views arose in respect of teachers' view of the design process, namely, design process as problem-solving and design process as a step-by-step process that provides comfort to learners. The data from the questionnaire and semi-structured interview were used to answer research question one. To answer the second research question data from observation of lesson and post-observation interview were used. In answering research question two, the following manifestation of PCK were interrogated, namely, instructional strategy, knowledge of technology curriculum and use of explanation, use of assessment strategies, knowledge of learners understanding. Teacher 5's (T5) espoused theory (view) of the design process is congruent to her theory in use (practice in respect of the design process) whilst these is a huge miss match between T8's espoused view of design process and his actual theory in practice.

In chapter 5 the findings are discussed. This chapter also discusses the recommendations relating to the findings and reflections. Limitations of the study together with suggested areas for further research are also highlighted before the chapter is concluded.

1.7 CHAPTER SUMMARY

This chapter provided a brief account of the study. It presented a summary of how the research was conducted by outlining the background of the research as well as the educational context within which the study was conducted. The chapter highlighted the focus, significance and the critical questions of the study.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter presents a review of literature and the conceptual framework pertinent to the purpose of this study. The literature surveyed focuses first, on the design process as there are differing perspectives amongst scholars as to how the design process should occur. Some scholars envisage the design process as linear whilst other scholars see the design process as iterative. Second, literature related to the teaching of the design process and pedagogical content knowledge (Shulman, 1986) is reviewed to support my argument that teachers' views of the design process influence their engagement and enactment of the design process. This is because what the teacher does in class depends on the teacher's knowledge of the design process as well as the pedagogy that is used to teach the design process. In this regard, it is worth noting that there is limited research on teachers' views and involvement of the design process. Lastly Argyris and Schön's (1974) notion of espoused theory and theory in use is presented as a conceptual framework for this study to explore and understand the relationship between grade 9 technology teachers views of the design process and its influence on their teaching of the design process.

2.2 THE DESIGN PROCESS AND ITS (RE)PRESENTATION

There are many perspectives amongst scholars of what the design process is and what it entails. It is therefore necessary to review these differing perspectives.

Mioduser and Dagan (2007) maintain that for technology students to develop capabilities and skill they need to engage with the design process. Therefore it is essential to examine what the design process entails.

2.2.1 The design process: What is it?

The central role design plays in technology education is reiterated by Burghardt and Hacker (2004) citing International Technology Education Association (ITEA) (2000, 2002) that "Design is regarded as the core problem-solving process of technological development, it is as fundamental to technology, as inquiry is to science and reading is to language arts" (p. 6-8). Mawson (2003) considers the design process to be the concept/model that undergirds technology education. Jones,

Buntting, and De Vries (2011) concur with Mawson and maintain 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 has to go through in order to come out with solutions to achieve the aims of technology.

According to the Curriculum Assessment and Policy Statement (CAPS) of the Department of Basic Education of South Africa (DBE, 2011) Senior Phase Technology (Grades 7-9): the design process allows learners to:

"Develop and apply specific design skills to solve technological problems; Understand the concepts and knowledge used in Technology education and use them responsibly and purposefully; Appreciate the interaction between peoples values and attitudes, technology, society and the environment" (p. 9). Therefore it is a systematic approach to problem solving in technology and is used to generate products, services, and systems to satisfy human needs and desires (Smith & Gray, 2009). From the point mentioned above it stands to reason that in Technology Education the term 'design process' and 'problem solving' are construed to be synonymous. According to Mawson (2003), these concepts are similar, as they both have the same sequence of activities, namely, the inception of an idea, the reflection stage and evaluation of the success of the outcome.

According to the Department of Education (DoE, 2002), the technological process or the design process are the activities that the learner engages in when identifying the need, investigating, and designing, making evaluating and communicating solutions. The processes students use to create solutions to technological problems are collectively referred to as the design process. Design activities and learning offer students great opportunities to deal with complex design tasks within original/real and meaningful learning (Kangas, Seitamaa-Hakkarainen, & Hakkarainen, 2013).

According to Pudi (2007), the design process (technological process) describes all that should take place from the inception through development to the end of a technological activity, therefore it is essential to know how the design process is represented if it is to be used to address or solve technological problems/needs.

2.2.2 How the design process is re (presented)?

The CAPS senior phase technology document (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 conceptualises the design process as:

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

It is worth noting that both curriculum statements identify the following five elements as constitutive of the design process: investigate, design, make, evaluate and communicate (Department of Education 2002, 2011), however, the diagrammatic (re) presentation of the design process differs in the two policies. The RNCS has a linear diagrammatic (re)presentation of the design process whilst the CAPS document has a cyclic diagrammatic (re)presentation of it. Irrespective of the diagrammatic (re)presentation of the design process it must be emphasised from the preceding discussion that both statements emphasise 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. Hence, it is necessary to explore the scholar's views on the nature of the design, that is, how the design process should unfold.

2.2.3 Views of scholars on the nature of the design process

According to Lawson (2006), the design process is regarded as a complex process and this 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. A survey of literature has revealed that there are two contrasting views in respect of how the design process should unfold. According to Williams (2000) and Mawson (2003), a common view amongst teachers is the understanding of the design process as a product based or a linear process. In other words, the design process is a series of steps that are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow these steps sequentially and diligently in their projects. The ideology behind this systematic process, Williams argues, is that it can be taught. This rigid procedure is inviting to teachers, because it provides a structure for the teaching of Technology.

Scholars such as Hill (1998), Williams (2000), Mawson (2003) and Rowel (2004) argue that the seemingly rigid nature of the design process does not provide enough room for developing the creative skills of the learner and suggest the need for an alternative pedagogy or approach. In this regard, Hill (1998) directs our attention to the disparity between the design process employed in problem solving in real life contexts and that which is found in the classroom. As she puts it, "In problem solving for real-life contexts, design processes are seen as creative, dynamic and iterative processes that engage exploration; join conceptual and procedural knowledge-both thought and action; and can encourage considerations to technology, human and environmental interactions. The approach suggested by Hill (1998: p. 203) is antithetical to what is typically found in schools: design, make and appraise cycles based on closed design briefs that are teacher assigned which incidentally are unrelated to the students' world". As an alternative, innovative approach to teach technology education, Hill suggested the need to interpret technology education as problem solving for real life context that employs the design process as tools for creation and exploration.

In this regard, Flowers (2010) has argued that the multiplicity of design briefs that learners deploy in their attempt to solve a particular design problem is indicative of the fact that technology education encourages problem solving in diverse and creative ways as far as design related problems are concerned. Furthermore, Flowers (2010) asserts that the complexity in design problem solving requires a multifaceted approach in solving them. He likens his assertion to the act of solving a simple problem vis-à-vis a complex problem. According to him (*ibid*.: p. 16), "A problem of how to get your friend's attention can likely be solved in one step (such as "saying your friend's name") but processes for solving environmental problems resulting from overpopulation are complex, convoluted, and certainly not easy to solve with any single prescribed method". A noteworthy observation made by , Flowers (2010: p. 16) is the dogmatism that is prevalent in the curriculum, literature and research in technology education that has made the field guilty of "dogmatically forwarding statements that seem to imply there exists only one problem-solving process, or only one that is worth knowing in solving design-related problems" .

Hartfield (2012) extends the idea of the design process being nonlinear by reflecting on the terms 'design problems' and 'design solutions'. Hartfield maintains that the "design problems" and "designs solutions" are complementary components within the design process, they are mutually

related and thus go hand in hand. Furthermore, Hartfield (2012: p. 133) contends that both design problems and design solutions evoke five sets of issues. These include:

> "(i) the 'over-accepted' assumption that design is problem-solving; (ii) the proposition that, in significant ways, designing far exceeds problem-solving; (iii) the view that design problems are inevitably 'wicked' problems for which single or 'set' solutions are not to be expected; thus (iv) the realization that design outcomes are inescapably 'satisficing' solutions; and (v) the critical contention that, it is the designer who sets the problem rather than simply 'receiving' it".

Hartfield (2012) concludes his argument by reiterating the following sentiments:

- That designers as well as theorists influence contemporary practice and what the design case/problem should be adding that contemporary practice as well as internally-persuasive contemporary positions and theories also influence design.

- That the designer has no role if we sublimate design.

- That the designer is not merely asserted to be a problem receiver and/or the problem- solver, but as "the agent who effectively determines the nature of the problem to be addressed – the problem-as-design goal – and establishes the very formalization and solution-type that will achieve this goal" (*ibid*.: p. 140).

Wong and Siu (2012) also suggests "The design model consists of 5 stages: situation, research (which also contains activities like data collection, decision making, and evaluation), ideation, development, and realization". It is also sometimes presented as a three-stage process consisting of Analysis, Synthesis and Evaluation (Jones as cited in Wong & Siu). The three stages are presented as a non-linear model emphasizing that design is continually evaluated through the three stages. This means that return loops are sometimes included so that the designer can at any stage of the design process go back to the previous stage for further analysis, synthesis or evaluation in order to address any ambiguities that may have arisen during the design process (Lawson, 2006). Wong and Siu (2012) have also cited the stages of the design process as outlined by Archer that consist of programming, data collection, analysis, synthesis, development, and communication.

A contrasting view of how the design process should unfold is provided by scholars such as (Hansen, 1993; Wong & Siu, 2012). These scholars have a totally different opinion in the discourse

relating to the dogma about problem solving. They believe that the one-way problem solving approach is what makes things easy for students during problem solving in design.

Wong and Siu (2012) cite the defense advanced by four different writers: Aspelund (2006), Peto (1999), Tunstall (2006) and Wise (1990) in support of the systematic nature of the design process saying by making it more systematic, novice designers are capable of applying the suggested procedures as they make their own designs. As Hansen (1993, p. 15) puts it, "It is quite a comfort for students to discover that the problem solving process has a set of universal steps and that the process involves the development of knowledge parallel to the one developed through, for example, the scientific method". Flowers (2010) condemns Hansen's belief in this discourse. Flowers posits construing problem solving as a set of universal steps is more likely to be a comfort for teachers rather that learners as it assists teachers with the teaching of the design process. This particular notion of problem solving protects us from having to question our assumptions and our knowledge. It is in this regard that Flower (2010: p. 16), contends that one should not lose sight of the fact that "we are not there for student or teacher comfort" and that associating "steps" in the teaching of design and problem solving may be the crutch that teachers cling to due their uneasiness and tension between their view of the design process and the pedagogy they use to facilitate the design process.

Therefore Flowers (2010), Mawson (2003) and Lewis (2006) suggest that a solution to curing the dogmatism that is associated with teaching design and problem-solving is to question our assumptions even at the expense of our comfort and to explore alternative pedagogies.

This leads one to question the knowledge base (content and pedagogy) of technology teachers on the design process. Research reports by Atkinson (2012) in the United Kingdom highlighted a disjunction or mismatch between design process and its implementation with the reason being that many teachers were not taught design in their training and that many teachers execute design and technology education within a craft paradigm (Mittel & Penny, 1997 ; Zuga, 1989). This, Atkinson said, has had a knock-on effect over the years due to the cyclical movement of knowledge from teachers to pupils who in turn become teachers and lecturer who train tomorrow's generation of teachers. This is true for practicing teachers in South Africa as well (Pool, Reitsma, & Mentz, 2013; Stevens, 2006). It has been indicated by Haynes (2010) that it is important for Technology practitioners to have an understanding and expertise in the teaching of the design process.

However, in their research, Pool et al. (2013) as well as Stevens (2006) identified particular shortcomings in the training of pre-service teachers as a result of the nature of the pre-service training programme and found that university teacher educators in South Africa had different views on the amount of depth of content knowledge a student teacher must gain so as to teach technology effectively. They also found that the professional teaching and learning practices of technology educators are based on approaches from other fields of knowledge and that no previous teacher training programs existed for technology education. According to Pool et al. (2013: p. 465), to explain why technology teachers lack Pedagogical Content Knowledge (PCK), Shulman, (1986) university teacher educators give explanations such as

> "We do not get to pedagogy. It is a big shortcoming in our programme. 10 sessions where you not only have to teach them the subject content but also how to teach the content. So it is a massive burden really. Pedagogy is not subject specific. They are getting a lot of pedagogy from their other subjects so one must be careful not to repeat things. They get … PCK … as a generic module in educational studies".

The consequences stated by Pool et al. (2013) are that technology teachers in South Africa lack the requisite appropriate subject specific PCK to teach technology and for that matter the design process which happens to be the backbone of technology education(Mawson, 2003). In other words, university teacher educators emphasise content knowledge in their programmes but overlook the pedagogy required to enact content knowledge in respect of the design process in the classroom. It is worth noting that Pedagogical Content Knowledge (PCK) is a result of the interaction of content and pedagogy. It is knowledge about the content that is derived from consideration of how best to teach it. For a particular topic, it includes knowledge of:

> (i) What makes the topic easy or difficult to understand – including the preconceptions about the topic that students bring to their studies;

> (ii) Those strategies most likely to be effective in reorganizing students' understanding to eliminate their misconceptions;

> (iii) A variety of effective means of representing the ideas included in the topic analogies, illustrations, examples, explanations, and demonstrations (Shulman, 1986: pp. 9-10).

A study by Potgieter (2012) alerts us to the trends amongst the strategies and methods that are used to teach and apply the design process in technology education within the South African context.

According to his findings, the design process is mostly taught in a rigid manner in line with the findings of Rowel (2004), Mawson (2003), Williams (2000), and Hill (1998) in other parts of the world. Potgieter (2012: p. 964) established that while many teachers create room for the design process to be interpreted differently; most teachers believe that "the steps in the design process should be followed in a particular order" and that the prescription of the curriculum should be closely adhered to.

For learners to play an active role in meeting the demands of the 21st century, (Atkinson & Sandwith, 2014) suggest that all teachers should aim at enabling pupils in schools to develop and enhance such human qualities as higher-order thinking and problem solving. Research by Bailey (2012) and Atkinson (2011) have, however, 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). Even though it has been found that enthusiastic teachers can induce similar enthusiasm in their learners, the need to sustain such enthusiasm is crucial if learners are to rise up to the challenge posed by the sometimes exciting but arduous and difficult processes to achieve outcomes that they (the learners) and their teachers can be proud of (Atkinson & Sandwith, 2014) In a study on design in the UK, Atkinson (2012) found that "there were many teachers who were not taught to design during their training", and that 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.

Norström (2014) studied the views of Swedish technology teachers on the technological knowledge and noticed that the technology teachers had different views on technological knowledge which could possibly lead them to variously prioritise what to teach and how to assess.

Atkinson (2012) presented a conference paper on the design process models that teachers present to pupils as well as the teachers' own understanding of designing. According to her (*ibid*.: p. 3), "Part of the problem has been that all the design process models produced over the years have been of necessity a simplification of the real process involved" and that this is unhelpful in explaining the

complex, interactive nature of the design activity. Thus she explains that both teachers and pupils perceive the requisite knowledge and physical skills in design to be straight-forward activities. This supports the claim by Mawson (2003), Rowel (2004) and Williams (2000) that the design process model used for teaching and learning does not make enough room for flexibility. For teachers to successfully guide students in the design process to generate creative output, it is imperative that they themselves understand the creative design process and its routine (Wong & Siu, 2012). Rowel (2004) argues that contrary to conceptual and procedure oriented approach, technology should be taught in a socio-cultural context where learners generate knowledge through interpretation of interaction with materials and tools thereby placing them "as critical inquirers into both tool-related and discursive practices of technology" and that early technology education should involve scaffolding the learning process. Joan (2013) prescribed the term 'flexible learning' or 'personalized learning' as the way forward. He describes it as "a set of educational philosophies and systems, concerned with providing learners with increased choice, convenience, and personalization to suit the learner. In particular, flexible learning provides learners with choices about where, when, and how learning occurs". When learners are allowed to explore as they move through the design process their skills are fostered thereby enriching the learning of such students (Hill, 1998).

Traditionally, art and design educators gain their understanding of teaching creativity from reflective experience rather than empirical research. Conversely, the majority of research studies into learner creativity are laboratory-based, producing results which are reliable and valid in their own terms but which are seldom tested within the complex richness of a 'real-world' learning environment (Dineen, Samuel, & Livesey, 2005).

Mawson (2007) observes that design at the workplace as it were, is different from how it happens in the classroom in the sense that at the workplace designers build their experiences in a natural way, and agrees with Lewis, (2006) that learners should also be helped to discover their own ability in reaching decisions and to state and visualize their ideas. This scaffolding (Rowel, 2004) will help replace the 'default' nature with 'surprise' problem/solution spaces of design for the purpose of creativity (Dorst & Cross, 2001).

2.2.4 Learner autonomy

Autonomy is the ability of the learner to be in control of their own learning (Holec, 1979). Asik (2010) explains learner autonomy as "a significant measure of independence from the control of

others" and that it is based on learner centered approaches of teaching which is also referred to as constructivism (Bodner, 1986). Here the learner is allowed some independence to learn on their own (Tok, 2011). 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. By doing so the default nature of design will be replaced with the surprise problem/solution spaces of design for the purpose of creativity (Dorst & Cross, 2001). The word 'help' as used by both Mawson and Lewis as well as Dorst and Cross is also referred to as minimal guidance (Kirschner, Sweller & Clark, 2006) in the sense that none of them places strong emphasis on guidance of the learning process of students.

Some loopholes have been identified in the constructivist approach to learning. Its unconditional effectiveness is questioned. According to Kirschner et al. (2006, p.75) "minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process. The advantage of guidance recedes when learners have sufficiently high prior knowledge to provide "internal" guidance". According to them:

> "Although unguided or minimally guided instructional approaches are very popular and intuitively appealing, the point is made that these approaches ignore both the structures that constitute human cognitive architecture and evidence from empirical studies over the past half-century that consistently indicate that minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process"

In order to foster creativity of students in the design process, Jones (2002), recommends that the teacher's occasional interruption during the generation of ideas by learners might also improve ideation productivity and that the teacher should be able to blend generative thoughts processes that give rise to original ideas and analytical thought processes required to refine the generated ideas during design activities in the classroom. This occasional interruption also fosters the student-teacher relationship which plays a crucial role in building up the strong symbiosis that exists between teaching and learning and which constitute the spine in education (Hartfield, 2012). Rutland (2009) advises that while interrupting the generation of ideas, care should be taken by the teacher to avoid idea fixation. This (Rutland) said, can be when the teacher ensures that the design

brief used for the project in Design and Technology is open ended without any definite destination towards the solution. Social interactions also play a vital role in problem solving activities during design. Wong and Siu (2012, p. 12) observe that "Sociologically, activities are best to be finished by working groups instead of individuals, as creativity involves a collection of ideas" and that socializing of family members as well as classmates has the tendency to support students' creativity (Webster, Campbell, & Jane, 2006).

2.3 CONCEPTUAL FRAMEWORK

Kuhn (1996) posits that professional practice is underpinned and shaped by a received set of beliefs, values, views and models. In agreement Ball, Hill, and Bass (2005) and Wenglinsky (2002) suggest that what a teacher does in class depends on the teachers' knowledge and the class context. Therefore, the constructivism epistemology, Shulman's Pedagogical Content Knowledge model (PCK) (1986), Argyris and Schön's (1974) notion of espoused theory and theory in use, and Singh-Pillay's (2010) notion of interface have been used to frame the research. An understanding of the role of constructivism in technology teaching is part of technology teachers "professional content knowledge". Teacher content knowledge is invariably linked to their espoused theory of the design process whilst their pedagogy is linked to their theory in use. One's espoused theory of the design process can be juxtaposed with their theory in use by using the notion of an interface.

2.3.1 Constructivist Epistemology

Constructivist epistemology is construed as a way of making sense to how students learn in a particular context (Cobern, 1995; Lorsbach & Tobin, 1992). The hallmark of constructivism is first, that learners are active in constructing their own knowledge and second, that social interactions are important in this knowledge construction. In other words, learning is a social activity whereby students are exposed to the thinking processes and successful problem solving techniques of others in order to arrive at their own solutions. Vygotsky (1978) argues that because education is intended to develop an individual's personality and it is also linked to the development of an individual's creative potential, therefore opportunities should be provided for this creative development. In this regard, Mawson (2007) suggests that learners should be allowed to discover their own ability in reaching decisions, state and visualize their ideas during the design process and engage in "lateral thoughts built on the recognition of their own existing knowledge and ability". This is supported by Lewis (2006) who also contends that children should rather be permitted to achieve creativity during

the design process. By doing so the default nature of design will be replaced with the surprise problem/solution spaces of design for the purpose of creativity (Dorst & Cross, 2001). Simply put, this means that constructivism embraces the notion of learner autonomy or creativity during the learning process (Bodner, 1986). According to Asik (2010) learner autonomy is "a significant measure of independence from the control of others".

2.3.2 Conceptualizing Pedagogical Content Knowledge

Shulman (1987) defines Pedagogical Content Knowledge (PCK) as "a special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding".

This means that Pedagogical Content Knowledge (PCK), distinguishes the teacher from the subject matter specialist. In Shulman's definition, PCK refers to the transformation of content into a form that makes learning possible. He further listed PCK as one of the seven fundamental knowledge domains in his professional knowledge base for teaching (Shulman, 1987: p. 8) as:

- Content knowledge

- General pedagogical knowledge with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter

- Curriculum knowledge with particular grasp of the materials and programmes that serve as 'tools of the trade' for teachers

- Pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding

- Knowledge of learners and their characteristics

- Knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures

- Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds

In the 27 years since Shulman's introduction of the concept, various conceptualisations of PCK have emerged, as reflected in Figure 2.1 below. A number of models have suggested that PCK is an integration of some or all of the other knowledge areas outlined by Shulman. For example, Bishop and Denley (2007) conceptualise the relationship between PCK and the other categories as a

'spinning top' (Bishop & Denley, 2007, p. 9) where all the categories in Shulman's knowledge base merge into PCK as the teacher transforms the content being taught. This model is shown in Figure

2.1.
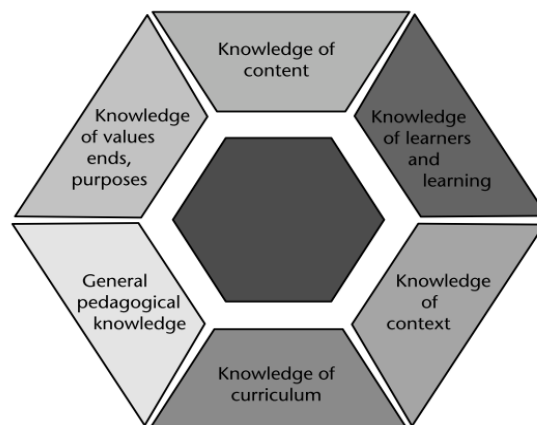
Figure 2.1: 'Spinning top' model for pedagogical content knowledge

(Source: Bishop & Denley, 2007, p. 9)

Another model which conceptualised PCK as an integration of other knowledge bases is that of Cochrane, De Ruiter, and King (1993), whose model emphasised the developmental nature of PCK. For them, knowledge of pedagogy, subject matter, students and environmental context played the most important roles in the development of PCK. This is shown in Figure 2.2. It can be noted here that they use the term 'knowing' to emphasise the dynamic and active nature of PCK. They also proposed a synthesis and integration of the constituent components of PCK, as shown by the overlapping circles in the diagram. The arrows are included to emphasise the possibility of expansion and growth. A teacher can have varying levels of knowledge of the components, and, for example, limited knowledge of subject matter will restrict PCK and growth in this area will grow PCK.
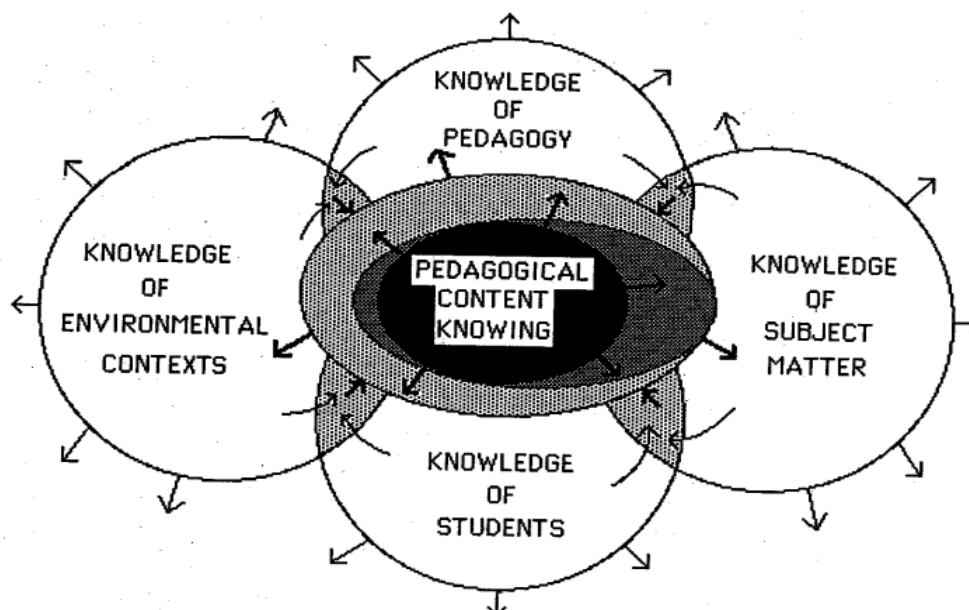
Figure 2.2: Developmental model of pedagogical content knowing (PCK)

(Source: Cochrane et al., 1993)

Another view of PCK identified by Gess-Newsome (1999) sees PCK as an *intersection* of subject matter knowledge, pedagogical knowledge and conceptual knowledge as shown in Figure 2. 3.
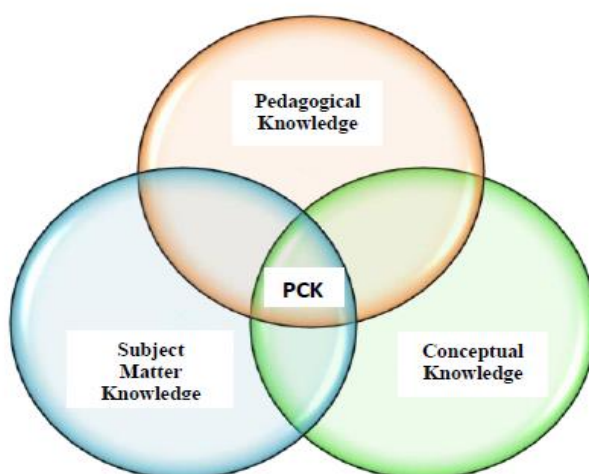
Figure 2.3: Gess-Newsome's model of PCK

(Source: Gess-Newsome, 1999) (redrawn)

Several authors view PCK as a *transformation* of the contributing knowledge categories (Grossman, 1990; Magnusson, Krajcik, & Borko, 1999). Grossman Context, as shown in Figure 2.4
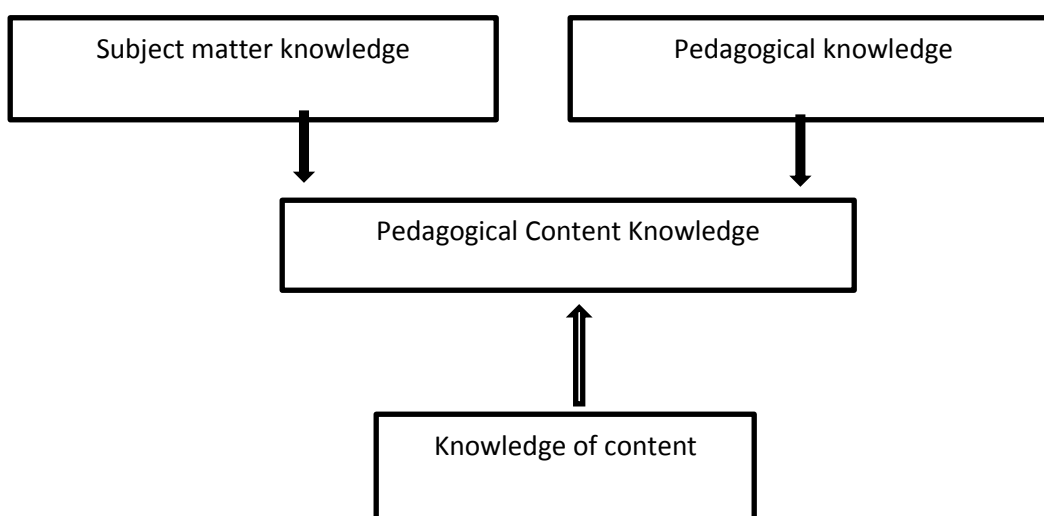
Figure 2.4: A transformative model of PCK

(Source: Grossman, 1990) (redrawn)

According to this model, content knowledge on its own, or pedagogy on its own, are not enough for quality teaching. Sound knowledge of these is necessary, but in addition, a transformation process is required in order for effective teaching to take place. The implication for research is that when studying PCK one cannot examine subject matter knowledge, pedagogical knowledge and contextual knowledge on their own, and then infer the PCK of the particular teacher. PCK itself also needs to be examined to obtain a more accurate reflection of the teacher's knowledge. To address this dilemma Loughran, Berry & Mulhall (2012) explain that PCK involves the teacher having a know-how of alternative forms of representation and that some of these teaching methods derive from research whereas others originate in what they call "the wisdom of practice". William and Lockley (2012) have outlined some characteristics of PCK. According to William and Lockley, (ibid.: p. 34), PCK "...is topic-specific, unique to each teacher and can only be gained through teaching practice". They continue that teaching is a complex and problematic activity which goes beyond a simple transmission of concepts and skills from the teacher down the line to the learner, and that teaching requires many and varied on-the-spot decisions and responses to the ongoing learning needs of students. William and Lockley (2012) cite the work of Magnusson, Krajcik and

Borko which identifies their proposed five components of PCK. In their view, the PCK of an experienced teacher includes his/her

- Orientations towards teaching: This component refers to teachers' beliefs about the purposes and goals for teaching technology at different grade levels (Grossman, 1990). Since the transformation of teacher knowledge from other knowledge domains into PCK is not a straightforward task but an intentional act in which teachers choose to reconstruct their understanding to fit a situation (Magnusson, Krajcik, & Borko, 1999), orientations to teaching technology influence PCK construction by serving as a concept map that guides instructional decisions, the use of particular curricular materials and instructional strategies, and assessment of student learning (Borko & Putnam, 1996).

- Knowledge of curriculum (what and when to teach): This refers to teachers' knowledge about curriculum materials available for teaching particular subject matter as well as about both the horizontal and vertical curricula for a subject (Grossman, 1990). This component is indicative of teacher understanding of the importance of topics relative to the curriculum as a whole. This knowledge enables teachers to identify core concepts, modify activities, and eliminate aspects judged to be peripheral to the targeted conceptual understandings. Geddis et al. (1993: p. 576) called this understanding "curricular saliency" to point to the tension between "covering the curriculum" and "teaching for understanding."

- Knowledge of assessment (why, what, and how to assess): Novak (1993) stated, "Every educational event has a learner, a teacher, a subject matter, and a social environment. I would like to suggest a fifth element – evaluation" (p. 54). In accordance with this, knowledge of assessment is an important component of PCK. This component is comprised of knowledge of the dimensions of technology learning important to assess, and knowledge of the methods by which that learning can be assessed (Tamir, 1988). Evaluation includes knowledge of specific instruments, approaches, or activities.

- Knowledge of students' understanding of the subject: To employ PCK effectively, teachers must have knowledge about what students know about a topic and areas of likely difficulty. This component includes knowledge of students' conceptions of particular topics, learning difficulties, motivation, and diversity in ability, learning style, interest, developmental level, and need.

- Knowledge of instructional strategies: This component consists of two categories: subject-specific strategies and topic-specific strategies (Magnusson et al. 1999). Subject-specific strategies are general approaches to instruction that are consistent with the goals of technology teaching in teachers' minds such as learning cycles, conceptual change strategies, and inquiry-oriented instruction. Topic-specific strategies refer to specific strategies that apply to teaching particular topics within a domain of technology.
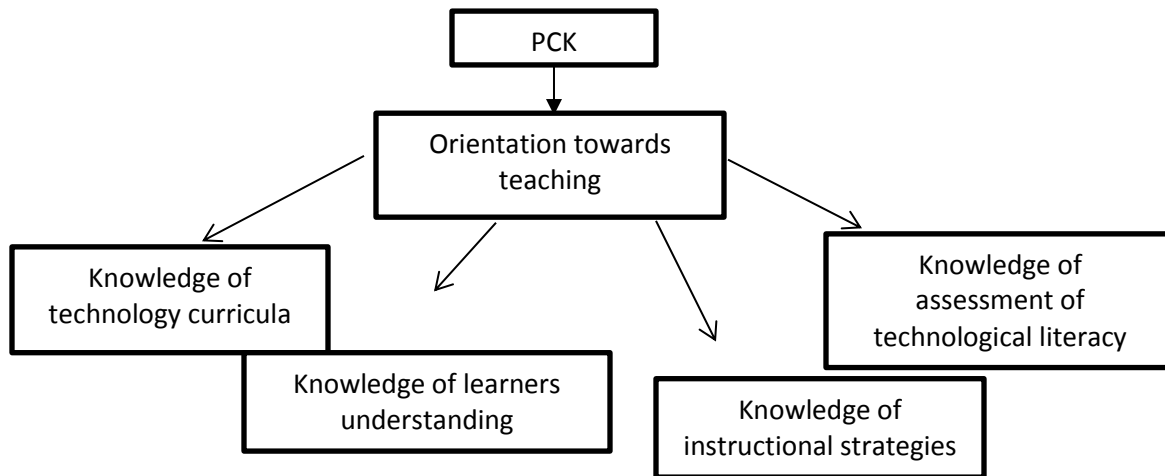
Figure 2.5: Components of PCK

(Source: Magnusson et al (1999) (redrawn)

According to Park & Chen (2012) all the components of PCK are closely integrated and that they influence each other when observed in practice as shown in Figure 2.6. They also identified that PCK developed through the teacher's reflection on a lesson while teaching (reflection-inaction) and after a lesson (reflection-on-action) (Park & Chen, 2012; Park & Oliver, 2008; Schön, 1983, 1987)
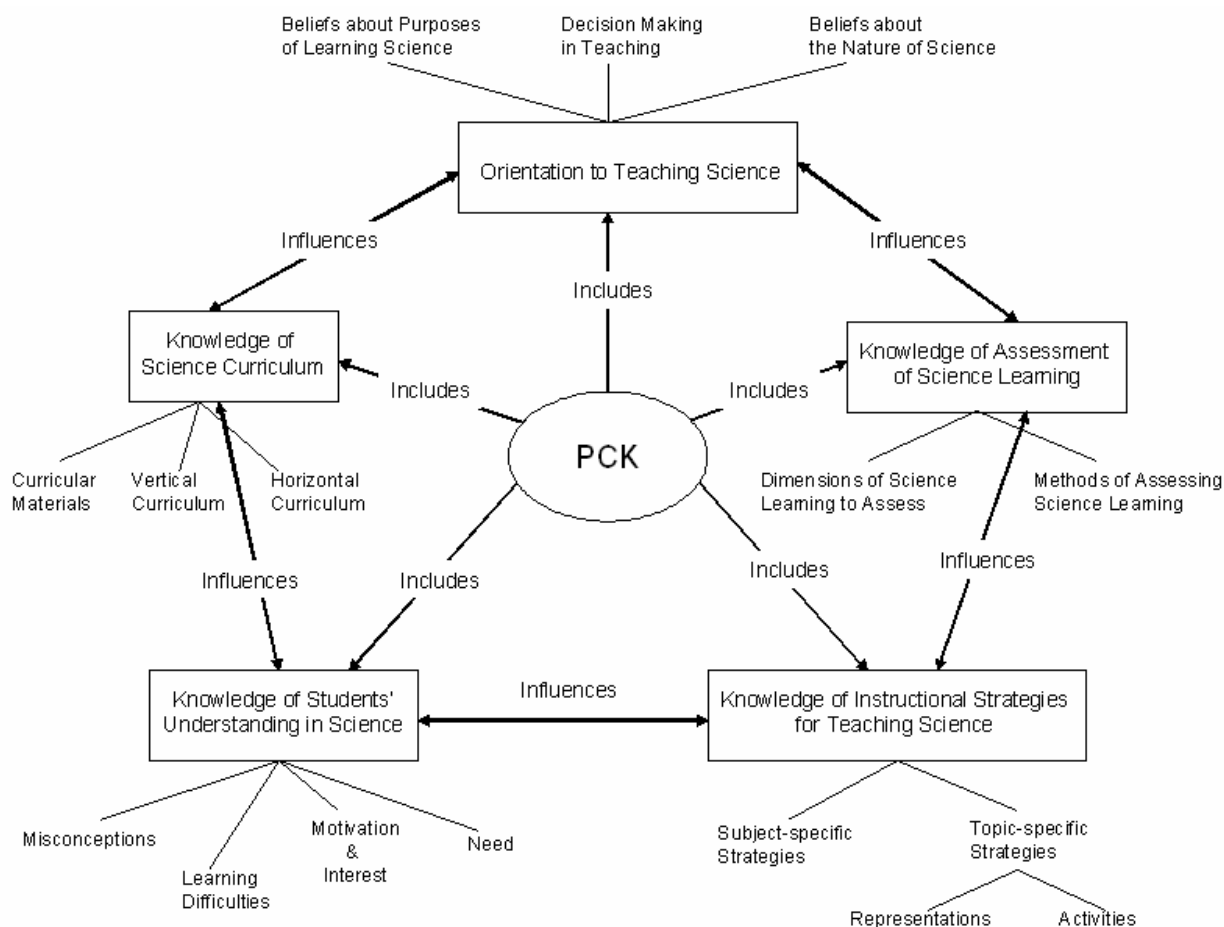
Figure 2.6: Park and co-workers' pentagon model of PCK
(Source: Park & Chen, 2012; Park & Oliver, 2008 (redrawn)

In light of the above advancement in the models that represent PCK , Rohaan, Taconis, and Jochems (2010) cited Bransford, Brown and Cocking argue that "Outstanding teaching requires teachers to have a deep understanding of the subject matter and its structure, as well as an equally thorough understanding of the kinds of teaching activities that help students understand the subject matter in order to be capable of asking probing questions". Since learners are from different backgrounds with different conceptions and preconceptions Loughran et al. (2012: p. 7) believe that it takes PCK to harness all such conceptions and preconceptions into knowledge. According to them "Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons". Explaining this, they paraphrase Shulman that "If those preconceptions are misconceptions, which they so often are, teachers need knowledge of the strategies most likely to be

fruitful in reorganizing the understanding of learners, because those learners are unlikely to appear before them as blank slates" (*ibid*.: p. 7). Expertise in PCK is not handed down to teachers at birth. This has been indicated by William and Lockley (2012) who believe that the bank of skills and knowledge needed by novice teachers to become professional teachers who are experts in their field takes time to develop and that these beginner teachers may not see the complexities involved in the processes of pedagogical reasoning and action (Shulman, 1986).

PCK, as defined by Shulman (1986), attempts to bridge what he describes as the gap between the content teachers are required and expected to know and the tools they should possess to make that knowledge accessible to students. A teacher's PCK impacts on learning. This is because an enhanced teacher's PCK developed with time stimulates positive attitude towards teaching and brings about increased learning and interest in technology (Rohaan et al., 2010) These are not simply the tools of classroom management but rather knowledge of strategies and student ideas that are particular to the content being taught in a particular context. This means that content knowledge alone is not enough to bring about learning in students. How to transfer this learned concept to students is crucial hence the use of constructivism, PCK and espoused theory and theory in use to frame this study. Shulman (1986: p. 7) describes PCK as "the most useful ways of representing and formulating the subject that makes it comprehensible to others". PCK comprises of the following components: orientation towards teaching (knowledge of and about the subject, beliefs about it and how to teach it); knowledge of curriculum (what and when to teach), knowledge of assessment (why, what and how to assess); knowledge of students' understanding of the subject and knowledge of instructional strategies.

Therefore, PCK is the intersection of content knowledge and pedagogical knowledge specific to a content area. Effective teaching is not achieved by simply being an expert in a field; nor is it achieved solely by possessing skills and knowledge of pedagogical practice. Using Shulman's PCK framework will be beneficial during data analysis as Shulman looked to understand where teachers' knowledge comes from, how teachers make decisions about how to teach a topic, and how they choose to represent an idea or address student misconceptions.

The perspective of the teacher impacts significantly on the development of creativity and collaborative learning and that those perspectives are influenced by PCK (Hämäläinen & Vähäsantanen, 2011). According to Hämäläinen and Vähäsantanen, (*ibid*.: p. 177) "there is a need to know the theories and contents of the learning and sense the contextual needs of the learning

situation. As artists must know the painting techniques before the creative painting can emerge, the teacher must have sufficient pedagogic expertise to orchestrate successful collaborative learning". It is therefore imperative to know the PCK of the teacher as such knowledge shapes up his views regarding the design process and will subsequently impact on their teaching strategies or styles.

Due to the disjuncture between content knowledge and PCK, teachers' class room practice is often not consistent with their views or beliefs about a specific topic such as the design process. In this regard, Agyris and Schön (1974) are of the belief that people are designers of their actions. Furthermore they maintain that people design action in order to achieve intended consequences and monitor to learn if their actions are effective.

2.3.3 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 has to 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.

2.3.4 Interface

According of Singh-Pillay (2010) the interface arises out of the points of convergence and divergence amongst the elements or people's views. It is this understanding that is applied in this study. The concept of an interface is construed as a meeting point (convergences) or a point of

deviations (divergences) amongst teachers' espoused theory and theory in use. Teachers' espoused theory of the design process will be juxtaposed with teachers theory in use to look for congruence (convergences) or divergences (non- congruence).

2.4 CHAPTER SUMMARY

In this chapter presents a review of literature on the design process, the differing perspectives amongst scholars as to how the design process should occur as well as how the teaching of the design process should occur. A brief explanation was provided for the study embracing a constructivist approach whilst the notion of pedagogical content knowledge was reviewed to support my argument that teachers' views of the design process influence their engagement and enactment of the design process. The conceptual framework used to explore and understand the link between grade 9 technology teachers' views of the design process and their class room practice of the design process was PCK, the concept of espoused theory and theory in use and the notion of interface. In the next chapter, the methodology used in this study is elaborated.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter I discuss the philosophical assumptions underpinning this study and explain why this study adopts a qualitative as well as a case study approach. It also describes the research site and the data collection method employed in the study. The chapter also gives an account of how various gatekeepers at each stage of the research were approached in order to gain access and gives an account of the dilemmas encountered by the researcher during the data collection phase of the research. The instruments used and the sampling procedure used in the study are explicated. This is followed by the description of data collection procedure and the method of data analysis. The chapter ends with the description of the validity and reliability of the instruments.

3.2. PHILOSOPHICAL ASSUMPTIONS UNDERPINNING THIS STUDY

3.2.1 Why this study involves qualitative data

This study is located within the interpretivist paradigm and adopts a qualitative approach for the methodology. According to Cohen, Manion, and Morrison (2011) the interpretivist paradigm aims to understand, describe and interpret in detail the lived experiences of participants in a study. 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. Hence, the study draws from the assumptions of the interpretivist paradigm to explore grade 9 technology teachers' views of the design process and its impact on their teaching of the design process. According to Mcmillan and Schumacher (2010) the goals of qualitative research are to "describe and explore" and to "describe and explain any phenomenon". The reason for collecting qualitative data for the study was to gain a greater and deeper insight (Bertram, 2003; Kumar, 2005) into grade 9 technology teachers' views of the design process and how these views influence their teaching of the design process.. In order to access such views there was the need to make room for flexibility at every stage of the research. Qualitative data was

deemed suitable as it captures a wide range of responses which entails observed situations and opinions of respondents.

3.2.2 Reasons for using a case study approach for the study

The ontological position of the interpretative paradigm directs this study to deploy a case study approach to explore grade 9 technology teachers' views of the design process and how these views influence their teaching of the design process. According to Creswell (2013), case study research approach aims to explore in order to understand things in detail. In this regard, Yin (2009) maintains that case study is an empirical inquiry approach that investigates a phenomenon within its real-life context. The method 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 for in-depth understanding of a specific event, process, organisation 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.

The distinguishing feature of case study approach is that the case study methodology provides rich thick descriptions of the participants lived experiences, thoughts and feeling about a particular phenomenon within a specific context, using multiple data sources.

There are different categories or types of the case study approach which a researcher can choose from (Cohen, Manion, & Morrison, 2013). These categories of case study are distinguished by the intention and purpose of the study (Stake, 2000; Creswell, 2013). In this regard, Stake (2000), Creswell (2013) as well as Cohen *et al* (2013) identified the following categories of case studies:

- Intrinsic case study: These are studies undertaken in order to understand the particular case at hand Cohen *et al.* (2013). According to Lapan, Quartaroli and Riemer (2012), the intrinsic case study focuses on the case being studied, answering questions about that entity or object and conveying the illuminated operations to its participants and stakeholders. Here, the purpose is not to understand some abstract generic phenomenon, but to develop a detailed understanding of

the case at hand. In other words, an intrinsic case study focuses on developing a deep insight of a particular case.

- Instrumental case study: This examines a particular case or instance to build new theories or to compare findings to new ones for corroboration or to question their validity Lapan, Quartaroli and Riemer (2012). The case here is of secondary interest, which is facilitating of theory.

- Collective case study: This involves studying a number of cases (multiple case studies) jointly in order to investigate a phenomenon Creswell (2013). This method is believed to offer better understanding of the phenomenon/case.

In another classification of case study research approaches, Yin (1994) cited in Cohen *et al*. (2013 p. 291) and Robson (1993) identified three categories of case studies with regards to their outcomes. These include:

- Exploratory case study: This serves as suitable means of eliciting information in order to seek new insights and clarify ones 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.

Taking the above into account whilst considering my research question I arrived at the decision that the first research question "What are Gr 9 technology teachers' views of the design process?" entails a descriptive case study whilst the second research question "How do these views influence their teaching of the design process?" embraces an explanatory case study.

The intention was not to judge teacher practice but to understand the reasons behind teacher practices with regard to the design process. The study involved real people in real situations and provides an in-depth study of participants' unique and common features in a limited time frame (Bell, 1993; Cohen, Manion, & Morrison, 2007; Denscombe, 2003; Kumar, 2005). According to Murray and Beglar (2009), "Case studies can be defined as the intensive, in-depth study of a

specific individual or specific context or situation. The real strength of the case study method is its potential to illuminate a 'case' in great depth and detail and to place that case in a 'real' context".

Adopting a case study approach in the study yielded some advantages. A case study allows the use of various method and that it does not claim any particular method for data collection in order to answer the critical question in a research (Bell, 1993; Denscombe, 2003). It provides a broadened view about varying human behaviours and exposes the views and choices of participants within a chosen context and that it addresses the 'how' and 'why' questions in research (Anderson & Arsenault, 1998).

Therefore a case study approach can offer is an in-depth understanding of how various aspects in the case interrelate. Case study is thus uniquely placed to deliver explanatory theory. The potential transferability of these findings to other similar contexts can only be partly suggested by the author but ultimately is the responsibility of the reader – who can compare the case to another context. In this sense then, it has been argued that the case study is associated with its own particular forms of generalizability (Flyvbjerg, 2006).

3.3 LOCATION OF THIS STUDY

This study is located in the township of Chatsworth, specifically in the Chatsworth West ward of the Chatsworth circuit in the Umlazi district of the Kwazulu-Natal Department of Basic Education (KZNDBE). Chatsworth is situated in South Durban basin in South Africa and is roughly bordered by the Umhlatuzana River in the North and Umlaas River in the South. The township of Chatsworth was created during the apartheid era specifically for Indians but currently it accommodates a mixed population. There are sixteen secondary schools within the Chatsworth West ward and out of these, fourteen are public schools and two are independent (KZNDBE, 2012). Schools within the Chatsworth West jurisdiction belonged to previous ex-departments of education, namely the House of Delegates which controlled Indian education prior to democracy), and the Department of Education and Training which controlled African education). The Chatsworth West was selected as the location for the study. This is because I teach in this area and I am known to many of the technology education teachers in this area as we meet at the KZN DoE technology meetings.

3.4 DATA COLLECTION METHODS

The findings of every empirical study should be evidenced in the data collected during the study. Failing to identify the appropriate instrument for data collection can impact negatively on the research findings. This is because the relevant information in the form of phenomena, patterns, actions and behaviours among others can only be extracted from the analysis of such data. Information may therefore be concealed from the researcher who employs inappropriate method(s) of data collection.

Data can exist in two ways. It can exist in the form of already existing information such as school records, census data, or other existing literature waiting to be accessed. This is known as secondary data (Kumar, 2005). Data collected directly and first-hand from the source such as interviewing and or observing people, collecting responses through the use of a questionnaire are referred to as primary data (Bertram, 2003; Cohen et al., 2007; Denscombe, 2003). The data collected for the purposes of this study is entirely from a primary source. In this section I discuss issues pertaining to gaining access, instruments used, sampling methods deployed, phases of data collection, how data was analysed as well as how issues of trustworthiness, validity and reliability.

3.4.1 Gaining access

Gaining access means dealing with various gatekeepers at each stage of the research. Formal permission to conduct research was obtained from UKZN's research office. Permission was also sought from the principals of the school within the Chatsworth West ward to conduct research at their schools. 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 particular school. In spite of all my efforts, the principals of two schools refused to grant me entry into their school premises as they were not *au fait* with the new regulations pertaining to permission to conduct research at schools. This reduced the number of participating schools from fourteen to twelve.

Once I had gained the consent of the principals to conduct research at their schools, I sought permission from grade 9 technology teachers' to participate in this study. Whilst acquiring permission from the teachers to participate, I verbally informed them about the background to the purpose for the study. Participants were made aware that they could withdraw from the study at any time they prefer to and they would also be guaranteed of confidentiality and anonymity.

I have come to realize that gaining access is an iterative process. It entailed dealing with various gatekeepers at each stage of the research. For example even though the principal of twelve schools had granted me access to their schools and the 12 teachers had consented to participate in the study, participants from two schools failed to return the completed questionnaire citing examination pressure as a reason. They had failed to indicate their unwillingness to participate in the study and this reduced the number of participants from twelve to ten. A methodological challenge encountered during the observation of lessons was teachers having to adhere to the standardized work schedule (a weekly and daily forecast of teaching and learning activities as outlined in the CAPS document). As a result, dates for observation of lessons had to be re-scheduled until the lessons involving the design process were being taught.

3.4.2 Instruments

The following instruments were used to capture data to answer the two research questions posed: questionnaire, semi structure interview, observation of lesson, post-observation interview. The reason for using the instruments mentioned was that they were suitable instruments to be used to collect qualitative data for the study which it also qualitative in nature.

3.4.2.1 Questionnaire

An open ended questionnaire was designed with the assistance of university researchers and piloted with technology Honours students who are teachers of technology (see appendix 2 for questionnaire). Using an open ended questionnaire to collect data for this study was deemed suitable because open ended questions capture the specificity of a particular situation (Cohen et al., 2007). Seeking the views of grade 9 technology teachers on the design process implies that many possible answers may be expected. In the light of this, Cohen et al. (2007: p. 321) cited the work of Bailey that "Open ended questions are useful if the possible answers are unknown or the questionnaire is

exploratory". Cohen et al (*ibid*.) add that open ended questions make it possible and easy for the respondents to answer the questionnaire without any restrictions on what they wish to say and this makes it suitable for enquiring into complex issues which demand more than just simple answers.

The questionnaire was piloted to check the clarity of the questionnaire items, eliminate ambiguities or difficult wording. The outcome of the piloting indicated that the questionnaire items had good construct validity. According to Cohen et al. (2011) a pilot study serves to increase the reliability, validity and practicability of the questionnaire. The rationale for using the questionnaire first was twofold. First, it allowed participants the opportunity to answer the questions privately, and the information is written down by the participants in their own words which reduces the possibility of the researcher misinterpreting the information and then misrepresenting in the field notes. Second the analysis of the responses to the questionnaire helped in the selection of the sample for the second phase of data collection. The questionnaire targeted biographical data as well as information on understanding of the design process, the importance of the design process in teaching technology, planning that goes into teaching the design process, and aspects of the design process that are emphasised during teaching. The information obtained from the questionnaire was used to map the grade 9 technology education topography within the Chatsworth West ward in terms of teachers' conception of the design process.

Copies of the questionnaire were delivered personally to twelve grade 9 technology teachers in the Chatsworth West Ward at their respective schools for completion. Teachers were given a timeframe of one week to complete the questionnaire before it was collected from them. As a follow-up measure, telephone calls were made to respondents after four days to remind them to complete the questionnaire in time. Contrary to expectation, it took two weeks to retrieve the distributed questionnaire. One teacher, who had agreed to participate in this study, returned a blank questionnaire as he had no clue as to how he can answer the questionnaire items and he was only able to complete the part that required his biographical data. Another teacher failed to complete and return the questionnaire. It appeared he had no time to complete the questionnaire since he kept on asking for extensions earlier on. The returned questionnaires were coded from T1 up to T10 (Teacher 1 up to Teacher 10) to represent the ten respondents and then analysed. The analysis of the questionnaire was used to select four teachers for the semi-structured interview (phase 2). The

criteria for selection of the four respondent was based on the analysis their biographical data as well as the analysis of their responses to the questionnaire items.

3.4.2.2 Semi- structured interview

A semi-structured interview was used as the second instrument as it allowed the researcher to probe the participants' responses from the questionnaire. In explaining a semi-structured interview, also referred to as informal, conversational or soft interviews, Longhurst, (2010, p56) quotes the explanation given by Krueger and Casey 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". In other words, the researcher has to be careful and systematic with the things people tell you. The purpose of the interview was to sample the respondents' responses by asking them questions in the same order thereby increasing comparability of responses (Cohen et al., 2007). Participants were purposively selected based on analysis of their perception of the design process and the impact of their perception on their teaching style. The selection criteria was informed by factors such as the qualification of teachers in the field of technology education as well as total number of years of teaching experience in technology, the relevant Pedagogical Content Knowledge (PCK) (Hämäläinen & Vähäsantanen, 2011; Koehler & Mishra, 2009; Shulman, 1986; Shulman, 1987) of teachers as well as gender balance were also taken into consideration.

The semi-structured interview was used to probe information about: teachers views of the design process, methods used to teach the design process, reasons for using the methods mentioned, kinds of activities given to learners during the design process and learner creativity during the design process. The semi- structured interview (see appendix 3 for semi-structured interview questions) was used to identify the sample for phase three of data collection.

3.4.2.3 Observation schedule

An observation schedule was designed with the assistance of university researchers to observe the teaching of the design process at two schools in the Chatsworth West (see appendix 4 for observation schedule). The observation schedule focused on the following aspects: how the lesson was introduced, methods deployed in teaching the design process, how learners' needs were catered

for as well as the kinds of activities learners engaged in. The purpose of the observations was to gain insight into the teachers' practice (theory in use) and to capture if any, transformation of the teachers' espoused views of the design process occurred.

3.4.2.4 Post-observation interview

Post-observation interviews were conducted with the two teachers whose lessons were observed (see appendix - for post-observation interview) to probe what was observed during the delivery of their lesson on the design process.

Post-observation interviews provide flexible opportunities to probe for greater depth than what video recordings can provide. The focus of the research was not only to explore how teachers' views of the design process influenced their teaching of the design process but also to gain insights into the thinking and reasoning that took place in the process of knowledge transformation, and the teacher's reflection in and on action (Park & Chen, 2012; Schön, 1983, 1987). The post-observation interviews were used in the study to clarify, supplement and support what was observed in the classroom and provide information that could not be captured by observation alone.

3.4.3 Sampling

Convenience sampling as well as purposive sampling was used for the study. Convenience sampling according to (Maree, 2007) refers to situations when population elements are selected based on the fact that they are easily and conveniently available. This sampling method was chosen on the grounds of proximity and affordability as I am a teacher in Chatsworth West ward. The aim of purposive sampling was to identify the relevant respondents who have the right information (Blanche, Blanche, Durrheim, & Painter, 2006). The participants in this study were also purposively selected as they were teachers of grade 9 technology within the Chatsworth West ward. The aim of using purposive sampling was to identify the relevant respondents who have the right information (Blanche et al., 2006). According to Maxwell (1998) this is a strategy in which particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be gotten as well from other choices.

3.4.4 Data Collection Plan

Data was collected in three phases as represented in Table 3.1 below:

Table 3.1: The phases of data collection, instruments used and the purpose of each phase

Phase	Data source	Instrument	Research question/s targeted	Purpose of phase
1	Ten grade 9 tech teachers	Questionnaire	1. What are Gr 9 technology teachers' views of the design process? 2. How do these views influence their teaching of the design process?	To obtain sample for phase 2
2	Four Grade 9 tech teachers who participated in phase I of data capture- selected purposively:	Semi-structured interview	1. What are Gr 9 technology teachers' views of the design process? 2. How do these views influence their teaching of the design process?	To obtain sample for phase 3 (classroom observation)
3	Two grade 9 technology teachers who participated in phase 2 of data capture- selected purposively –	• Observation schedule • Post-observation interview	1. What are Gr 9 technology teachers' views of the design process? 2. How do these views influence their teaching of the design process?	To validate data obtained from phase 2

- **Phase 1 The use of a questionnaire**

An open ended questionnaire was used to collate data in phase one from ten grade 9 technology teachers who consented to participate in the study. The purpose of this phase was to purposively select a sample for phase 2, once the data from the questionnaire is analyzed and to map the grade 9 technology education topography within the Chatsworth West ward in terms of teachers' conception of the design process.

- **Phase 2: semi-structured interviews**

Four out of ten grade 9 technology teachers who participated in phase one were purposively selected for the second phase of data collection. The criteria for selection was based on the analysis

of their views of the design process and how those views impact on their teaching styles (in phase one). Teachers purposively selected were teachers given the pseudonyms of T2, T4, T5 and T8.

- **Criteria for the selection of participants for phase two**

One factor that was considered was the availability and willingness of teachers to participate in the semi-structured interviews. The biographical data of respondents were also taken into consideration. This included the age of respondents as well as the number of years of teaching experience of each selected participant and more specifically their number of years of teaching technology. Teaching experience was perceived as a crucial factor in the development of teachers' PCK (Shulman, 1987). Hence, the years of relevant teaching experience of a respondent were also taken into account. Another crucial factor that was worth considering was the teachers' responses to the questionnaire items. Some teachers were selected for phase two of data collection because they either did not complete some aspects of the questionnaire or they were inconsistent in their responses. Therefore, the need to revisit those teachers and to explore their views was crucial. Teachers were therefore selected individually based on specific reasons.

- T2: At the time of the study, T2 had taught technology throughout his fourteen years career as a teacher and had a qualification of M+4 (Higher Education) in the field of technology education. It was therefore deemed reasonable and suitable to evaluate his PCK in the light of his teaching experience and relevant academic qualification. Secondly, even though he answered ''Yes'' to questionnaire item 4 (Do you do any planning before teaching the design process? Please elaborate.), he (T2) did not elaborate on what type of planning he does before teaching the design process. In spite of his rich teaching experience, his responses were very sketchy and incomplete in some instances hence the need to include him in the group for interviews. Also, he had already indicated his willingness to participate in any of the phases of data collection activity.

- T4 is a female teacher with an Advanced Certificate (ACE) in Technology Education. She had indicated how interesting her ACE programme was and how it made her understand more about

technology education. It was therefore going to be interesting to research her PCK. Her responses in phase one indicated that she had a lot to contribute towards the study.

- T5 is also a female. She was the only respondent who indicated that the design process is a non-linear (cyclical) process. Therefore, there was the need to know more about how she presents it. Just like T2, T5 indicated she plans before teaching the DP but did not indicate the preparation she does before the presentation of the DP. There was therefore the need to know more about how she prepares before presenting the DP in a non-linear model. Secondly, she had nine years of teaching experience in technology out of her twenty two year career and had an M+4 (Higher Education) qualification in the field.

- T8 was the most interesting respondent in phase 1. He happened to be the oldest and the most experienced among all the respondents. He was a fifty eight year old male teacher with twenty seven years as a teacher and eight year as a technology teacher. Even though he was not the respondent with the highest relevant teaching experience in technology education, he had other experience. After considering his responses, it became apparent that unlike all the other respondents he was the only one who had some experience in the design process outside the classroom (in industry). There was therefore the need to establish if his experiences impacted on his PCK.

Special arrangements were made with respondents so that the schedules for the interviews would coincide with the non-teaching time of both the researcher and respondents. However, things did not work out as planned. Interview schedules were disrupted due to the non-adherence to time agreed upon by the researcher and respondents. Notwithstanding this, five semi-structured interviews were finally conducted and out of these, four were selected for analysis. Interviews were audio-recorded. The interviews enabled the interviewer to probe participant responses and participants were given the opportunity to clarify and justify their responses. Probing questions were occasionally used to seek clarity of respondents' responses. Each interview lasted an average of six and a half minutes during which respondents answered questions that were pertinent to their views of the design process as well as their teaching styles.

- **Phase 3: Observation of Lesson**

The third phase of data collection involved an observation of two teachers as they presented a design lesson to their learners in a design class. The purpose was to check how teachers' views on the design process impacted their teaching of the design process. This was done by collecting data from the lessons observed and also from the post-observation interview in order to juxtapose this data with the data from research question 1 to answer research question 2 of this study. To juxtapose the data, I deployed Singh-Pillay's (2010) notion of an interface. She construed the interface as both points of convergences (congruence) and points of divergence (no congruence) among elements or people's views. The idea of interfaces is used to juxtapose espoused views and theory in use in order to note congruence or non-congruence between them. According to Cohen et al. (2007) observation:

> "offers an investigator the opportunity to gather 'live' data from naturally occurring social situations. In this way, the researcher can look directly at what is taking place in situation rather than relying on second-hand accounts. The use of immediate awareness, or direct cognition, as a principal mode of research thus has the potential to yield more valid or authentic data than would otherwise be the case with mediated or inferential methods. And this is observation's unique strength" (p. 396).

Both lessons observed were also video recorded till the end. Video recordings can capture non-verbal data (body gestures, facial expression, and tone) that audio recordings cannot or that the observer may miss. The advantage of using video recordings is that it is a mirror image of what occurs, and it allows for repeated viewing and checking. During this phase an observation schedule (see appendix 3) was used to observe teachers' enactment of the design process in their classroom.

- **Criteria for the selection of participants for phase three**

Two of the participants from phase 2 were purposively selected based on the analysis of their views of the design process and its impact on their teaching style ascertained during the semi-structured interview conducted in phase 2 of data capture. It, however, took a lot of convincing to get at least one of the female respondents from phase two to participate in this third phase of data collection activity since the one who was selected had stated in the answering of the questionnaire that she was

camera shy. At this stage it was very clear that there were two opposing views regarding the nature of the DP and for that matter how it is presented to learners. T5 and T8 were purposively selected for the live presentation and observation of their lessons.

T5 expressed duel views of the design process, as being iterative as well as being a set of procedures to be followed whilst T8 construed the design process as involving critical and creative thinking.

In both cases (T5 and T8), very interesting patterns were noticed in their responses in both the questionnaire and the focus group interview. This was one of the reasons for selecting T5 and T8 for lesson observation. According to Sharan (2009), "a case might also be selected because it is intrinsically interesting, and one would study it to achieve as full an understanding of the phenomenon as possible".

Phase three was therefore the final phase of data collection where two identified methods of presenting the DP were going to be observed in a real classroom presentation. The intention was to trace how teachers' views on the design process influence their teaching of the design process. All the data obtained from the three phases were compared for the purposes of triangulation (Creswell & Miller, 2000).

A post-observation interview was also conducted after the observation of the lessons. The post-observation interviews were also audio-recorded. The purpose was for both interviewer and respondent to reflect on the lesson observed and to seek clarity on the teaching procedure used by the respondent during the lesson delivery. It was also to seek clarification on the teaching styles adopted.

3.4.5 Data analysis method

Hatch (2002) explains data analysis as:

> "a systematic search for meaning. It is a way to process qualitative data so that what has been learned can be communicated to others. Analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations, mount critiques, or generate theories. It often involves

synthesis, evaluation, interpretation, categorization, hypothesizing, comparison, and pattern finding. It always involves what Wolcott calls "mind work where researchers always engage their own intellectual capacities to make sense of qualitative data" (p. 148).

Inductive data analysis methods were used in the three phases of this study. This approach primarily involved detailed reading of raw data in order to derive concepts, themes or a model as the researcher or the evaluator draws interpretations from the raw data (Thomas, 2006). The purpose of using the inductive approach, as Thomas (2006: p. 237) puts it was to "(a) condense raw textual data into a brief, summary format; (b) establish clear links between the evaluation or research objectives and the summary findings derived from the raw data; and (c) develop a framework of the underlying structure of experiences or processes that are evident in the raw data" and that inductive reasoning was used to generate ideas from the data collected (Thorne, 2000).

The two research questions posed in this study were used for organizing the analysis. In this approach all the relevant data from data sources (questionnaires, interviews, and observation schedule) were collated to provide a collective answer to each research question. This was in line with the explanation given by Cohen et al. (2011) that qualitative data involves organising, accounting for and explaining the data in terms of the participant's conception of the phenomenon being explored, noting patterns, themes and categories and regularities. In this study, technology teachers' views of the design process was the unit of analysis. Shulman's (1986) PCK framework was used to understand where teachers' knowledge comes from in respect of the design process (that is, use of instructional strategies, knowledge of the technology curriculum, use of assessment strategies, knowledge of learners' understanding in technology and use of explanations). Singh-Pillay's notion of interface was applied to Argyris and Schön's (1974) espoused theory and theory in use to establish if teachers espoused views of the design process were congruent with their theory in use.

3.4.6 Credibility and Trustworthiness

To ensure credibility of this study, detailed description of the settings, participants and themes are provided. (Creswell & Miller, 2000, p. 128). In addition multiple data collection strategies such as questionnaires, semi-structured interviews, lesson observation and post lesson interviews were used to ensure credibility and trustworthiness. To enhance the credibility and trustworthiness of the data I engaged in triangulation of data and member checking.

3.4.6.1 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 at work.

3.4.6.2 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 a research. According to Creswell and Miller (2000), triangulation is used to increase credibility and check dependability by sourcing information from different sources to forms themes for the study. This was done by collecting data through the use of 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 sorting out inconsistencies encountered in the three phases of data collection.

3.4.6.3 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 & Johhnson (2000). This was done in close and frequent consultations with my supervisor.

3.4.6.4 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 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

3.5 CHAPTER SUMMARY

In this chapter, the philosophical assumptions underpinning the study were discussed. Explanations were given as to why this study adopts a qualitative approach and also uses a case study approach within the interpretivist paradigm. The chapter also justified the collection and use of qualitative data to answer the research questions. The research design including a description of the research site, the data collection method, issues relating to gaining access to the research site as well as to the respondents, sampling and sampling procedures together with the instruments used were also discussed. The chapter also gave a description of the methods of data analysis and ended with a discussion of issues of validity and reliability which ensure the credibility and trustworthiness of the study. In the next chapter I present the finding and analysis of the data collected.

CHAPTER 4

PRESENTATION OF FINDINGS AND ANALYSIS

4.1 INTRODUCTION

This chapter aims to answer the two research questions posed, namely, "What are Gr 9 technology teachers' views of the design process?" and "How do these views influence their teaching of the design process. As mentioned in the previous chapter data was collected using a questionnaire, semi-structured interview, observation and post-observation interview. The chapter is divided into part A and part B. Part A aims to answer the first research question whilst part B attempts to answer the second research question.

4.2. PART A

The first research question, "What are Gr 9 technology teachers' views of the design process?" is answered by using data from the questionnaire and semi-structured interviews. The two core views on the design process that emerged from the thematic analysis are explored, namely:

- Design process as problem-solving; and
- Design process is a step-by-step process that provides "comfort" to learners during problem-solving.

An analysis of the findings on the categories of descriptions that emerged on teachers' views of the design process from the questionnaire and the semi-structured interview is presented.

4.2.1 Analysis of data

As mentioned in the previous chapter the questionnaire comprised of two sections. Section A elicited biographical responses from the participants while section B consisted of questions pertaining to the two research questions of the study. The first three questions of the questionnaire targeted research question 1 (What are grade 9 technology teachers' views of the design process) and the last three questions focused on research question 2 (How do these views influence their teaching of the design process). In the section below, I present and discuss the finding from section A of the questionnaire.

4.2.1.1 Biographical responses

The data acquired from the biographical section of the questionnaire was to create a context for grade 9 technology education within Chatsworth West 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.

In respect of teacher qualification, it is interesting to note eight out of the ten teachers have a qualification to teach technology education. In addition to their qualification, these eight teachers had attended technology education workshops offered by the KZN DoE to support curriculum implementation. At a glance, an assumption can be made that these teachers should be *au fait* with

the design process as they have studied the design process, have a qualification to teach technology education and have attended the workshops organized by KZN DoE as shown in Graph 4.1 below.

Graph 4.1: Technology teachers' qualifications
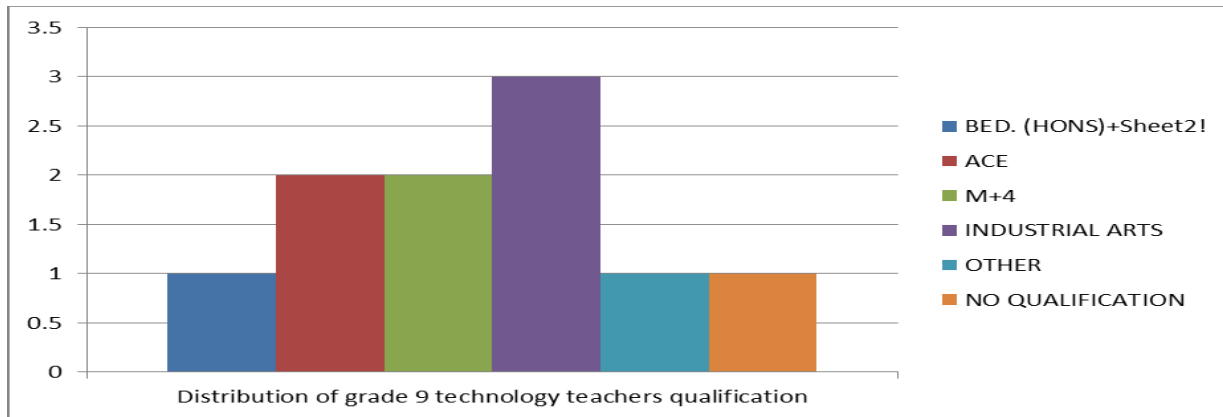
However, it is worth noting that there is a disparity between the number of years of teaching and the number of years teaching technology amongst these teachers (Graph 4.2). This disparity indicates that teachers' had to "re-train and re-skill" to teach technology at schools due to multiple factors such as Post Provisioning Norm (PPN), and drop in learner enrolment at school. These factors were not investigated as they do not fall within the scope of this study. The retraining and re-skilling that these teachers had to endure might in some imperceptible way impact their views of the design process as well as their engagement of technology education.

Graph 4.2: Depicting Teacher age, years of teaching and years teaching technology
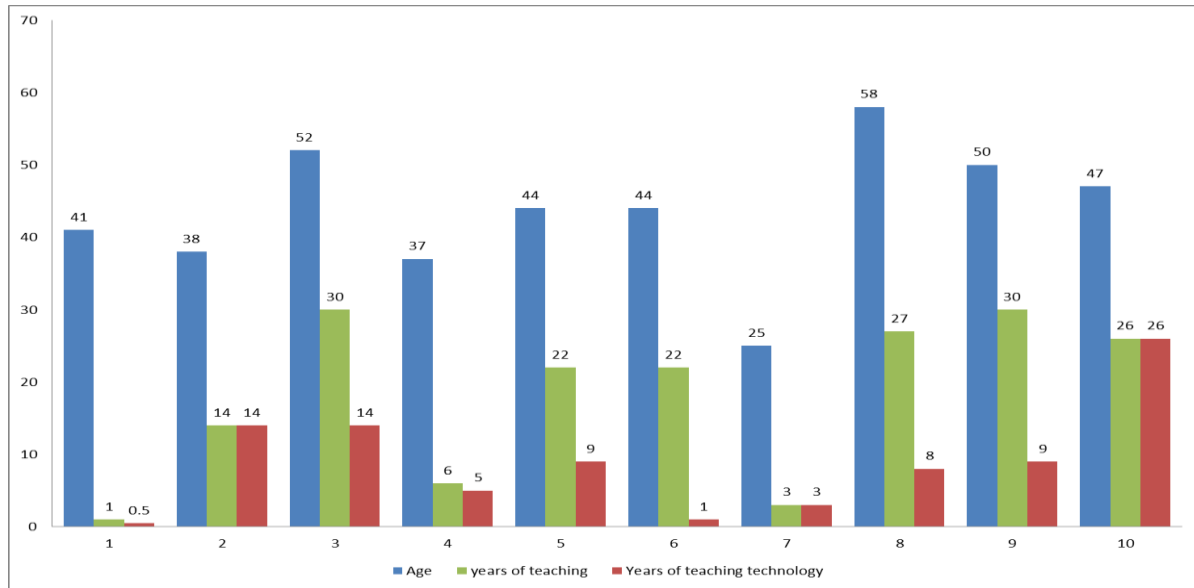
Another interesting finding from the biographical data shows that technology education remains largely a male dominated terrain (Graph 4.3). Seventy percent of this sample of technology teachers was male.

Graph 4.3: Depicting gender distribution of teachers
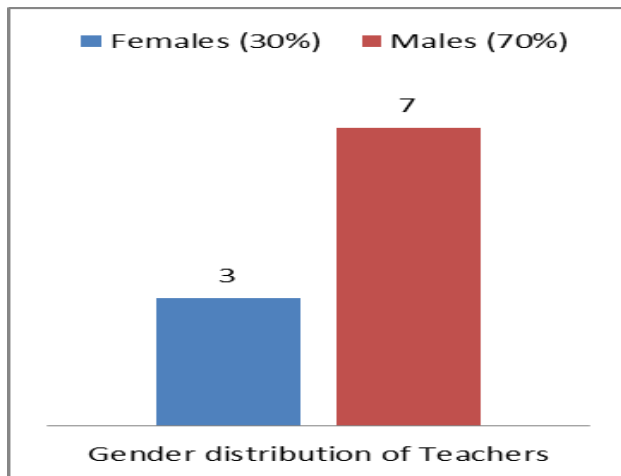
4.2.1.2 Analysis of the findings on the categories for teachers' view of the design process

These views were drawn from the questionnaire and the semi-structured interview. As mentioned earlier in the introduction the points elucidated were:

- Design process as problem-solving
- Design process is a step-by-step process that provides "comfort" to learners during "problem-solving"

In the section that follows the 2 points mentioned above are elaborated.

4.2.1.2.1 Design process as problem-solving

In the relationship between the design process and problem-solving the following 4 categories emerged:

- Used to solve problems
- Decision making process involving critical and creative thinking
- Cyclical process
- Core of technology

4.2.1.2.2 Used to solve problems

Seven technology education teachers view the design process as an activity that can be used to solve problem as reflected in the excerpts below:

- T4: *The design process is the same as problem-solving, you identify and define the problem, also solve the problem;*
- T5: *it is the same process like problem-solving;*
- T10*: it's a successful solution to a problem.*

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.

4.2.1.2.3 Decision making process involving critical and creative thinking

Three teachers construe the design process as being related to critical thinking and creativity. Put simply this means, for these particular 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 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:

- T3: *They must be creative and yet achieve its purpose.*
- T8: "*Sometimes a child may have one of the better solutions which I as a teacher would not have thought about. They are doing projects on their own, some of them come up with really good examples*".
- *T10: Try not to copy ideas, create your own design by thinking out of a box.*

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 particular 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. What is interesting about these teacher's views is that when I traced the response to the biographical data, these particular teachers have been engaging with technology education for more than 10 years and they have attended all the workshops conducted by the KZN DoE for policy implementation. One can reason that their years of experience engaging with technology education have impacted on how they view the design process and their embracing of learner-centred classroom pedagogy.

4.2.1.2.4 Cyclical process

Only two participants viewed the design process as being cyclical. This means the design process is viewed as linear but the actions undertaken are seen as iterative:

- T5*: "the design process is an iterative process to solve problem…..developing original ideas to meet the needs or wants";*
- T8*: "It's a cyclic process, not a linear way to solve problems".*

For these teachers the design process is not reduced to a "cook book recipe" whereby learners follow the steps of the design process in a sequentially progressive fashion. For these teachers the stages/steps of the design process lack sequential rigidity; rather it is an iterative process that involves back and forth movement between stages or the skipping of a stage to refine ideas and the end product. It is important to note that these teachers' views are aligned with the CAPS senior phase technology policy's notion of the design process (DoE, 2012). In addition, the views of these teachers conform to the views of scholars such as Lawson (2006) and Hill (1998) who maintain the design process involves refinements of the design solution by ever changing design ideas.

4.2.1.2.5 Core of technology

In their overall view of the design process as problem-solving, teachers were of the opinion that the design process supports the teaching of technology education.

- T5: "*It is the most important process in technology education*".
- T6: "*It is what drives technology and innovation*".
- T8: "*It is the backbone of technology education*".

This finding corresponds with the philosophy of scholars just as Mawson (2003); Jones, Bunting & de Vries (2013) as well as the *Standards for Technological Literacy* (ITEA, 2000, 2002) on the design process being the core of technology education. The implications are that the design process ought to guide teaching and learning in technology education.

4.2.1.3 Design process is a step-by-step process that provides comfort to learners during problem-solving

A conflicting finding that presented itself within the collated data was some teachers who considered the design process to be a method/plan used to solve problems also saw the design process as a step-by-step process that provides comfort to learners during problem-solving. Within this theme the following two categories emerged, namely

- Specific step-by-step process; and

- Safety net during problem-solving.

4.2.1.3.1. Specific step-by-step process

The view that the design process consists of steps or stages implies that the design process is a rigid foreseeable, expected, banal, unsurprising linear process as can be inferred from the excerpt below:

- T6: *"Basically the need to follow, I tell them to follow the six steps one after the other";*
- T2: *"The steps you need to follow when you have to solve a problem"; and*
- T5: "*A set of procedures that needs to be followed*".

These particular views of the design process contradict the view of the design process as cyclical and restricts the design process to a rigid process that unfolds in a particular sequence ("*you identify, define….and solve the problem"*). The implication of the above views of the design process is that learners cannot skip stages to reach a solution. According to Williams (2000) and Mawson (2003), a common view amongst teachers is the understanding of the design process as a linear process. In other words, the design process is a series of steps that are outlined by the teachers, viz. identify-design-make-appraise, and students are expected to follow these steps sequentially and diligently in their projects. In addition, the linear view of the design process hinders learner creativity as learners do not have the freedom to explore design solutions using their own ideas or methods. Scholars such as Hill (1998); Williams (2000); Mawson (2003) and Rowel (2004) argue that the seemingly rigid nature of the design process does not provide enough room for developing the creative skills of the learner, and have suggested the need for an alternative pedagogy or approach. It is interesting to note the contradictory view expressed by T5, earlier. T5 considered the design process as iterative and now it is seen as a "*set of procedures that needs to be followed*".

4.2.1.3.2 Safety net during problem-solving

The step-by-step nature of the design process is construed by some teachers as what makes things easy for students during problem-solving in design. The rigid structure provided by the sequential step-by-step process offers earners some sort of security framework or comfort within which to work when solving problems in technology education. In a surreptitious way, it also offers teachers a security framework or "comfort" to represent the design process as linear as it is easy to teach,

especially if their PCK is not well grounded in technology education as reflected in the excerpt below:

- T6: *"The step-by-step process gives learners directions towards the end product";*
- *T2:"It is not easy for the learners to finish their task and I can only teach design process if I follow the steps";*
- *T7: "It is easier to teach the design process in a step-by-step manner".*

It is in this regard that Williams (2000) contends that the rigid procedure or systematic re-presentation of the design process is inviting to teachers, because it provides a structure for the teaching of Technology. The biographical data indicates that T6 and T7 have very little experience teaching technology education hence an assumption can be made that they lack the necessary PCK to engage with the design process.

4.2.2. Answering research question one

In section 4A I have presented and analysed the data from the questionnaire and semi-structured interview to answer research question 1. The two core views of the design process presented by teachers are Design process as problem-solving and Design process is a step-by-step process that provides "comfort" to learners during problem-solving. T5 and T8 were purposively identified based on their espoused views of the design process to have their lessons observed. Of importance is T5's espoused, dual view of the design process as problem-solving as well as a step-by-step process, whilst T8 is of the view that the design process involves critical and creative thinking. T8's view of the design process reveals that he has a learner-centred classroom. In exploring teachers' views on the design process, it is obvious that their espoused views are shaped by their PCK and experiences which ought to impinge on their practice. In section 4B I present and analyze the data from the observation and post-observation interview.

4.3 PART B

In this section I present data in response to research question 2, "How do these views influence their teaching of the design process?" The observation of lessons was followed by post-observation interviews. The purpose of the observation was to trace how their espoused views or theory of the design process impacted their actions during practice i.e. the teaching of the design process. The following manifestations of PCK were used to analyse the data: use of instructional strategies, knowledge of the technology curriculum, use of assessment strategies, knowledge of learners' understanding in technology, and use of explanations. Argyris and Schön's (1974) espoused theory and theory in action was also used to was interrogated the data. Narratives of T5 and T8 lesson observations are presented.

4.3.1 Lesson observation T5

Due to contextual factors, such as teacher strikes, backlog in teaching and assessment as well as urgency to be on par with the designated work schedule, I was only able to observe one lesson each for T5 and T8 on the design process. The lesson for T5 lasted for forty two (42 minutes) whereas that of T8 lasted a period of thirty five (35) minutes. The disparity in the duration of the lesson was due to the different teaching cycle adopted by the management and School Governing Body of each school. T8's school runs a thirty minute cycle of periods after break and T5's school runs a forty five minute cycle whereas some schools also do this on Thursdays and Fridays only.

4.3.1.1 Lesson observation of T5

As mentioned earlier the following five manifestations of PCK, namely, use of instructional strategies, knowledge of the technology curriculum, use of assessment strategies, knowledge of learners' understanding in technology and use of explanations as well as Argyris' and Schon's (1974) espoused theory and theory in action was used to interrogate the data.

- The context

T5 teaches at Westview secondary school situated within the Chatsworth west circuit. The school has a student population of 1,100 and charges a school fee of R2700 per learner per annum. It is situated in a multiracial community comprising of Indians (89, %) , Africans (8)%) , Coloured (1.%)

and whites forming a total of less than one percent (Frith, 2014). The community is heterogeneous in terms of socio economic living conditions. This socio-economic heterogeneity is visible in the different types of dwellings in this area. Unemployment and crime is on the increase in this community, as is in the rest of South Africa, hence security is a major concern to the residents of this area. Even the school is conscious of need for security and is encircled by four concrete walls of about 2 meters high with a remote controlled steel gate manned by a security guard at all times. The school is neat, free of liter and well maintained. As I entered the school gate I observed there were no learners loitering around the school. The first impression that greets any visitor to the school is the aura of quiet and discipline.

Upon arrival at T5's school, I went to the administration block to sign the visitors book and to announce my arrival, I waited at the reception area for about fifteen minutes for T5 to finish her lunch (in the staffroom) before we proceeded to the classroom for the observation of her lesson. T5 was gracious and took me to her classroom ten minutes before her lesson could begin. As we waited for the learners to arrive, I went around the classroom to observe the classroom setting. It was an exceptionally well-resourced classroom with a variety of colourful, neatly drawn and very attractive posters mounted on the walls. The posters and drawings pertained to a wide range of topics in grade 9 technology curriculum. These included posters on mechanisms, systems and controls, electricity, gears, orthographic projection, perspective drawings among others. T5 indicated that she made most of these posters herself. There were other posters of civic significance. These included posters of human rights, the Constitution as well as those for HIV. The classroom was also decorated with models (mock-ups) made by learners in their previous mini Practical Assessment Task (PAT) projects. These included models of houses, hydraulic systems, and bridges among others. Half of the chalk board was covered with a large white screen used for power point presentations. There was an overhead projector hanging from the deck (ceiling) of the classroom and a connected laptop computer on the desk of T5. Hanging in the windows were thick, long and opaque red curtains to prevent outside light from entering the classroom during a presentation. The classroom setting and the quality of the mini PAT projects on display illuminated T5's enthusiasm about teaching technology education and the standard of work she expected of her learners. It was clear that T5 was proud of her achievements in terms of resources. All these varying resources together with educational technology made the classroom of T5 an interesting place not only for teaching and learning but for observation as well. The buzzer sounded to signal the end of the break and the commencement of the next period. Learners walked into the classroom at a rapid pace in an orderly

fashion and settled down quickly waiting for the lesson to begin. It was obvious that learner discipline was a priority for the management of Westview secondary school and hence learners did not loiter around and reported to classes promptly.

- The lesson

Introduction stage

An examination of T5's technology master file revealed that each year she made use of a different lesson plan, set of notes and PowerPoint slides. She keeps a collection of school textbooks in her classroom which she mainly used as a source for exercises. Her master portfolio was meticulously maintained. It was indexed and it contained the policy document, the work schedule for the year for each grade of technology education she taught, the department's common assessment plan per grade, learner assessment with rubrics and memos. It was interesting to note that diagnostic and statistical analyses were done for tests written by learners. These analyses were then used for the creation of extension activities or remediation activities for learners to support their learning in technology education. The review of the lesson plan for the lesson to be observed indicated that the specific aim for the lesson was to calculate gear ratios. The resources to be used to teach the calculation of gear ratios included power point presentation, models, and charts. This was a follow up lesson to the introduction on gears. T5 introduced the lesson by tapping into the learners' relevant previous knowledge on gears using the question and answer technique. The teacher used a colourful visually stimulating power point presentation for the revision of learners' relevant previous knowledge. Here, learners were made to answer simple questions as a revision of their previous knowledge. Some of the questions asked were; 1. What is a gear? 2. What are the functions of gears? 3. What is an idler gear among others? Learners were enthusiastic and participated actively in the lesson. The content T5 taught was strongly guided by the curriculum requirements. The introduction stage of the lesson lasted for approximately seven minutes thirty seconds.

Presentation stage:

T5 then followed up with the main lesson for the day. *(What I want you to look at now, class is calculation of gear ratio).*

- Instructional strategy

Analysis of the lesson observation revealed that T5 used four instructional techniques, namely

- question and answer technique(brain storming),
- demonstration,
- guided discovery, and
- problem-solving

to facilitate the learning on the concept of gear ratios. When using the question and answer or brain storming techniques, she showed learners a real model of a gear train together with 3-D animations from the slides in the power point presentation as the resources for the calculation of gear ratios and asked learners question pertaining to the gear train. As part of her demonstration, T5 showed and demonstrated how the model gear train works by turning it manually as learners watched. As part of her guided discovery technique, she then guided learners to establish the number of cogs in each gear in the gear train that was on the screen before using problem-solving to introduce the learners to the gear ratio formula for the calculation. Learners were given a task to solve problem on gear ratio calculation and to apply their knowledge of gear ratio to specific cases highlighted in the worksheet provided.

- Knowledge of technology curriculum and use of explanations

T5 was very knowledgeable about the technology curriculum goals, philosophy, content, specific outcomes and what was required for assessments and examination purposes. She has access to curriculum materials and made use of these in her teaching. She is passionate and enthusiastic about teaching technology as can be gleaned from the excerpt below:

> "*I love teaching technology, it's so alive and interesting, you know, I am a qualified Geography teacher but I have been teaching technology for the past 9 years, I attended the training workshops conducted by the subject advisor, but it wasn't enough so I started reading to learn as much as I can, and I'm still learning, I try and get many textbooks and study them to help me, I treat the policy like the bible – it guides me in my teaching and assessment*". (T5 semi-structured interview)

From the foregoing it is evident T5 is *au fait* with the policy document and is guided by the policy in her teaching and assessment practice. This means that T5 embraces the philosophy of the CAPS technology policy in her teaching. In this regard it is worth noting that T5 exposes learners to a criticism free environment and embraces the idea of learner-centred classroom environment as reflected in the excerpt below:

> *"Thank you, son, for coming to show your friends how to do the calculation. 15 goes into 15 once. It goes into 30 two times. What does 2:1 simply mean? Do not shout out. Raise your hand! Rihanna".*

From the observation of the lesson, it was conspicuous that the atmosphere in T5's classroom is nurturing and learners freely answer questions posed and willingly participate in solving problems on the board. This means that learners were confident in their learning and dealing with the problem-solving approach. She uses positive reinforcement to maintain the interest of learners in the lesson (*good, thank you for coming to show your friends how to do the calculation, come you try).* In addition, she encourages learner engagement in her class *(come you, try)* and promotes particular patterns of thinking amongst learners to solve the problem on gear ratio. She uses practical examples to scaffold understanding of concepts such as driver and driven gears. The teaching of the concept of gear was influenced by the teacher's own understanding (content knowledge) of the concept as well as her pedagogical content knowledge. This was obvious in the way the teacher explained the placing of the driver and the driven gear with her own reasons and explanations.

- Use of assessment strategies

From her comments in the interview, the tension between completing the syllabus and making sure that all the learners understand was exposed. Managing this tension is what Geddis et al. (1993) included as part of curriculum saliency. As part of her daily assessment practice, two types of questioning were identified in T5's classroom: one type was used to provide her with feedback on the progress of her learners, whether they grasped what had been discussed, and the other was more a rhetorical type question which I have considered to be part of her teaching style. She used the questions to give her a general sense of whether the learners were following her, the various

cognitive level of questioning allowed for their use to probe for deep understanding. Another assessment strategy that was used was that of giving the learners exercises or worksheets to do, either at home or in class. As part of her assessment strategy, T5 acknowledged that learners learn in different ways. She identified visual, audio and verbal learners and expressed the need to engage with these learners in different ways to make learning more meaningful. She mentioned that she could use pictures, models, you tube, videos and PowerPoint slides in addition to the usual talking as a learning aid for her learners.

- Knowledge of learners' understanding

In the calculation of gear ratios and the application of gear ratios, the learners were allowed some independence to find solutions (learn) on their own. In other words she allowed learners the space to solve problems and apply their own ideas to solve those application problems. This embraces Asik's (2010) notion of creativity.

It was interesting to note that evaluation was a continuous process throughout the lesson. The teacher used diagnostic questions to establish areas of difficulty as teaching and learning continued. To establish if learners understood the contents of the lesson, they were engaged in a group activity; a game competition during which marks were awarded for correct solutions to problems. T5 was aware that there were certain sections within gear ratios where her learners would struggle more. T5's explanations followed a largely procedural approach.

- How does T5's view of the design process influence her teaching of the design process?

T5 espoused dual views of the design process during the semi-structured interview. On the one hand, she viewed the design process as being iterative whilst on the other hand she considered the design process a set of procedures to be followed. She also regards the design process as the: *"most important process in technology education"*. To unpack how these views on the design process impact on the teaching of the design process, I draw on Singh-Pillay's (2010) notion of interface. According to Singh-Pillay, the interface is a meeting point that arises from juxtaposing elements or views. Interfacing T5's espoused theory on the design process (from the semi-structured interview) with her theory in use (from the observation of the lesson and post-observation interview), one can

see that her espoused theory is directed at two levels: at the level of subject specific strategies (design process is iterative) and at the level of topic specific strategies (design process is a step-by-step process), and one can see congruence's between her espoused theory and theory in use. The above-mentioned congruence could be attributed to T5's biographical data as well as her passion and interest in teaching technology. According to her biographical data, T5 has been teaching technology education for 9 years and has attended workshops for curriculum implementation and conferences on technology education. Technology education makes up 50% of T5's teaching workload and her comments in the semi-structured interview confirm her deep interest in technology education.

T5 is well informed about the design process, her experience, training as well as her in-depth content knowledge of the technology curriculum enables her to shift between subject specific strategies (Design Process is iterative) and topic specific strategies (Design Process is a step-by-step procedure) when engaging the teaching of the design process. Subject-specific strategies are general approaches to instruction that are consistent with the goals of technology teaching in teachers' minds such as learning cycles, conceptual change strategies, and inquiry-oriented instruction whereas topic-specific strategies refer to specific strategies that apply to teaching particular topics within a domain of technology (Magnusson et al., 1999).

Her orientation towards teaching (constructivist – learner-centred), the use of teaching technology (power point, models) has a direct bearing on her PCK in terms of the design process. Her PCK of the design process in this case for gear ratio serves as a concept map that guides her instructional decisions and strategies. T5's concept map for the teaching of design process (gear ratio in this case) is guided by her understanding of the importance of the design process in the teaching of technology education ("*It is the most important process in technology education*"). T5, being well informed about the content related to gear ratio, modifies explanations and activities to suit the need of her learners. T5 is, therefore, just not "covering the curriculum" but is "teaching for understanding" (Geddis, Onslow, Beynon, & Oesch, 1993). T5 also exhibits knowledge of students' understanding of gear ratio and the areas of likely difficulty (she makes references to challenges learners encounter in the exams). As a result she uses simple analogies to show learners how to distinguish between the driver and driven gear (If a smaller child has to race against…). Shulman (1987) wrote that PCK included "an understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners, and presented for instruction". Shulman

(*ibid*.: p. 15) also suggested that pedagogical content knowledge was the best knowledge base of teaching. The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students". In addition, T5 suggested strategies such as the use of mnemonics to help learners learn to remember the formulae when calculating gear ratios as can be seen in the excerpt below:

> "*Now, many pupils in a test situation, they confuse. Is it driven gear over driver gear or is it driver over driven. Am gonna (going to) teach you a very simple pneumonic to remember.. and this is if you look at it alphabetically 'n' comes before 'r'. So to calculate gear ratio you say gear ratio equals driven gear over driver gear" "…Always look at this (points to the equation for gear ratio) n before r alphabetically, because people always get confused, should put driver divided by driven?"*

Furthermore, T5 was aware of individual cognitive differences amongst the learners in her class as evidenced in the excerpt below:

> *"…each child thinks differently. Each child is unique in their own way. … there are different levels er…in questioning techniques; there are different levels in which they will answer a question."*

Rohaan et al. (2010) citing Bransford, Brown and Cocking state that "Outstanding teaching requires teachers to have a deep understanding of the subject matter and its structure, as well as an equally thorough understanding of the kinds of teaching activities that help students understand the subject matter in order to be capable of asking probing questions".

From the foregoing it is evident that T5's view of the design process has influenced her teaching of the design process. T5's teaching presented evidence of a rich store of pedagogical knowledge. She operated in a functional classroom where teaching took place every day. She understood the logic of the school where she was teaching and was able to operate in it. Furthermore, she had a good rapport with her learners and they had the freedom to ask her about the work, even outside of the normal lesson times. The key findings regarding the manifestation of PK and PCK emerging from the case of T5, were that expert content knowledge is essential for well-developed PCK, and that knowledge of learners' understanding is vital for alignment of teaching strategies used. It can

therefore be affirmed from this observation, that content knowledge and congruency between espoused theory and theory in action is important. Shulman's (1986: p.7) definition of PCK as the "amalgam of content and pedagogy" has emerged as one of the central themes in this observation. The observation has shown that pedagogy can ensure a functional classroom, but a deep understanding of the content and knowledge of learner's understanding is essential for truly effective teaching of technology.

4.3.2 Lesson observation T8

- The context

T8 teaches in a public fee paying school, Southfolk secondary within the Chatsworth west circuit. Southfolk secondary has a student population of 600 and charges a school fee of R1200 per annum. It is situated in a multiracial community dominated by Indians. The school is encapsulated by four concrete walls of about 2 meters high with a manually operated steel gate manned by a security guard at all times. The physical structure of the school is well maintained and the resources available at this school make it conducive for learning. I arrived at the school during lunch break. I was therefore, asked by T8 to wait under the tree as learners prepared to come back to class. It was about 11:45 am (15 minutes to the start of the lesson). I joined T8 in his classroom prior to the arrival of the learners and used that opportunity to take a look around. I went around observing the classroom setting. There was no physical evidence of the availability of any resources that are used for lesson presentation. Materials such as posters, projectors, and computers were not found in the classroom. The walls were bare and did not create a stimulating environment for learning. Even though the school has had a reputation of having well maintained resources in technical subjects in the past, the situation was the opposite in the classroom of T8. As a matter of fact, T8's classroom was no different from that of an ordinary classroom in the school. The only items one could find were a few models of mini PAT that had just been submitted by learners for assessment. The projects were poorly constructed. The only resource used by T8 was a worksheet and chalkboard illustrations.

- The lesson

  Introduction stage

T8 did not have a master file for technology education nor any lesson plan for the lesson that was going to be taught. He explained that he was a seasoned teacher and did not need any lesson plan to teach; he bragged could teach "off the cuff" due to his years of experience as a teacher and painstakingly mentioned that he had an advanced certificate in technology education unlike most technology teachers who had no formal qualifications to teach technology education. Furthermore, T8 stated the CAPS policy was filed in the office by the school administrator, and he did not need to look at the document to teach or plan or be guided by it. . Once the learners settled down, he distributed a worksheet right at the onset of the lesson and told learners the purpose of the lesson which was to understand the different views (orthographic projection) of pictorial drawings as well as its significance in the design process.

There was no engagement of learner during the introduction of the lesson.

Presentation stage

- Instructional Strategy

Analysis of the lesson observation revealed that T8 used only one instructional technique, namely the telling method /lecture mode.

(T8) used telling method or lecture method for the delivery of his lesson as a means of directing learners towards establishing the technique of identifying the various planes, the lines, the faces and the points of a pictorial drawing on a multi-view drawing (pictorial drawing). According to Anbessa (2012), the lecture method is best suited for achieving objectives of the lower-cognitive type for dealing with basic facts and principles rather that the achievement of higher-cognitive objectives normally associated with the design process. This means that the lecture method of instructions does not encourage inquisitive or creative mind. Furthermore, it also does not provide students with enough opportunities to practise their oral communication skills.

- Knowledge of technology curriculum and use of explanations

The content representations he used had limited variety, were not visually stimulating and did not offer learners multiple ways of thinking about and visualizing pictorial drawings. T8 did not engage learners to establish if they had any misconceptions in respect of the drawing they did in grade 8

(*you merely did sketches*). In other words, he disregarded the sequential progression of knowledge development as embraced in the CAPS policy document (DBE, 2011). T8 is a strict teacher who does not allow room for learner discussion or peer-learning to take place when learners are trying to label the drawings (*There shouldn't be any talking*). This means that students are not allowed to collaborate with other learners. T8 does not realise that learners can learn from each other and that the deepest learning happens when learners have the opportunity to practice and obtain feedback from their peers. From the foregoing discussion, one can conclude that T8 has not made the shift in his teaching philosophy from teacher-centred classroom to a learner-centred classroom as espoused by the CAPS policy document. T8's relies more heavily on his knowledge of teacher-centred disciplined classroom. This finding corresponds to that of Lee (1995) where she found that teachers with limited experience of learner-centred classroom pedagogy often relied on strict classroom order and generally tended to avoid discussion activities in class.

- Use of assessment strategies

It is interesting to note that T8 allowed very limited room for learner interaction and he sometimes answered the questions that he posed to the learners (*What would you see from 'C'? You'll see '12'*). The implications are T8 does not allow learners' time to think about the questions posed – it seemed as if he was in a hurry to just get the lesson over and move on. As a result students were not allowed to express themselves or ask important questions to direct their own learning. This meant that questioning in class did not probe for deeper understanding and he did not elicit learners' own opinions or prior knowledge. His explanations generally followed a procedural approach and did not encourage learners to think deeply about the content. According to his biographical data, T8 has been teaching for 27 years from a time when teacher-centred classrooms were the order of the day. It is highly possible he finds it difficult to relinquish some of the power associated with a teacher-dominated classroom. In other words in his current practice, he does not espouse the philosophy of the policy in terms of learner-centred classrooms and constructivism. Besides, the teacher takes the leading role in the telling or lecture method of teaching; he is limited in his judgment regarding the understanding of his learners as he does not probe their prior learning on drawings. T8's lecture mode of teaching has very little scope for students' activity; it is mostly one-way communication; it doesn't consider the concept of individual differences and it is against the principle of "active learning" or "learning by doing"; and it is less effective in stimulating students' interest. The

intricate nature of the topic, however, made it a bit challenging for learners to cope with the activities.

- Knowledge of learners' understanding

T8 did not directly link the lesson to the relevant previous knowledge of the learner. He did not conduct any form of evaluation to ascertain the previous knowledge of the learners before building on it. The lesson was therefore presented based on the assumption that learners still remembered what they were taught in grade 8 and that there were no misconceptions carried by the learners. The excerpt below clarifies how T8 trivialized learners' prior learning.

OK! (Keeps on distributing the work sheets)

Right! Now from grade 8, when you did projects, you didn't do serious drawing. You merely did sketches of all different things that you wanted to make., you know, wanted to make and you drew sketches of images that you saw and you looked at your investigation you make sketches of that and you did simple working drawings. But now as you get into grade 9 and grade 10 when you start EDG, you need to work with bigger projects, you need to do drawings that are intricate. And you will only be able to do that if you know what views you are looking at. When you pick up something in front of you, an object or a part, you need to see and you need to see it in from all angles. Ok? Because there are things that if you look at it in front, are not the same on the side, is not the same on the top, is not the same on the back or is not the same at the other side. So you need to draw the different views of that. Now on the board we've got some drawings.

From the foregoing excerpt, It is obvious that T8 disregards the learning that occurred in grade 8 (*you didn't do any serious drawing … merely did sketches*) and hence does not interrogate the learners' prior knowledge in order to establish if misconceptions exist in the learners' knowledge. During his lesson he came across as the figure of authority with knowledge to impart and learners were construed as "sponges" waiting to absorb the imparted knowledge or as empty vessels waiting to be filled as can be seen the excerpt below:

(Teacher goes around checking on learners).

What you going to do first is an exercise. Now they've given you an example there. They give you the pictorial view; that's your views in there: ABCDE (points to the board).

Right? Now from there you will see you've got your front view. You've got front view. What do you see in the front view? You see line '8'. Ok? You see er… 'B'. On this side here you

see line '10'. Ok? C; you would see line '1'. Ok? D; you would see line 3 from your front view ok? Then E; you will see line 2, because you just seeing the straight line. You not seeing the line going at an angle. Now if you go to the top view, we look at the ..."

- How does T8's view of the design process influence his teaching of the design process?

As mentioned earlier in chapter 4A, T8's espoused theory of the design process is that it involves critical and creative thinking. T8's espoused view of the design process alludes to him having a learner-centred classroom. The interview conducted with T8 confirms that, in principle, he embraces the idea of a learner-centred classroom as can be seen in excerpt below:

"you must alter your teaching strategy to cater for the learner so that at the end of the lesson the learner must be able to understand what is there".

It is significant to note T8's espoused view of the design process as a learner-centred approach to teaching has no bearing on the teaching approach he uses to teach the design process. In other words, there is a huge mismatch between his espoused theory and theory in use. Even though T8 demonstrated that he was *au fait* with content knowledge in technology education, the teaching strategies used to teach the content, which was about understanding the different views (orthographic projection) of pictorial drawings, was not aligned to the outcomes of technology education, thus making it impossible for learners to be involved in critical or creative thinking. The kind of tedious activity learners were involved in does not promote active learning. He could have altered his teaching strategy to make the lesson learner-centred in order to promote learner participation, provoke thinking and allow for learner creativity. Tracing T8's biographical data shows that his view or espoused theory could have been influenced by his past experience in the industry, his ACE qualification in technology education or his attendance at training workshops for the implementation of the technology curriculum. T8 is unable to blend pedagogical knowledge with content knowledge. His teaching strategies (subject specific and topic specific strategies) were different from what he had earlier on indicated in the semi-structured interview. This is reflected in the excerpt below:

"I normally go back to er... indigenous knowledge which I think technology is based on. And if you look at indigenous knowledge, although it is still in existence today, it is the foundation of technology and I take my learners back to that stage and tell them to work from very

basics and look at what was done and er.. build on that and look at everything else and at least you will be able to work and produce work that you are expected to produce."

None of these strategies mentioned in the excerpt above were observed in T8's lesson. T8's lesson has no direct bearing on his PCK regarding the design process. His PCK was not a reflection of his stated orientation towards teaching as well as preparation and use of resources. Although the lesson was initially intended to be constructivist (learner-centred) in nature, learners did not have enough opportunity to engage in lesson activities. Again this was also contrary to T8's responses in the semi-structured interview. The lesson observed was generally teacher-centred with no group-centred interaction. This hampered the development of learner creativity and or autonomy. The PCK of T8 (in this case the reading of multi-view drawings in the design process) was not a guide to his instructional delivery decisions and strategies. As a result, learners could not demonstrate understanding of the concept.

Resources in the form of educational technologies (projector, or computer) were not used in the presentation. Nor were any other resources in the form of real objects or models and posters or even improvised materials used in the lesson of T8. So far, the only form of evaluation that was observed was the learners' responses to questions as the teacher was explaining the given examples. Activities on the worksheets could not be evaluated as learners did not complete their activity.

As pointed out by Shulman (1987), content knowledge alone does not bring about learning and neither does pedagogical knowledge alone. It takes a balanced blend of the two (into PCK) to bring about effective teaching and learning. This is because teaching is a complex and problematic activity which goes beyond a simple transmission of concepts and skills from the teacher down the line to the learner and that teaching requires many and varied on-the-spot decisions and responses to the ongoing learning needs of students (William & Lockley, 2012).

4.3.3 Answering research question 2

To answer research question 2, "How do these views influence the teaching of the design process?" the case of T5 and T8 were used. The case for T5 highlights that the teacher's view or espoused theory of the design process is aligned with her teaching of the design process or her theory in use, whilst the case for T8 brings to the fore the mismatch between his espoused theory of the design process and his theory in use or practice. T5 is of the view that the design process is as an interactive problem-solving activity based on teacher-given scenarios (problem identification) and

that it is a nonlinear process driven by evaluation and which forms the backbone of technology education. She believes that the design process is used to structure the delivery of learning aims and gives learners focus and direction towards the end product. She is of the view that her understanding of the design process enables her to encourage learner autonomy (constructivism) and systematic problem-solving. This view influenced her teaching in the following ways.

T5 tapped and linked learners' PCK to the new lesson. T5 used a Power Point presentation as well as whole class discussion, demonstration, guided discovery and questioning techniques to arouse and sustain learner interest in the lesson. There was indication of learner participation and excitement during problem-solving activities (social constructivism). T5 catered for individual differences by allowing fast learners to assist slow learners while at the same time engaging the fast learners in extra activity. Teaching of the concept of gear was influenced by the teacher's own understanding (content knowledge and pedagogical knowledge) of the concept. This was specifically evidenced in the way that she explained the placing of the driver and the driven gear. The lesson was evaluated and concluded. As seen across the analysis, T5's practice was largely characterised by a didactic approach to teaching (Magnusson et al., 1999) where the focus was on the transmission of information in a clear and logical way. Her explanations, worksheets and representations presented the learners with the information that was required for the examination and provided rules to help them remember the 'facts'. Friedrichsen et al. (2009) found that, despite a push for teachers to teach in a more progressive style, many teachers in their study were still teaching from a strong didactic viewpoint. The importance of content knowledge has been affirmed in this study. T5 affirms what was found by a number of studies into the crucial role that content knowledge plays in PCK (Bishop & Denley, 1997; Hashweh, 2005; Lee, 1995; Rollnick, Miller, & Butler, 2008).

The case of T8 elucidates the slippage between his view of the design process and his classroom practice when engaging with the design process. This study shows that context exerts a very powerful influence on what is possible, and logical, in a South African classroom. T8 has not showed any willingness to change his practice ("*I'm an experienced teacher … I don't need … I can teach off the cuff*") and was unable to include new strategies or embrace new philosophies in his teaching. Therefore it can be concluded that the teacher's orientation to teaching plays a role, but this is overarched by the contextual influences. T8's PCK was limited by his lack of knowledge in

two main areas – knowledge of learners' understanding of drawings and the areas where they might struggle and the reasons for their struggle, The importance of content knowledge has been affirmed in this study. For example, teachers saw learning as acquiring a body of knowledge (exemplified by their need to cover the syllabus/scheme of work); that the teacher had this knowledge and that the learner did not ("*I always take a lot of time [explaining] because [the students] don't have any idea or knowledge about anything*"). T8 sees the role of the teacher as imparting this knowledge to the learner through various activities ("*We have to keep on teaching and explaining until they learn*"). In the teachers' descriptions of an ideal teacher, the three most common features were "explains clearly", "is knowledgeable" and "maintains discipline". None of these relate directly to engaging students, improving learning or developing successful learners. They focus on the teacher rather than highlighting the interaction of teaching and learning, and the important role that the teacher plays in making this process a fruitful one. This, to me, is indicative of the teachers' view that learning occurs in a linear process, dependent solely on the actions of the teacher. The teacher appeared to be concerned more about classroom management issues than teaching approaches or the learning process. T8's hesitancy to adopt more learner-centred techniques such as encouraging group discussions among learners stemmed from his fear of disruption and losing control of the class. T8 regarded classroom management as a necessary and sufficient condition for learning to occur.

The way a teacher may teach the design process is influenced by their views which are in turn influenced by their PCK. This is because the views expressed by the individual teachers (T5 and T8) were a reflection of their PCK which also translated into teaching and learning of the design process. It can therefore be said that the views of the technology education teacher have an impact on their teaching of the design process.

4.4 Chapter summary

This chapter presented the data analysis for the study. It was in two parts (part A and part B). Part A was the analysis of the research questionnaire as well as the semi-structured interviews. The intention of the analysis was to obtain information that could answer the first research question of the study (What are Grade 9 technology teachers' views of the design process?). Two different views were identified. These were: Design process as problem-solving and Design process as a step-

by-step process that provides "comfort" to learners during problem-solving. It was found that these views were shaped by the PCK of the teachers.

Part B of the analysis sought answers to the second research question of the study (How do these views influence their teaching of the design process?). It was found that the views of the teachers influence the way they teach the design process and that the views expressed by the individual teachers were a reflection of their PCK which also translated into teaching and learning of the design process. In the next chapter, I discuss the implications of the finding of this study for teacher development.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The analysis of the data collected to answer research question 1 illuminated that Grade 9 technology teachers had two distinct views of the design process, namely: Design process as problem-solving and Design process as a step-by-step process that provides "comfort" to learners during problem-solving. T5 espoused a dual view of the design process as problem-solving as well as a step-by-step process, whilst T8 is of the view that the design process involves critical and creative thinking. T5 and T8 were purposively selected for phase two of data collection, in order to answer research question 2: How do teachers' views of the design process influence their teaching of the design process? To determine how these views on the design process impact the teaching of the design process, I drew on Singh-Pillay's (2010) notion of interface. According to Singh-Pillay, the interface is a meeting point that arises from juxtaposing elements or views.

Interfacing T5's espoused theory on the design process (from the semi-structured interview) with her theory in use (from the observation of the lesson and post-observation interview) revealed that her espoused theory was directed at two levels: at the level of subject specific strategies (design process is iterative) and at the level of topic specific strategies (design process is a step-by-step process) and that one could see congruence between her espoused theory and theory in use. The analyses indicated that her pedagogical knowledge manifested quite strongly in her practice and was supported by her in-depth PCK. She understood her learners, was *au fait* with the content and examination requirements in technology education and responded by preparing her learners for the high stakes examination at the end of the year. Her teaching was framed by what she believed good teaching to be. She reflected on her practice, and it enabled her to use different teaching strategies for the benefit of her learners. T5's case study illuminates that growth and congruency can occur between espoused theory and theory in action provided the individual teacher is prepared to change /adjust their mental maps that guide their actions.

T8's espoused view of the design process as a learner-centred approach to teaching has no bearing on the teaching approach he uses to teach the design process. In other words there is a huge mismatch between his espoused theory and theory in use. This means there is dissonance between

T8's statements about teaching and his descriptions of his own practice and his real practice. Even though T8 demonstrated he was *au fait* with content knowledge in technology education, the teaching strategies used to teach the content on orthographic projection of pictorial drawings were not aligned with his espoused views of the design process thus making it impossible for learners to be involved in critical or creative thinking. The major finding of this study is that not all technology teachers apply their espoused view of the design process in their teaching of the design process. Thus the challenge of getting congruence between teachers' espoused theories and their theories-in-use is taken up in this chapter as part of the discussion and the significance of the case study is brought to bear.

I also outline recommendations that are based on the findings for appropriate action to be taken to address the gaps between grade 9 technology teachers' views of the design process and their teaching practice of the design process. The limitations of the study are elucidated and suggestions for further research are presented.

5.2 IMPLICATIONS OF THIS STUDY

5.2.1 Reflective practice

In this section I look at the intricate, intertwined relationship between espoused theory and theory in action in order to see how teachers can integrate theory and practice and thereby design a learning environment that can contribute to that integration.

Conflicts and dilemmas occur when theories in action and realities of practice clash and this may initiate change and development of teaching (Argyris & Schön, 1974). Essential improvements to the quality of teaching and learning are more likely if teachers have an understanding of the link between espoused theory and theory of action, and can assess whether their espoused theories are congruent, or incongruent, with their actual practice (Kane, Sandretto, & Heath, 2002). In this regards, Baxter and Lederman (1999) state that PCK is not limited to what a teacher knows about teaching a specific topic but it also refers to "what a teacher does" in the classroom, and the reasons for the types of actions that he/she takes in relation to teaching a specific topic. Therefore, it is important to establish an explicit link between teachers' knowledge and classroom practice and explore factors that facilitate or impede teachers' enactment of PCK in the classroom. Teachers

appear to hold personal conceptions of teaching and learning that presumably have an influence on how they teach, which also influence their learners' approach to learning and in turn affect learning outcomes (Kember, 1997; Trigwell, Prosser, & Waterhouse, 1999). Academic developers therefore often work on the assumption that enhancing learners' learning by altering approaches to teaching requires that teachers' conceptions of teaching be changed as well (Ho, 2000). A change in approach will not happen without a change in conceptions of teaching (Kember, 2009). Some teachers think of teaching as being about imparting information and transmitting knowledge to their learners; these teachers are best characterised as having teacher-centred/content-oriented approaches to teaching. Others conceive of teaching in terms of helping students to develop conceptions, and of helping to facilitate learning. These are said to have student-centred/learning-oriented approaches to teaching. Notwithstanding, Thiessen (2000) contends there are two elements that can assist with the integration of theory and practice, namely, reflective practice and development of professional knowledge. Thiessen maintains the reflective practices orientation concentrates on skills which help teachers think through what they have done, are doing or are about to do.

5.2.2 Professional development

If change is to be sought at the chalk face, then teacher pre-service preparation programmes and more critically, ongoing professional development programmes for in-service teachers in South Africa would have to focus more on the development of content knowledge, specifically conceptual knowledge. A deep understanding of the content and how to teach it was shown to be essential in the teaching endeavour. This study further showed that curriculum materials have the potential to impact classroom practice. However, these need to be accompanied by training sessions which address the development of pedagogical content knowledge rather than purely providing implementation or examination support. South Africa already has a number of such initiatives to support teachers. An example is the various Provincial Education Departments' professional development programmes. These programmes, however, need to be expanded. Furthermore, these programmes need to provide ongoing support over an extended period of time. In addition to curriculum resources, the value of human resources, like expert colleagues or mentors cannot be underestimated and these should form part of professional development programmes at a ward level. The research on Lesson Studies (Lewis, Perry & Hurd, 2004) is one example where such programmes, which incorporate planning, doing and reflection with colleagues, have led to

successful teacher development. The findings of this study confirm that some experienced teachers are set in their instructional strategies and that these teachers need to learn how to engage in reflective practice in a supportive environment.

5.2.3 Resourcefulness

The resourcefulness of a teacher in preparation for a lesson delivery is also motivated and shaped by their PCK. A teacher like T5 who sees the need to produce and use colorful eye-catching resources in lesson delivery has a rich PCK. Unavailability of such resources is not a limiting factor to such a teacher. This is because they also have the ability to improvise using readily available and easily obtainable everyday materials. A teacher with a rich PCK will surely deliver irrespective of the learning environment. It has therefore been noticed that the view of the teacher is a reflection of their PCK and that such views may or may not translate into both lesson preparation and lesson presentation in the design process.

5.2.4 Learner autonomy/ creativity

Even though there was an indication of problem-solving the dominance of the teachers reflected in their incessant explanation of concepts did not allow enough time for leaners to solve problems with minimal guidance as suggested by Mawson (2003). The teachers observed employed instructional approaches that placed a strong emphasis on guidance of the student learning process in line with Kirschner, Sweller, and Clark (2006) and to provide learner comfort during problem-solving (Hansen, 1993).

5.2.5 Collaborative learning and problem-solving

Even though the problem-solving activity in design and technology has been seen as a potentially rich arena for collaborative learning (Hennessy & Murphy, 1999), this was not always the case in the lessons observed. T8 did not provide opportunities for collaborative learning among learners. He used orders such as: *"Foster, why are you going there to look at her work? You sit down and do your own work. You wanna ask, you ask me!"*. The seating plan was so regimented that each learner had to mind his/her own work. This was a serious hindrance to social constructivism since no opportunity was allowed for learner-learner interaction. In a situation where there was some kind of group activity (T5), such activities did not involve group interaction. Rather individual learners were called forward to solve problems on behalf of their respective groups while other group

members sat and looked on. The teacher who sees the design process as a step-by step problem-solving process is more dominating in his lesson delivery. Lessons were presented in steps to ensure that students understood every step of the way. This deprived many learners the opportunity to solve problems in their own way. The lessons were but a teacher centred interaction where learners get less opportunity to solve problems autonomously and collaboratively.

5.3 RECOMMENDATIONS

In line with the findings of this study some recommendations have been outlined to improve the teaching and learning of technology education. The recommendations relate to curriculum design and implementation, teacher interference during the design process, professional development of teachers, research, and collaborative learning.

5.3.1 Curriculum design and implementation

The role of the teacher is crucial in the implementation of curriculum reforms and innovations (Zipf & Harrison, 2003). Their views therefore form part of the factors that determine the success or failure of the education system of any country. It is therefore necessary that teachers are involved not only in the implementation of the curriculum but also in its planning and development. A curriculum policy that will survive the test of time should also take cognisance of the views of its implementers.

Curriculum developers should lighten the emphasis that is placed on assessment of a product or the end solution. The means through which the solution was reached should rather receive more attention and assessment. Learners should be assessed more on what they did when trying to solve the problem and not the nature or quality of the solution. The views of learners should be respected regarding which approach they choose in solving a problem. A learner who feels like solving their problem in an interactive way should not be prevented from doing so, and so is the one who prefers to do it in a sequential manner. This is because there are as many possible approaches of solving a particular problem as there are many design briefs for the same problem (Flowers, 2010). Just as different researchers suggest different approaches to problem-solving, so too do learners. The curriculum should therefore provide more options for learners to design and or solve problems freely.

5.3.2 Teacher interference

Although the teacher's occasional interruption in design problem-solving might improve ideation productivity (Howard- Jones, 2002) and build up the strong symbiosis that exist between teaching and learning (Hartfield, 2012), the extent of teacher interruption in problem-solving in a lesson should also be regulated. How a problem is solved should be free from teacher biases or dictatorship. The teacher should only be available to address learners' challenges during problem-solving and not to impose their own views on learners. This hampers the development of the creative potentials in learners and lead to idea fixation (Rutland, 2009). This is because, as stated in the teachers' own responses, learners have their own inborn talents that stimulate creativity in their problem-solving process.

5.3.3 Professional development

Inasmuch as PCK is seen to be a byproduct of experience and practice, it is also paramount that further education for the professional development of teachers of the subject (Technology) be provided. This is because many of the technology teachers, as shown in the biographical data still use their knowledge in industrial arts to teach technology today (Pool, Reitsma & Mentz, 2013; Stevens, 2006). This places more emphasis on the making of a product at the expense of the process emphasis. There should be frequent in-service training for technology education teachers to address issues of concern in the implementation of the new curriculum. Teachers should be encouraged to attend relevant conferences on technology education and for that matter the design process. By doing so, teachers have contact with colleagues and are able to share ideas (Dekker & Feijs, 2005). Professional development should focus on teaching technology applying the design process.

5.3.4 Designing in groups

Group work that ensures effective member participation should be encouraged as this has the potential to support students' creativity (Webster et al., 2006). It has also been observed by Doise and Mugny (1984) and cited in (Donald, Lazarus, & Lolwana, 1997) that "under the right conditions, students solving problems in pairs and small groups can promote one another's cognitive development". Effective group work in which every group member has a role to play should therefore be encouraged in problem-solving activities in technology education.

5.4 LIMITATIONS OF THE STUDY

Major limiting factors which might have had a negative impact on the findings of the study have been identified by the researcher. In the first place, the study was limited within the confines of the Chatsworth west circuit and that the findings are also from the Chatsworth West circuit only. Generalising the findings to represent the entire country (South Africa) might not be possible.

Another limitation was that not all the teachers initially earmarked for the study participated. Some four teachers out of the fourteen opted to drop out of the study and this reduced the number of respondents. As a result, the findings may not be representative of all the technology teachers' views within the Chatsworth west circuit.

Another factor that might have had a negative impact on the research findings was time. The data collection activities coincided with the examination season of the schools involved. In most instances, respondents rescheduled the meeting with the researcher citing workload-related reasons. During the semi-structured interview sessions, respondents were always in a rush to get back to their respective classrooms to continue with their work. The number of lesson observations per respondent had to be reduced to one from two due to time constraints. This was in response to the fact that respondents were not readily available due to their tight work schedules. As a result, respondents might not have had the chance to put all the views expressed on the design process into action in a single lesson.

Existing literature together with the personal experiences of the researcher indicate that the design process is not a simple concept which can be presented in its entirety within a single lesson. Observing a single lesson per teacher is therefore not enough to cover the various aspects of the design process and this might have affected the findings of the study.

5.5 RECOMMENDATIONS FOR FURTHER RESEARCH

- Further research should be conducted to ascertain the relevance and effectiveness of current teacher training programmes in technology education in South Africa. This will expose areas that need amendments so as to bring the knowledge of newly-trained technology teachers in line with the current curriculum for its successful implementation.
- The frequency and effectiveness of technology teacher workshops should also be researched in order to identify ways of making them more effective for the benefit of teachers, learners and all

stakeholders of education. This study should involve the subject specialist as well as the subject teachers themselves.

5.6. CONCLUSION

Just as it is in many other countries, the introduction of technology education has been faced with many challenges including availability of resources and policy implementation. The shift away from the industrial arts style of teaching (Zuga, 1989) to the present method of problem solving has posed challenges to teachers of the subject as a result of the difficulty and or the uncertainty they encounter during the implementation of the design process. The views of the teacher are crucial to the implementation of the curriculum and that such view is shaped by the PCK of the technology teacher (Shulman, 1987). This research studied the views of the technology teacher and how such views influence their teaching of the design process.

Data collection was in two phases. The first phase sought to collect data on the views of the grade 9 technology teacher of the design process using questionnaire and semi structured interviews as instruments for data collection. In the second phase lessons were observed to see how the teachers present the design process to their learners and to compare their practice with their views.

Some limiting factors which might have had a negative impact on the findings of the study were identified by the researcher. These include the fact that the study was confined within a limited geographical area and that generalizing the findings within the context of the entire South Africa might defeat the reliability and trustworthiness of results. Another limiting factor was the decision of some participants to opt out of the study thereby reducing the number of respondents. Time constraint was also identified to be another limitation and that the number of lessons observed was inadequate to satisfactorily unpack the complex nature of the design process and how it unfolds in the classroom context.

The views and practices of the teachers were analysed and the findings were interrogated in the light of Shulman's PCK and the theories of human action (espoused theory and theory in use) as outlined by Argyris and Schön (1974). Two views of the design process were identified after the analysis of the first phase of data collection. These were:

- Design process as problem solving

- Design process is a step-by-step process that provides "comfort " to learners during problem solving

It was found that most of the technology teachers within the Chatsworth circuit viewed the design process as a step-by-step problem solving that caters for learner comfort whereas others had a duel view of the design process to be both iterative as well as being a set of procedures to be followed. During the lesson observations it came out that T5 demonstrated congruency between her espoused theory and her theory in use. The opposite happened in the case of T8 who demonstrated a remarkable mismatch between his responses in the focus group interview and what he actually did in his lesson presentation. It can therefore be concluded that different grade 9 technology teachers in the Chatsworth west circuit have different views of the design process and that their individual views may not always influence their teaching of the design process. This is because their individual espoused theories may not always be in congruence with their theory in action.

The findings of the study have both direct and indirect implications on the teaching and learning of the design process in technology education. These include implications on reflective practice, professional development, resourcefulness, learner autonomy as well as collaborative learning

Some recommendations relating to curriculum design and implementation, teacher interference during the design process, professional development of teachers, further research, and collaborative learning have also been outlined. It has been suggested that further research should be conducted to ascertain i; the relevance and effectiveness of current teacher training programmes in technology education in South Africa, ii; the frequency and effectiveness of technology teacher workshops so as to identify ways of making it more effective for the benefit of teachers, learners and all stakeholders of education.

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Appendix 1:

Ethical clearance certificate

UNIVERSITY OF KWAZULU-NATAL ™

INYUVESI YAKWAZULU-NATALI

30 June 2014

Mr Frank Ohemeng Appiah (212562162)
School of Education
Edgewood Campus

Protocol reference number: HSS/0622/014M
Project title: *Teaching the design process in the Grade 9 technology class*

Dear Mr Appiah,

Full Approval – Expedited Application

In response to your application dated 10 June 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have 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

....
Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr A Singh-Pillay and Mr MP Moodley
Cc Academic Leader Research: Professor P Morojele
Cc School Administrator: Mr Thoba Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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Website: www.ukzn.ac.za
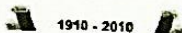
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Appendix 2: Editors letter

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3 December 2014

Declaration of professional edit

TEACHING THE DESIGN PROCESS IN THE GRADE 9 TECHNOLOGY CLASS
by Frank Ohemeng Appiah

I declare that I have edited and proofread this thesis. My involvement was restricted to language usage and spelling, completeness and consistency, referencing style and formatting of headings, captions and Tables of Contents. I did no structural re-writing of the content.

Sincerely,

"Electronic signature withheld for security reasons".

Dr Jacqueline Baumgardt
Member, Professional Editors Group

Professional
EDITORS
Group

Appendix 3: Permission letters from principals to conduct research in their schools

School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,
4 June 2014

The Principal,
………..Secondary School

Sir,

Permission to conduct research

My name is Frank Ohemeng-Appiah, I am a Masters candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am conducting research on Grade 9 technology teachers' perceptions of the design process.

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 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 grant me access to your school please indicate (by ticking as applicable)

	Granted	Not granted
Access		

I can be contacted at:
Email: frankyways@yahoo.com

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

My Co-supervisor is Mr. M.P.Moodley,
School of Education
Edgewood campus, University of KwaZulu-Natal
(Tel) 0312603655 Email:moodleym1@ukzn.ac.za

To whom it may concern:

Permission is hereby granted for Frank Ohemeng-Appiah, 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 4: Participants' informed consent

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

Dear Participant

INFORMED CONSENT LETTER

My name is Frank Ohemeng-Appiah, I am a Masters candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa.

I am interested in learning about Grade 9 technology teachers' perceptions of the design process.

To gather the information, I will be asking you some questions via a questionnaire and a focus group interview. In addition I also require permission to video 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 10 minutes to answer and interview may last for about 30 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 video 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		
Photographic equipment		
Video equipment		

I can be contacted at:
Email: frankyways@yahoo.com

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

My Co-supervisor is Mr. M.P.Moodley,
School of Education
Edgewood campus, University of KwaZulu-Natal
(Tel) 0312603655 Email:moodleym1@ukzn.ac.za

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 5: 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. Please use your own words to describe what the design process means to you.

_____

_____

2. What influences your understanding of the design process? Please elaborate

_____

_____

3. Is the design process important in teaching technology? Kindly explain

_____

_____

4. Do you do any planning before teaching the design process? Please elaborate.

_____

_____

5. Do you emphasize any particular aspect during your teaching of the design process? Please explain.

_____

_____

6. Does your understanding of the design process influence/impact the way you teach the design process? Please explain how?

Appendix 6: Semi-structured interview

Interview Questions

1. What is your view of the design process?
2. Why do you have this view of the design process?
3. What methods do you use to teach the design process?
4. How do you present the idea of the design process to your learners?
5. Is this the only method you use to teach the design process?
6. Why do you use the method/s you mentioned?
7. What type/ kinds of activities do you give to learners during your design lesson?
8. Do you allow learners to create their own solutions when designing? If so how do you do this? If not, why is this the case?

Appendix 7: Observation schedule

Theme	Guiding questions	comment
Structural	How is the lesson introduced?	
	What is the pace of the lesson?	
	What were the specific aims for learners to learn in this lesson?	
	What motivation was given for learners to learn /follow the intended outcomes?	
	How is the lesson concluded?	
	What type/kind of activity did learners engage in?	
Methods	What approaches are used to organize and stimulate learner learning or cater for learner misconceptions?	
	Teaching procedure and reasons for using these procedures to engage with teaching of design	
	What teaching and learning resources are used in the lesson?	
	How do learners respond to the methods?	
	Were Difficulties /limitations connected with teaching this idea noted/justified/explained	
	Was there a link between knowledge about learners thinking that influences the teaching of the design process	
	What other factors influenced the teaching of this idea/design process?	
Overall impression	What is the atmosphere in the lesson like?	
	How did the teacher relate to the learners?	
	How are learners with special needs catered for?	

Appendix 8: Table of Analysis for Questionnaire

	1. Meaning of Design
T1	Has no knowledge
T2	Identifying a problem Steps that we follow. Solving problem in technology.
T3	solve problems. May involve designing and making something
T4	guideline that assist the learners in the project. Assist them to solve problems. Learners to follow the design process at all times
T5	Forms the backbone of technology. It Is not a linear process, but is usually a cyclical process driven by evaluation
T6	Drawing and sketching of an image of what the product will look like. Sketch may also show different confrontations - top view, side
T7	Identifying problems. Solving Problems. Decision making through critical and creative thinking. Involves Investigating, Making, Designing, Evaluating and Communicating with others
T8	A logical way of putting one's ideas
T9	Steps you will follow. A solution to a problem.
T10	a set of procedures that are required to be followed. The solution of problems. Depends on the expected outcome.

	2. what influences your understanding of DP?
T1	Has no knowledge
T2	Identifying and solving problems through the technological process
T3	most objects that people use everyday has been designed and made by somebody
T4	since I started teaching tehnology is not easy for the learners to finish the project given to them for every scenario in technology there must be a problem to be solved since I started teaching tehnology
T5	The design process forms the backbone of the subject and is used to structure the delivery of the learning aims
T6	Prior knowledge from the concept of design
T7	The way I was taught in schools and in University to understand Technology as a subject *(PAST EXPERIENCE)*
T8	As an educator who has worked in industry.
T9	It allows them (learners) to use different skills like investigations, making etc
T10	For every challenge there is a technological solution. Technology and its advancement have helped us improve.

	3. Why is the DP important in Technology Education?
T1	Has no knowledge
T2	it is the instrument that we use when designing and making a project
T3	The design process incorporates this designing and planning as well as making the object
T4	It helps learners to do their project step by step and understand what is needed
T5	Learners are exposed to a problem, need or opportunity at the starting point. They are then engaged in a systematic process of developing solutions that solve the problem, rectify the design issues and satisfy any needs
T6	Gives learners focus or direction towards the end product it will help plan putting the project together
T7	Technology is about skills, knowledge and values. Its about designing and solving human problems and make life more easier to live
T8	Learners need to apply all these steps as it gives them all the expanded possibilities. Graphic communication solves half the problem
T9	sometimes the requirements are of a far higher level and learners then "refuse" to do the extra work and wait for the educator to give them answer
T10	The technology is always evolving and moving ahead of its predecessors. Curriculum needs updating and comparisons made from the past for the present and for the future

4. Elaborating teachers' planning before DP?	
Teacher (T)	**Explanation**
T1	No Explanation
T2	No Explanation
T3	You need to have resources available so that learners can engage in the design process.
T4	learners to know each and every step of the design process for them to understand the given case study
T5	No explanation given
T6	I will firstly explain what the PAT is about - then ask learners to sketch/draw what the PAT will look like.
T7	Resources to use in class while teaching the design process
T8	I think of a product and make up a scenario.
	We look at the logical steps to follow and how each step fits into place when designing to solve that problem.
T9	to have an idea of what you think the learners response will be so that you can guide them in the right direction
T10	To plan the lesson presentation in advance
	The traditional 5-step sequence is taught

Aspects teachers emphasise in DP			
		(All teachers have aspects of emphasis in the design process)	
	Teacher (T)	Explanation	
	T1	Has no knowledge	
	T2	Every step has to be properly explained to learners	*follow steps*
	T3	Learners need to know that every object that has been created has gone through the design process -	*Creativity*
	T4	there must be a problem to be solved	*problem solving*
	T5	learners are given a scenario and they will identify needs or problems and find a solution	*problem solving*
	T6	they must be creative and yet achieve its purpose	*Originalty/ Creativity*
	T7	I encourage learners to work effectively with others	*Group work*
	T8	Research/Investigation; Safety, Graphical representation - Clear and informative at every step.	*follow stept*
		We look at the logical steps to follow and how each step fits into place when designing to solve that problem.	*follow stept*
	T9	Try not to copy ideas. Create your own	*Originality/ Creativity*
		Have fun	*Group work*
	T10	successful solving of a problem	*problem solving*
		Originality and creativity used to do this is most welcome	*Originality/Cr eativity*
		Creativity	*Originality/ Creativity*

	6. Does your understanding of DP influences how you teach DP?	
T1	Has no knowledge	
T2	YES. learners are able to implement the steps when solving problems	*Step-by-step*
T3	YES. The design process should allow the learner complete freedom of thought and expression	*Learner Autonomy*
T4	YES. If its explained wrongly (Design process) learners will not understand what is needed from them	
T5	YES. Learners are provided with opportunities to explore values and attitudes and develops informed decisions that will help them to make compromises and value judgements.	*Learner Autonomy*
	Learners are engaged in a systematic process to develop solutions that solve the problems	*Step-by-step*
T6	YES. I will implement guidelines if there are any	
	they would be more guided as to what to do.	*Step-by-step*
T7	YES. The way I teach is about how I understand the DP	*Teacher comfort*
T8	YES. By using and emphasising all the steps, the learners get to know/realise that there are no shortcuts to designing a good solution to a problem	*Step-by-step*
T9	YES. If you are familiar with the process then it makes teaching easy because you will already know what is expected and you can explain to the students exactly what is expected	*Teacher comfort*
T10	YES. The sequential manner in which this design process is implemented brings some kind of standardisation for this aspect. Sometimes the environments may differ but the methods of solving problems will entail a certain set of activities in a particular sequence	*Step-by-step*

Appendix 9: Table of analysis for semi-structured interview

	1. What is your view of the design process?	2. Why do you have this view of the design process?	3. What methods do you use to teach the design process?	4. How do you present the idea of the design process to your learners?	5. Is this the only method you use to teach the design process?	6. Why do you use the method/s you mentioned?	7. What type/ kinds of activities do you give to learners during your design lesson?	8. Do you allow learner to create their own solutions when designing? If so how do you do this? If not, why is this the case?
T2	I think it is a very good instrument in the sense that it talks to the learners as to which steps they need to follow if they have to solve a particular problem in technology: Steps!! The steps that need to be followed when you have to solve a problem	I think is very very important to them to know the steps because is gonna help them when it comes to solving problems in technology because technology as a subject or as a learning area is all about problem solving.	Most of the time I just… eh I look around and I pick whatever system or whatever things is there and to tell them 'why do you have this, what was the motive behind' like with the case of cell phone "why do we have cell phones?" And then they will tell us that the reason why we have cell phones is purely for communication purposes INT: Oh! So more or less is like it involves some discussions and things! RS: YEBO! Then it means someone out there identified the problem, then, the steps follow	well I think is boiling back to the last question that I answered. It's a question of coming up with a scenario. Then ask them some few questions then you are able to introduce the.this design process to them.	Most ly it is the only method because if find it much more familiar. Its working for me and the students are enjoying it.	Ehehehe! Ehh! For the years that I have taught I find it much more useful as my useful tool and is helping a lot and I do have results to show its helping.	Well, after one has explained everything as far as the design process cycle is concerned, the steps are there starting from 1. Identifying the problem, investigate to design. Uhm! Then at times I take any particular system; can be a cell phone again, then ask them to follow the very same steps as to how one came about the introduction of cell phones	Yes!, Actually, as I introduce my lesson on the design process cycle I just tell them that why do you have this thing is because someone out there identified the problem. So them, they can also identify the problem and come up with their own solution and it is up to us to check the one solution whether it is really meeting the requirement for trying to solve the problem. INT: Ok! That means you allow some degree of independence and freedom as they generate their own solutions RS: Yes!, Yes!
T4	is to identify and defining the problem, also solving the problem by having various possible solutions. The problem must be clearly identified and statement of the problem should be short and complete. It must give all the information that are available about the problem.	Ok. All I can say is that I have the view about the design process in this manner because it was presented to me this way in the manner that I can understand easily.	Ok., basically the method that I use eh I can say is the guideline which have to do with identifying the problem; that's number 1. And it must have possible solutions and designing as well as to evaluate	Ok, I present the design process to my learners by explaining the design process. Then the learners must identify the problem. I do this through drawing, taking into consideration the 2 dimensional and 3 dimensional as well as to sketch some freehand drawing.	this is the method. I don't have another method	I think it is suitable for learners; that's number 1. And by using it you can see that they understand it better and they show interest in drawing different designs.	I give them a case study that present the problem to be solved. Basically they need to follow, I tell them to follow the six technological processes steps. Yea, so that eh.. they have to identify the problem, after that they come up with eh.. possible solutions for the problem and they design the solution. After that, they present it in class. INT: wonderful! So you follow the steps. RS: I just follow the steps.	Yea, Yea! : I do it because of the case study given to them. They must identify the problem, that's the main aim. And therefore it is possible for them to come up with the best possible solution. : I give them first, individual learner to come out with the a solution to the problem they are given. After that they can work as a group and ehm.. try to come out or to choose the best solution towards the problem.

T5	OK. The design process is an interactive approach used to develop solutions to an identified problem or human need. Now the associated skills are investigating, designing, uh thats the development of initial stage or ideas, making evaluating and communicating. Now the design process is used by engineers, architects, industrial designers and many others when developing original ideas to meet needs or wants and in order t solve a problem.	The design process forms the backbone of the subject, and it is used to structure the delivery of the learning aims. No product has ever been manufactured that did not undergo development through design. All tend to use the design process as they develop solutions to problems needs or wants.	Ok. The learners are generally exposed to a problem, a need or opportunity as the start point. They are then engaged in a systematic process to develop solutions that solve the problem, rectify the design. issues and satisfy any need. Now the design process in not a linear process but a cyclical one. The different skills can be applied in any order.	Ok! Learners are generally exposed to a problem, need or opportunity as a starting point. They are then engaged in a systematic process to develop solutions that will solve the problem, rectify the design issue and obviously satisfy a need.	No! The recommended approach will be to introduce the required knowledge followed by practical work in which the knowledge is applied	Ok. In all cases the teaching will be structured using the design process as the backbone for the methodology. Now some of these elements will be eh.. assessed formally each term. As learning pro.. progresses learners must be made aware of the interrelationship between technology society and the environment. Wherever applicable, learners should be made aware of different co-existing knowledge systems.	Ok! Learners are firstly given the problem. I teach them methodologies that will lead up to solving the problem. : They are shown PowerPoint presentation, they are given models, worksheets etc.. The skills and concepts give them an understanding of the problem. They then apply this knowledge to the design process. The practical skill activities help them to create the solution.	Yes! As learners progress through a task, they are… as they progress through a task, they use the associated knowledge and skills that I taught them and then they modify the ideas to create a solution. They just don't memorize what I taught them. They become innovative in developing solution to solve a problem. They are encouraged to explore their own ideals, attitudes and also to develop uhm informed opinions that they can help them to make compromises and value judgment
T8	Well, as a technologist, in order to perform and perfect your work, you do need to go through the design process in every step. Well we will consider the six steps as being important. And in order to perfect that, you need to go and do your research on all these things first so that you can do better designs, you have a bigger scope of possibilities and you can get information and then sit down and brainstorm the information and then and eh.. work and then you can design something that is worthwhile it. Now in case of children, is very important to learn to use the design process because it gets their mind working so that they can work step-by-step and develop their minds in the different sections and build something that they could be proud of and see their short comings and remedy them.	Ok, I am a qualified diesel fitter; a fuel pump technician and training officer and through the years we've learnt that in order to perfect something you've got to be logical in the way you think. And in order to do that you have to follow the steps of previous people and build on it. And technology is all about building on previous experiences and trying to perfect previous imperfections.	alright. I normally go back to eh… indigenous knowledge..which I think technology is based on. And if you look at indigenous knowledge, although it is still in existence today, it is the foundation of technology and I take my learners back to that stage and tell them to work from very basics and look at what was done and eh.. build on that and look at everything else and at least you will be able to work and produce work that you are expected to produce.	Alright! First, we normally produce a scenario. Ok! We give them a we give them a scenario because that is you tell them a story and you build in your work into it, we catch their attention. From there we tell them that now the problem is within the scenario, you now need to design your design brief from there… : ….and see what your problem is and what is your expectation to overcome the problem.	No! not really. It depends on situation you are in. : Eh.. because every situation is different but if you are working with learners especially in technology you have to include that to start off with.	: Eh.. because every situation is different but if you are working with learners especially in technology you have to include that to start off with.	Alright. First in the design we will give them books to read through. Relevant books on the topics that you've got then we will give them possible workings to draw to brainstorm their ideas in groups to see what they can come up with. And once they come up with some idea then you've got.. eh say you've got a book there then that gives them an idea to work away from that and try and try and work with what they are expected to do.	Uh! Yes! But we give them the opportunity to do all that but in terms of if they are doing projects on their own, then they are welcome to do that. But remember, today, in terms of material usage sometimes is not possible. So, we give them that opportunity and then we standardize a project. Right. We give them an opportunity to build their own projects. Right? They come.. some of them come up with really good example and you work through step by step what is expected of them and show them how its gonna be done and the you build…and then they give you sketches of their project and then you show them how to do a scale drawing of the project and then start working on materialcollection and then start building step by step all the processes… Within their own freedom and within their own time.

T10	In terms of it being in our syllabus, there is a need for it because we have children nowadays that are not uhm! really cultured in the way of thinking in terms of uhm! being creative, you know? Uhm! back in the days when we were in school, we were we were.. it was instilled on us to think creatively. We had various programmes; visual arts and so on which uhm assisted us in our creative judgment. nowadays with the increase of technology, the child's mind is getting more relaxed in working terms of working in a creative way. Uhm the thing is as I mentioned early it was.. it is necessary. Uhm it is a good thing because in terms of technology the design process is important for us to use in terms of solving problems. Most of what is around us now has been the result of the design process.	Our world is very dynamic and many new things are coming up on a daily basis. Ehh the history of design has evolved to such an extent that now we're finding that our people are now going to go out to live in an outer space. You know? So from where it is coming to where it is going, the design process is always going to be there to meet that technological need.	Uhm! There is no set method; we have to follow the procedures uhh! The five elements within the design process. But we have to ascertain the level at which the child is thinking first….. ….in order to ehm… start the process. Sometimes the child does not understand what is meant by design. We have to teach that aspect then go to through the processes. : and sometimes they intermix processes; they do not keep it in a structured manner where we have ideas first and we refine ideas to final design more or less.	Uh! I coach it in such a way in terms of making a problem, and, uh.. the children must use their skills and knowledge in order to circumvent the problem. They must come about a certain solution and no one can get the solution straight on but the ideas that they put forward will lead to a possible solution.	Sometimes you have to use other methods. Uhm.. it depends on the responsiveness of the children. Sometimes a certain method may not really unlock the potential and another way will do that. Maybe if you're just discussing it, some children may understand. Another way is to really communicate in terms of ehh! visual ideas.. because if you put a visual idea before a child certainly they understand where they are at that point in time and where they are going to move forward.	Uhm! There's no particular reason but you know as an educator we need to try to instill in the child that they need to uh use this method. Because when you teaching the design process, it is not only for when they are here in school… ….it is to help them in their lives as well because they are gonna come up with certain technological problems which they need to eh.. solve themselves. I mean it could be anything; big or small.	Uh! I try to vary but the most uh! results I've got was where you are showing them via sketches….. … because at that point in time when you using the sketches, the child can make a mistake and adjust accordingly rather than go and build the model and find that they haven't thought about certain things and then to, to destroy and restart is going to become problematic.	: Always. Uh! sometimes a child may have one of the better solutions which I as a teacher would not have thought about. You understand that! So, that's the original thinking and that's what I want children to come up with original ideas. : I guide them as far as the design brief. I explain what is required at every level and am not descriptive as to what needs to be done at any specific point. : I look at the variables that come through and ehh applaud them for the originality of their ideas.

9a.

Teacher	1. What is your view of the design process?	*Categories*
T2	I think it is a very good instrument in the sense that it talks to the learners as to which **steps** they need to follow if they have **to solve a particular problem** in technology: **Steps!! The steps that need to be followed** when you have **to solve a problem**	*Step-by step process* **problem solving**
T4	is to **identify and defining the problem, also solving the problem** by having various possible solutions. The problem must be clearly identified and statement of the problem should be short and complete. It must give all the information that are available about the problem.	*Problem identification,* **problem solving**
T5	OK. The design process is an interactive approach used to develop **solutions to an identified problem or human need**. Now the associated skills are **investigating, designing, uh thats the development of initial stage or ideas, making evaluating and communicating**. Now the design process is used by engineers, architects, industrial designers and many others when developing original ideas to meet needs or wants and in order to solve a problem.	**problem solving.** *Problem identification*
T8	Well, as a technologist, in order to perform and perfect your work, you do need to go through the design process **in every step**. Well we will consider *the six steps as being important*. And in order to perfect that, you need to go and do your research on all these things first so that you can do better designs, you have a bigger scope of possibilities and you can get information and then sit down and brainstorm the information and then and eh.. work and then you can design something that is worthwhile it. Now in case of children, is very important to learn to use the design process because it gets their mind working so that they can work step-by-step and develop their minds in the different sections and **build something that they could be proud of** and *see their short comings and remedy them.*	**Step-by step process.**

9b.

Teacher	2. Why do you have this view of the design process?		
T2	I think is very very important to them to know the steps because **is gonna help them when it comes to solving problems in technology** because technology as a subject or as a learning area **is all about problem solving.**	*Learner comfort in problem solving*	
T4	Ok. All I can say is that I have the view about the design process in this manner because it was **presented to me this way in the manner that I can understand easily.**	*Past experience. Teacher comfort*	
T5	The design process **forms the backbone of the subject**, and it is used to structure the delivery of the learning aims. **No product has ever been manufactured that did not undergo development through design**. All tend to use the design process as they develop **solutions to problems needs or want**s. I love teaching technology, it's so alive and interesting, you know, I am a qualified Geography teacher but I have been teaching technology for the past 9 years, I attended the training workshops conducted by the subject advisor, but it wasn't enough so I started reading to learn as much as I can, and I'm still learning, I try and get many textbooks and study them to help me, I treat the policy like the bible – it guides me in my teaching and assessment.	*Underpins technology education. Past experience problem solving.*	
T8	Ok, I am a qualified diesel fitter; a fuel pump technician and training officer and **through the years** we've learnt that in order to perfect something you've got to be logical in the way you think. And in order to do that you have to **follow the steps of previous people and build on it**. And technology is all about building on previous experiences and trying to perfect previous imperfections.	*past experience.*	

9c.

	3. What methods do you use to teach the design process?	
T2	Most of the time I just… eh I look around and I pick whatever system or whatever things is there and to tell them 'why do you have this, what was the motive behind' like with the case of cell phone "why do we have cell phones?" And then they will tell us that the reason why we have cell phones is purely for communication purposes INT: Oh! So more or less is like it involves some discussions and things! RS: YEBO! Then it means **someone out there identified the problem,** then, the steps follow	*Scenarios,* Discussions **(Problem solving),** *step-by-step* *process, Problem* *identification*
T4	Ok., basically the method that I use eh I can say is the guideline which have to do with **identifying the problem**; that's number 1. And it must have possible solutions and designing as well as to evaluate	*Problem* *identification Step-* *by-step process.* *Problem solving*
T5	Ok. The **learners are generally exposed to a problem,** a need or opportunity as the start point. They are then engaged **in a systematic process to develop solutions** that solve the problem, rectify the design. issues and satisfy any need. Now the design process in not a linear process but a cyclical one. ***The different skills can be applied in any order.***	*Problem* *identification* *scenario, Problem* *solving,* non-linear approach
T8	alright. I normally go back to eh… indigenous knowledge..which I think technology is based on. And if you look at indigenous knowledge, although it is still in existence today, it is the foundation of technology and I take my learners back to that stage and tell them to work from very basics and ***look at what was done and eh.. build on that*** and look at everything else and at least you will be able to work and produce work that you are expected to produce.	*Problem* *identification.* *Problem solving* with indigenous knowledge

9d.

	4. How do you present the idea of the design process to your learners?	
T2	well I think is boiling back to the last question that I answered. It's a question of ***coming up with a scenario*** . Then ask them some few questions then you are able to introduce the..this design process to them.	***Scenario (problem identification),*** questioning,
T4	Ok, I present the design process to my learner**s** ***by explaining the design process*** . Then ***the learners must identify the problem*** . I do this through drawing, taking into consideration the 2 dimensional and 3 dimensional as well as to sketch some freehand drawing.	***By explaining the DP. (Scenario) Problem identification***
T5	Ok! ***Learners are generally exposed to a problem, need or opportunity as a starting point*** . They are then engaged in a systematic process to ***develop solutions that will solve the problem*** , rectify the design issue and obviously satisfy a need.	***Problem identification*** , ***problem solving,***
T8	Alright! ***First, we normally produce a scenario*** . Ok! We give them a we give them a scenario because that is ***you tell them a story and you build in your work into it,*** we catch their attention. From there ***we tell them that now the problem is within the scenario*** , you now need to design your design brief from there... : ....and see what your problem is and what is your expectation ***to overcome the problem.***	***Scenario (Problem identification), Problem solving***

9e.

	6. Why do you use the method/s you mentioned?	**Category**
T2	Ehehehe! Ehh! For the *years that I have taught I find it much more useful* as my useful tool and is helping a lot and I do have results to show its helping.	Past experience, Teacher comfort, *usefulness , Successful outcome.*
T4	I think *it is suitable for learners* ; that's number 1. And by using it you can see that *they understand it better and they show interest* in drawing different designs.	*Suitability for learners, learner comfort, results*
T5	Ok. In all cases the teaching will be structured using the design process as the backbone for the methodology. Now some of these elements will be eh.. assessed formally each term. As learning pro.. progresses learners *must be made aware of the interrelationship between technology society and the environment.* Wherever applicable, learners should be made aware of *different co-existing knowledge systems.*	*To extend learners' knowledge* (Exposing learners to different co-existing knowledge systems)
T8	: Eh.. because every *situation is different* but if you are working with learners especially in technology you have to include that to start off with.	*Situations may differ.*

9f.

	7. What type/ kinds of activities do you give to learners during your design lesson?	**Theme**
T2	Well, after one has explained everything as far as the design process cycle is concerned, *the steps are there starting from 1. Identifying the problem, investigate to design.* Uhm! Then at times I take any particular system; can be a cell phone again, then ask them *to follow the very same steps* as to how one came about the introduction of cell phones.	To follow the steps to design
T4	I give them a case study that present the problem to be solved. Basically they need to follow, *I tell them to follow the six technological processes steps.* Yea, so that eh.. they have to identify the problem, after that they come up with eh.. possible solutions for the problem and they design the solution. After that, they present it in class. INT: wonderful! So you follow the steps. RS: I just follow the steps.	follow the six technological processes steps.
T5	Ok! Learners are firstly given the problem. *I teach them methodologies that will lead up to solving the problem*. : They are shown PowerPoint presentation, they are given models, worksheets etc.. The skills and concepts give them an understanding of the problem. *They then apply this knowledge to the design process*. The practical skill activities help them to create the solution.	Problem solving
T8	Alright. First in the design *we will give them books to read through.* Relevant books on the topics that you've got then *we will give them possible workings to draw to brainstorm their ideas in groups to see what they can come up with.* And once they come up with some idea then you've got.. eh say you've got a book there then that gives them an idea to work away from that and try and try and work with what they are expected to do.	Constructivism

9g.

	8. Do you allow learner to create their own solutions when designing? If so how do you do this? If not, why is this the case?	Category
T2	*Yes!*, Actually, as I introduce my lesson on the design process cycle I just tell them that why do you have this thing is because someone out there identified the problem. *So them, they can also identify the problem and come up with their own solution* and it is up to us to check the one solution whether it is really meeting the requirement for trying to solve the problem. INT: Ok! That means you allow some degree of independence and freedom as they generate their own solutions RS: Yes!, Yes!	*Constructivism (Autonomy)* in problem identification and solving
T4	*Yea, Yea!* : I do it because of the case study given to them. *They must identify the problem*, that's the main aim. And *therefore it is possible for them to come up with the best possible solution.* : I give them *first, individual learner* to come out with the a solution to the problem they are given. *After that they can work as a group* and ehm.. try to come out or to choose the best solution towards the problem.	Group work *(social constructivism)* in problem identification and solving
T5	*Yes!* As learners progress through a task, they are… as they progress through a task, they use the associated knowledge and skills that I taught them and then they modify the ideas to create a solution. They just don't memorize what I taught them. *They become innovative in developing solution to solve a problem*. *They are encouraged to explore their own ideals, attitudes* and also to develop uhm informed opinions that they can help them to make compromises and value judgment	Problem solving through innovation, Application of learned skills, *Constructivism (Autonomy)*
T8	*Uh! Yes*! But we give them the opportunity to do all that but in terms of if *they are doing projects on their own*, then they are welcome to do that. But remember, *today, in terms of material usage sometimes is not possible. So, we give them that opportunity and then we standardize a project.* Right. *We give them an opportunity to build their own projects.* Right? They come.. some of them come up with really good example and you work through step by step what is expected of them and *show them how its gonna be done* and then you build…and then they give you sketches of their project and then you show them how to do a scale drawing of the project and then start working on materialcollection and then start building step by step all the processes… *Within their own freedom and within their own time.*	*Demonstration, Constructivism (Autonomy)*

Appendix 10: Transcript of post observation interview

Post observation interview: (T5) (10th September, 2014)

INT: Ok! Mam, thank you very much for giving me the opportunity once again to record this lesson and to

observe it as well. Ehm I have so few questions that I want to ask In relation to the lesson that was

presented. Can I please go on and ask.

RS: (Nods) yes

INT: Mam, what was the reason for using the teaching procedure that you used during the design lesson?

RS: Ok! Uh! as you observed, I used the power point presentation because I feel that sometimes as a teacher

who is standing in front of the class and basically talking about certain concepts or skills, the child doesn't

really know what you are talking about. But having like visual aids, the child know exactly what you talking

and you find that tends to be more effective, its more stimulating and children's response as you can see was

more effective.

INT: Ok! Thank you. Ehm! What did you intend the learners to learn from the activity that you gave them.

RS: I basically wanted the learners to learn everything about gears and eeeh… looking at gears…how to

calculate mechanical eeh.. mechanical… sorry I made a mistake.

INT: Gear, no its fine.

RS: I wanted them to basically calculate gear ratio. And eeeh…yea that's it. To basically calculate gear ratio

to look at eeh.. the input, the output which is the input gear, which is the output gear in terms of speed,

rotation.

INT: Ok! So why is it important for learners to know about this?

RS: because if you look at gears, gears is used in almost every mechanism in reality. And now that we are living in modern technology, you will find gears everywhere and then peoples know exactly what we talking about, and coming to school they are in a car; eeh..we have gears.

INT: Yea!

RS: They know what is speed and what is going slow and eeh.. obviously when it comes to the building of mechanisms as well, they know how to eeh..basically engage in or employ this in eeh..future inventions and so forth.

INT: Ok! Number four what else do you know about the design process that you do not intend learners to know yet?

RS: (Silent)

INT: Because you know that there are so many aspects of the design process. in fact they cannot take place….all of them cannot take place in one lesson. So by all means there are so many aspects of it that you possibly could not have taught within this short time. So…

RS: Well obviously eeh… time is a constraint so what else do I know about the design process that I did not intend the learners to…. eeh.. obviously uhm..!

INT: Looking at their level.

RS: Obviously eeh.. looking at their level, obviously uhm.. later they are going use gear systems when they are working with their Mini PAT. And eeh… whatever mechanism or structure they have to build, they are going to employ the use of gears in it. So, obviously that will be the types of gears. I haven't taught them that as yet..

INT: Ok!

RS: That's a follow up activity, and then they're going to definitely use one of these type of gears to….eeh build a mechanism for the next Mini PAT.

INT: Ok! Thank you. What knowledge about learners' thinking influences your teaching of the design process?.. because, the.. eeh… as a teacher, teachers usually know how the learners… the direction in which they are thinking. And that also informs them about their teaching strategies and all those things. So in this case, how do you know the learners in terms of how they are thinking?

RS: Well, each child eeh.. each child thinks differently. Each child is unique in their own way. Eeh.. there are different levels eeh.. in questioning techniques; there are different levels in which they will answer a question. And eeh.. I find that sometimes the lesson that I did using a powerpoint presentation, even a weaker learner will automatically be able to pick up some things and eeh…. They are able to give their view point; they express themselves. The lesson becomes quite child friendly , and I find that even the slow.. the so called slow shy child, you bring out this effectiveness in them where they want to be part of this lesson as well and participate.

INT: Ok! Thank you so much. Number six; What other factor/s influence the way you teach the design process? because you see, like….myself for instance in my school, I don't have all these resources. So, definitely the way I present it will be very different from the way it will be here. But then… yea! Something like that.

RS: uhm..! obviously not all schools have access to resources and stuff like that. So how would you go about teaching a lesson like so in a school without a PowerPoint presentation; a school that has no access to electricity. Uhm! Well basically you will use eeh.. child friendly worksheets. Eeh….. the teacher may create posters….. eeh… simple things as getting children to bring bottle caps, eeh… finding resources, renewable resources and stuff at home that they can engage in a class activity where they are building simple gear trains using bottle caps and the concept and the idea of these skills are definitely coming. Simple things like a coke can..

INT: Mhm!

RS: You know smashing it and making a gear system, eeh.. taking simple corrugated cardboard from boxes that they can use eeh… for a gear system… uhm! So am sure methods like this can be employed basically in any school situation.

INT: So, besides the available resources that you have here you are saying you can also consider other readily available materials that are out there. From the environment.

RS: Yes! Yes. From shopping centres, from the environment itself.

INT: Ok!

RS: They can eeh… use this to create… even the teacher himself or herself can eeh… can basically pre prepare by cutting out cardboard and making models of a gear system that he or she can use to engage in a lesson that the child knows what to do.

INT: Ok!

RS: And also you can do stimulating activities with learners where they are eeh… in a class activity they're building eeh… gear systems out of things that they will find in the neighbourhood themselves. Even if they are going to their house they must find something; bottle caps, eeh… stuff like that that they can basically use in …..

INT: Thank you so much. The next one is what do you do to ascertain ascertain learners understanding or confusion around the design process? how do you find out whether they understand it or they are confused?

RS: Eeh.. as a teacher hmhm!!! (clears her throat) when am teaching, obviously you looking at all children as you are teaching. And the moment I find that a child is confused, I will not go further in the lesson. I normally stop and I make sure I drill simple pneumonics. I like drilling simple pneumonics like for example when you observed my lesson, as simple things in an exam situation you ask a child to calculate gear ratio, they are confused: is it the number of cogs in the driver divided by the driven or vise versa? So simple things as using pneumonics like 'n' comes before 'r' alphabetically.

INT: That is what you do when you discover that they are sort of confused. But then how do you know that they are confused before you remedy the confusion?

RS: eeh.. body language. When when you as a teacher when you are teaching, you can see body language. You know when a child doesn't know. For example if you ask a child 'Do you understand?' and you just say right Jack did you understand?' and there's this confusion but they will say 'yes Mam' you understand? And you know as a teacher its your intuition that tells you that a child doesn't understand and I think I as a teacher read body language very well. And I can see when a child is confused. I can see when a child eeh… echoes the other pupils sentiment in the sense that…. In order to keep up with him and to show that 'hey am not a slow learner, I know what is happening' and will yes I understand, I know it. And as a teacher you can sense that and therefore I will stop the lesson and I will drill. So you may ask me the next question 'so what happens to the high-flyers you know they work. Aren't they gonna be bored? So sometimes you can even call those high fliers in front of the class to explain to the weaker learners.

INT: Ok!

RS: So everybody is engaged and they are not bored.

INT: And then now you can that they actually understand.

RS: Yea, so the higher fliers also feel they are not left out.

INT: Ok! Thanks Mam. Ehm! How do you assess learners' work when it comes to the design process? actually I saw that there was some sort of assessment that was taking place. Yea but I want you to say it just for the sake of the record.

RS: OK! Ehm… there are so many ways in which you can assess a learner's work. Number 1 is class activities eeh…when you give the class activities, obviously we are…. After the child finishes the class activities, we recappin and remarking the activities. Then they have follow up activities like Mini PATS where we teachers assess them. They are given marks according to a rubric. And the reason why I use a rubric system is because eeh… a child is never disadvantaged. Eeh… somehow or the other… every child eventually gets to pass. Another way of assessing them is… sometime you play little games. You'll find that

children love things like games. You know, when you see these things like test, a child is bored and they feel they just have to learn for the sake of…but when you play games like as I played battle of the sexes…

INT: mmm! Yea!

RS: Eeeh..! children are competitive. You find that boys always want to compete against girls, vice versa. And eeh… it somehow brings out. Even the shy kidsautomatically want to answer. Competition is something that is an inborn thing in every human being.

INT: Yea!

RS: And eeh… having little fun games like quizzes, eeh… 'Battle of the sexes' you know where… at the end of the lesson you're recapping. So basically you are killing two birds with one stone. You recapping the lesson and at the same time the lesson is so child friendly that better understanding takes place. And if you noticed the lesson as well, you found the kids were eager to answer question.

INT: Yes!

RS: Even I have some shy kids who never even speak. You won't even hear them utter a word, came in the front and they were trying to challenge the other half.

INT: Ok! Mrs. Gounden. Thank you so much. From Crossmoor Secondary School. Actually I also enjoyed the lesson so much and it was very interesting.

RS: No Problem!

INT: Ehm… I would like to express my appreciation and gratitude for all the things you've done to help me do this study. Thank you! I will get back to you.

RS: Ok!

INT: Thanks! Thank you so much!

Post observation interview: T8

INT: Good morning Mr. Naidoo.

RS: Good morning

INT: Eehm! Thank you very much for giving me the opportunity to observe your lesson

RS: No problem!

INT: And eeh! I would like to ask some questions in relation to the observation that took place.

RS: You most welcome.

INT: Yes sir, thank you. The first question is that what was the reason or reasons for using the teaching procedure that you used during the design lesson?

RS: Ok! Most of our learners today are not observant. They pass objects, they pass buildings they pass machinery without being obvious and looking at what they are looking at. And so when you start your lesson and you ask some "what is a front view"? "what have you seen"? "did you see anything unique about it"? they don't know.

INT: Ok!

RS: So that is why you start with this technique on looking at different views, looking at points and planes so they can identify all this. So when it comes to using it in their own work when doing their project you know they have a better understanding of what they are looking at. And then they can look and see from different angles you will see different things.

INT: Ok! So, number two: What did you intend the learners to learn from the activities that you gave them?

RS: My intention was to draw their attention to show them that when you look at something you need to look at it a little more than just looking at it and see what you see. Because often when you look at something, it has a different meaning to you. But when you studying something it is totally different from what you would

have observed initially. So you need to bring this to the attention of the learners because their purpose is to study things a little more intensively so that they have a better understanding of what they are looking at.

INT: Ok! So, why is it important for the learners to know about this?

RS: Ok! We send learners out, we ask learners to do research, to go and observe. So when the go out and they do this, you give them a project, they need to do this research. You give them this knowledge first. So that when they go out they are observant, they have a knowledge they have or they know what to go and look for specifically and how to go looking at it.

INT: Ok! Marvelous! Ok! Question four: What else do you know about the design process that you do not intend learners to know yet?

RS: these learners are young, they've been introduces to drawing at the beginning. So there are certain aspects that you don't bring to them first. They need to have an holistic view of something first before you can start showing them. Now important to children is what we will call machine drawing where you breaking up into parts. Ok? Children don't need to know that first especially when they are introduced to drawing. They need to see the whole picture and later as they progress, then we need to break it down and tell them this is what this is. This is a mechanism that makes the whole machine.

INT: Ok!

RS: Get part by part so they understand. Now in most of these drawings when we look at the whole drawing there are many things inside the drawing that needs to broaden   so we use the technique of hidden detail.

INT: Ok! Thank you so much. Question five: What knowledge about learners' thinking influences your teaching of the design process?

RS: Ok! Over the period of time, we've come to know that children are less observant today (coughs) and as a result when you speak to them about a..an object or a machine or whatever you want to, they don't have that ability to see things that the teacher would see. So is important that you bring this to the attention of the child so that when he goes to the scene to look at this again he looks at it at.. from a different view, from a different viewpoint

INT: Ok! Thank you Sir. What other factors or what other factor influence the way you teach the design process?

RS: right! Now today you must alter your teaching strategy to cater for the learner so that at the end of the lesson the learner must be able to understand what is there. And he must be able to now go and relate that information and use the information he is given to work his workings when he's doing his project.

INT: OK! So what do you do to ascertain learners' understanding or confusion around the design process?

RS: Right! Continuously you do recaps on your work and you question them at different points to see that at that point have you understood what we are looking, what we are trying to get through and what I am trying to bring to you, so that you are more observant and when you are observant, you will be able to pick up all the final points about objects, machines. And then when it comes to drawing you have that knowledge to put it to practice because you've seen it. Now you understand where it is and what it is, then you can put it down on paper.

INT: Thank you so much. The last but not the least question: How do you assess learners' work when it comes to the design process?

RS: Ok! Now there are many ways in which you assess learners' work. Like yesterday's lesson we at the beginning where we were teaching them drawing, we used worksheet and we went around, I went around to

see that at each stage whether the child understood what he was doing and assistance was given and reassurance was given to the child to make sure that he understands.

INT: Ok!

RS: And all that. Now when you are in a practical situation you go to the child and you will see how he is working. If he is off line then you will put him back unto the correct line, show him exactly how it would be done.

INT: Ok sir! Ehm! I have another question which is a bit personal because part of this list. Ehm, as I was observing, it came to be that you were teaching a multi-view drawing. Like, something like orthographic projection.

RS: Yea!

INT: but one would have expected that when is about design process, maybe is about ehm, you know Generation of ideas, scenarios and all those things. So is there any link between what you were teaching and the design process, or has it got any relation?

RS: Yes there is. Definitely there is a relation. Because, when you come to draw your final drawing; your detailed drawing, a detailed drawing is not just one piece of drawing. It makes up different aspects. When you do detail you do details of all different parts, ok? And you look at different sides of the different views. Then you put it together.

INT: Yea!

RS: So..

INT: So all those things also form part of the design

RS: (responds simultaneously) …part of the design. That's when you are doing your specific engineer drawing as you call it or your detail drawing where you'll have parts and say somebody else, you have the drawing and somebody else is building that project. Say a school has a project to do something and to pass unto another person to manufacture. The other person will not be able to manufacture a product if he doesn't have the explanatory drawing, different views of each individual thing and clearly detailed. Then only will (will he) be able to build it.

RS: Ok?

INT: Thank you sir. Thank you so much for your time.

RS: No. not a problem! I'll always be of assistance to you. I appreciate this

INT: Thank you

Appendix 11 : Table of analysis of post observation interview

Post Observation Interview Analysis

	Interview Question	T5	Category	T8	Category
1	What was the reason/s for using the teaching procedure you used –during the design	Ok! Uh! as you observed, I used the power point presentation because I feel that sometimes as a teacher who is standing in front of the class and basically talking about certain concepts or skills, the child doesn't really know what you are talking about. But having like visual aids, the child know exactly what you talking and you find that tends to be more effective, *its more stimulating and children's response as you can see was more effective.*	*It is more effective: Learners demonstrate understanding*	Ok! Most of our learners today are not observant. They pass objects, they pass buildings they pass machinery without being obvious and looking at what they are looking at. And so when you start your lesson and you ask some "what is a front view"? "what have you seen"? "did you see anything unique about it"? they don't know. So that is why you start with this technique on looking at different views, looking at points and planes so they can identify all this. So *when it comes to using it in their own work when doing their project you know they have a better understanding of what they are looking at.* And then they can look and see from different angles you will see different things.	*It is more effective: Learners demonstrate understanding*
2	What did you intend the learners to learn from the activity given/undertaken?	I basically wanted the learners to learn *everything about gears* and eeeh… looking at gears…how to calculate mechanical eeh.. mechanical… sorry I made a mistake. I wanted them to *basically calculate gear ratio*. And eeeh…yea that's it. To basically calculate gear ratio to look at eeh.. the input, the output which is the input gear, which is the output gear in terms of speed, rotation.	Everything about gears: basically calculate gear ratio.	My intention was to draw their attention *to show them that when you look at something you need to look at it a little more than just looking at it and see what you see*. Because often when you look at something, it has a different meaning to you. But when you studying something it is totally different from what you would have observed initially. So you need to bring this to the attention of the learners because *their purpose is to study things a little more intensively so that they have a better understanding of what they are looking at.*	To observe objects closely. To study objects in detail
3	Why is it important for learners to know about this?	because if you look at gears, *gears is used in almost every mechanism in reality*. And now that *we are living in modern technology*, you will find gears everywhere and then peoples know exactly what we talking about, and coming to school they are in a car; eeh..we have gears. They know what is speed and what is going slow and eeh.. *obviously when it comes to the building of mechanisms as well, they know how to eeh..basically engage in or employ this in eeh..future inventions and so forth.*	*modern technology applies it* (gears in mechanisms.) *Learners employ it* (principles of gears) *in their designs*	Ok! We send learners out, we ask learners to do research, to go and observe. So when they go out and they do this, you give them a project, they need to do this research. *You give them this knowledge first. So that when they go out they are observant, they have a knowledge they have or they know what to go and look for specifically and how to go looking at it.*	*Learners employ it* (careful observation) *in their projects/research*

4	What else do you know about the design process that you do not intend learners to know yet?	Well obviously eeh… time is a constraint so what else do I know about the design process that I did not intend the learners to…. eeh.. obviously uhm..! Obviously eeh.. looking at their level, obviously uhm.. *later they are going use gear systems when they are working with their Mini PAT*. And eeh… whatever mechanism or structure they have to build, they are going to employ the use of gears in it. *So, obviously that will be the types of gears. I haven't taught them that as yet..That's a follow up activity, and then they're going to definitely use one of these type of gears to….eeh build a mechanism for the next Mini PAT.*	*Types of gears*	these learners are young, they've been introduces to drawing at the beginning. So there are certain aspects that you don't bring to them first. They need to have an holistic view of something first before you can start showing them. Now important to children is what we will call *machine drawing where you breaking up into parts.* Ok? Children don't need to know that first especially when they are introduced to drawing. They need to see the whole picture and later as they progress, then we need to break it down and tell them this is what this is. This is a mechanism that makes the whole machine. Get part by part so they understand. Now in most of these drawings when we look at the whole drawing there are many things inside the drawing that needs to broaden so we use **the technique of hidden detail**.	*Machine drawing.* *The technique of hidden detail*
5	What knowledge about learners thinking influences your teaching of the design process?	Well, each child eeh.. *each child thinks differently. Each child is unique in their own way.* Eeh.. there are different levels eeh.. in questioning techniques; there are different levels in which they will answer a question. And eeh.. I find that sometimes the lesson that I did using a powerpoint presentation, even a weaker learner will automatically be able to pick up some things and eeh…. They are able to give their view point; they express themselves. The lesson becomes quite child friendly , and I find that even the slow.. the so called slow shy child, you bring out this effectiveness in them where they want to be part of this lesson as well and participate.	*Individual differences*	Ok! Over the period of time, we've come to know that *children are less observant today* (coughs) and as a result when you speak to them about a..an object or a machine or whatever you want to, *they don't have that ability to see things that the teacher would see.* So is important that you bring this to the attention of the child so that when he goes to the scene to look at this again he looks at it at.. from a different view, from a different viewpoint	*Children are less observant*

| 6 | What other factor/s influence the way you teach the design process? | Uhm..! obviously not all schools have access to *resources* and stuff like that. So how would you go about teaching a lesson like so in a school without a PowerPoint presentation; a school that has no access to electricity. Uhm! Well basically you will use eeh.. child friendly worksheets. Eeh….. the teacher may create posters….. eeh… simple things as getting children to bring bottle caps, eeh… finding resources, renewable resources and stuff at home that they can engage in a class activity where they are building simple gear trains using bottle caps and the concept and the idea of these skills are definitely coming. Simple things like a coke can.. You know smashing it and making a gear system, eeh.. taking simple corrugated cardboard from boxes that they can use eeh… for a gear system… uhm! So am sure methods like this can be employed basically in any school situation. Yes! Yes. From shopping centres, from the environment itself. They can eeh… use this to create… even the teacher himself or herself can eeh… can basically pre prepare by cutting out cardboard and making models of a gear system that he or she can use to engage in a lesson that the child knows what to do. And also you can do stimulating activities with learners where they are eeh… in a class activity they're building eeh… gear systems out of things that they will find in the neighbourhood themselves. Even if they are going to their house they must find something; bottle caps, eeh… stuff like that that they can basically use in ….. | *Availability and or non-availability of resource. Improvisation.* | RS: right! Now today you must alter your *teaching strategy to cater for the learner so that at the end of the lesson the learner must be able to understand what is there.* And he must be able to now go and relate that information and use the information he is given to work his workings when he's doing his project. | (Learner friendly) teaching strategy |

| 7 | What do you do to ascertain learners' understanding /confusion around the design process? | : eeh.. **body language**. When when you as a teacher when you are teaching, you can see body language. You know when a child doesn't know. For example if you ask a child 'Do you understand?' and you just say right Jack did you understand?' and there's this confusion but they will say 'yes Mam' you understand? And you know as a teacher its your *intuition* that tells you that a child doesn't understand and I think I as a teacher read body language very well. And I can see when a child is confused. I can see when a child eeh… echoes the other pupils sentiment in the sense that…. In order to keep up with him and to show that 'hey am not a slow learner, I know what is happening' and will yes I understand, I know it. And as a teacher you can sense that and therefore I will stop the lesson and I will drill. So you may ask me the next question 'so what happens to the high-flyers you know they work. Aren't they gonna be bored? So sometimes you can even call those high fliers in front of the class to explain to the weaker learners. So everybody is engaged and they are not bored. Yea, so the higher fliers also feel they are not left out. | *Check (observe) body language. Teacher's intution* | : Right! Continuously you do recaps on your work and *you question them at different points to see that at that point have you understood what we are looking,* what we are trying to get through and what I am trying to bring to you, so that you are more observant and when you are observant, you will be able to pick up all the final points about objects, machines. And then when it comes to drawing you have that knowledge to put it to practice because you've seen it. Now you understand where it is and what it is, then you can put it down on paper. | *Questioning (The use of questions)* |
| 8 | How do you assess learners work when it comes to the design process? | OK! Ehm… *there are so many ways in which you can assess a learner's work.* Number 1 is *class activities* eeh…when you give the class activities, obviously we are…. After the child finishes the class activities, we recapping and remarking the activities. Then they have *follow up activities like Mini PATS where we teachers assess them.* They are given marks according to a rubric. And the reason why I use a rubric system is because eeh… a child is never disadvantaged. Eeh… somehow or the other… every child eventually gets to pass. Another way of assessing them is… *sometime you play little games*. You'll find. that children love things like games. You know, when you see these things like test, a child is bored and they feel they just have to learn for the sake of…but when you play games like as I played *battle of the sexes…* : Eeeh..! children are competitive. You find that boys always want to compete against girls, vice versa. And eeh… it somehow brings out. Even the shy kids automatically want to answer. *Competition* is something that is an inborn thing in every human being. And eeh… having little *fun games like quizzes,* eeh… 'Battle of the sexes' you know where… at the end of the lesson you're recapping. So basically you are killing two birds with one stone. You recapping the lesson and at the same time the lesson is so child friendly that better understanding takes | So many ways: *class activities; follow up activities like Mini PATS where we teachers assess them. sometime you play little games* (Competition; fun games like quizzes) | Ok! Now there are many ways in which you assess learners' work. Like yesterday's lesson we at the beginning where we were teaching them drawing, we used *worksheet* and we went around, I went around to see that at each stage whether the child understood what he was doing and assistance was given and reassurance was given to the child to make sure that he understands. And all that. Now when you are *in a practical situation* you go to the child and you will see how he is working. If he is off line then you will put him back unto the correct line, show him exactly how it would be done. | *Many ways: Worksheets; practicals* |

		place. And if you noticed the lesson as well, you found the kids were eager to answer question. Even I have some shy kids who never even speak. You won't even hear them utter a word, came in the front and they were trying to challenge the other half.			