

**AN EXPLORATION OF CREATIVE THINKING SKILLS IN THE GRADE 9 TECHNOLOGY  
CLASSROOM**

By

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## DECLARATION

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I declare that the Dissertation hereby submitted to the University of Limpopo for the Degree of Master of Education has not previously been submitted for a degree at this or any other University, that it is my own work in design and execution, and that all materials contained therein have been duly acknowledged.

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## DEDICATION

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I dedicate this dissertation to my family and friends. A special feeling of gratitude to my loving wife Nonhlanhla Cynthia Ngwenya-Nkosi and my son Zwelihle. I also dedicate this dissertation to my friend Xolani Mabila whose words of encouragement and push for tenacity ring in my ears.

God almighty has never left my side and I am forever thankful.

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## ABSTRACT

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The purpose of this is to investigate how teachers go about for the development of Creative Thinking Skills (CTS) in a grade 9 technology classroom. The introduction of technology in the South African curriculum by the Department of Basic Education (DBE) to develop CTS through the Design Process (DP) as the cornerstone of the learning area. Technology as a learning area should provide learners with opportunities to solve real-life problems, in the process developing their CTS (DBE, 2011).

In the 21<sup>st</sup> century, CTS have been seen as skills that are crucial across the spectrum of day to day activities. However; it appears to be very complex for technology teachers to enhance the teaching and learning of CTS in a technology classroom. The literature suggests that technology teachers tend to suppress the development of learners' CTS by limiting the process of teaching and learning to low order thinking cognitive levels rather than high order cognitive levels.

This study employed a qualitative research enquiry, purposive sampling was used for the selection of the relevant participants. Qualified technology teachers who teach grade 9 technology with at least three years' experience in teaching technology were considered. Data collection was obtained through interviews, observation and document analysis.

The research finding showed that teachers lack the understanding of policies, particularly CAPS hence they continuously compromise its implementation hindering with the development of CTS of learners as it is envisaged in the CAPS document. Furthermore, the research findings reveal that the teacher has a little or no understanding of what is creative thinking (CT) and what it entails, hence they did not unpack what is it exactly that they do to support the development of learners CTS in a technology classroom.

This study recommends that technology teachers be familiar with the CAPS document and implement it correctly without any compromise. Furthermore; understanding of the design process is of vital importance to teachers as it is the cornerstone of teaching and learning, particularly the development of CTS of learners. Technology teachers need also to have a clear understanding of what CT is and what it entails, that will assist to arouse their CT and help to develop the CTS of learners in a technology classroom.

**Keywords:** Creative Thinking Skills, Design Process, Creative Process; Social Cognitive Learning Theory; Creative Learning Process, Digital Technology, Divergent Thinking

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Above ground, I am indebted to the participants, (both teachers and curriculum implementers of Technology Education) whose identity cannot be revealed to ensure compliance with the sacrosanct rule of anonymity.

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## LIST OF ACRONYMS

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CAPS	Curriculum Assessment Policy Statement
CI	Curriculum Implementer
CLE	Creative Learning Environment
CTS	Creative Thinking Skills
DBE	Department of Basic Education
DP	Design Process
DTs	Digital Technologies
IDMEC	Investigate, Design, Make, Evaluate, and Communicate
PAT	Practical Assessment Task
TE	Technology Education
SCLT	Social Cognitive Learning Theory

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## CHAPTER ONE: GENERAL INTRODUCTION TO THE STUDY

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### 1.1 Background to the Study

The introduction of Technology Education (TE) as a subject by the Department of Basic Education in the South African curriculum was a response to the need for engineers, technicians, and artisans in the country (DBE, 2011). It was also as a result of the need for developing a modern society as well as developing a technologically literate population. Moreover, TE was introduced as a new subject. Hence, policies aligned to the subject were also developed to address the specific and objectives related to this newly-introduced subject (DBE, 2011).

Referring to this subject, the Curriculum and Assessment Policy Statement (CAPS), stipulates that TE should provide learners with opportunities to solve problems creatively using a combination of thinking and practical skills way that link abstract concepts to fundamental understanding and calls for the use of a variety of skills such as decision making, creative and critical thinking, as well as problem-solving skills within an authentic context (DBE, 2011). On the other hand, TE is expected to provide an environment conducive for inculcating positive attitudes, perceptions, and aspiration towards technology-based careers amongst learners. Technology as a subject, it is believed should stimulate learners to be more innovative and develop CTS so that learners are provided with a solid foundation for various FET subjects as well as in lifelong learning, for the corporate world (DBE, 2011).

Creative Thinking Skills are broadly viewed as a desired attribute for the quality of thinking that lays a foundation for innovation and change (Murillo-Zamorano, Sánchez, & Godoy-Caballero, 2019). Furthermore; Serdyukov (2017); Murillo-Zamorano, et al. (2019) argue that in the 21<sup>st</sup> century CTS has become increasingly important in the creation of a fertile ground for learners' success in modern society. It is in TE were a

manifestation of human creativity, concerned with how learners understand their role in the terrain technological creativity (Tan, 2020).

The foregoing discussion perhaps justifies the fact that in the last two (2) decades or so, there has been increasing interest in the subject of creativity in TE, although that had no impact in classroom practices (VanSlyke-Briggs, 2019). Instead, VanSlyke-Briggs, (2019) further argues that approaches such as the traditional “drill and kill” or standards-based teaching have often pushed creativity out of the curriculum or areas of policy and assessment.

Other authors reveal that CTS are available to everyone, but most predominant in young children who are still at school (Sternberg & Sternberg, 1999; Lucchiari, Sala, & Vanutelli, 2019). Furthermore; Lucchiari, et al. (2019) argue that it may be difficult to find creativity in older children and adults because their potential “has been muffled by society that encourages intellectual conformity”. Even though this has been the case, Ariba (2019) laments the fact that there has been little research regarding creativity in classrooms.

### **Rationale of the study**

Working as a teacher in a high school since 2007, and over the years as a qualified technology teacher, the researcher interacted with technology teachers in both formal settings and informal settings. The researcher also made presentations of different topics during technology content enrichment workshops, at circuit and district level. This experiences helped in gaining some insights into several issues with regards to the teaching and learning of TE in South African schools. Technology is a subject that stimulates learners to be innovative and develops their creative and critical thinking skills and these skills provide a solid foundation for several FET subjects as well as for the world of work (DBE, 2011:8). Hence; I developed interests in the teaching and learning of CTS.

Most teachers tend to have the view that learners as children are naturally creative, open to experience, and tend to be attracted by novel things. Hence; if the natural



quality is not nurtured correctly, it will vanish (Lin, 2011; Wilson, 2018). Creative Thinking Skills teaching focuses on teacher classroom practices, whereas teaching for creativity highlights learner agency (Davies, Jindal-Snape, Collier, Digby, Hay, & Howe, 2013). Creative Thinking Skills are the ultimate skills to possess in the 21<sup>st</sup> century. (Collins, 2018) reveals creative industries and services today, creativity forms the core activity of a growing section of the global economy.

Lucas and Spencer (2017) agree that a supportive ethos for nurturing CTS can be found in both practices. Through teaching creatively, teachers encourage learners' creativity by passing on their enthusiasm, imagination, curiosity and other talents. Creative thinking is not an innate quality of only a few selected individuals, hence it can be learned, practised and developed by the use of proven techniques which, enhancing and stimulating the creative abilities, ideas and creative results (Vogel, 2014).

Therefore, it was under these bases that the researcher realised the importance of investigating the development of CTS. This motivated the researcher to conduct this study to attempt to fill this gap.

## **1.2 Research Problem**

Creative Thinking Skills are essential skills for 21<sup>st</sup>-century success since societal problems become more interdependent, global and complex. There has been increased interest around creativity in general education but none in the specific field of TE (Henriksen, Mishra & Fisser, 2016; Freiman & Tassell, 2018; Strydom, 2020). Hence, creativity is a concept that has not been well understood, framed, or defined in TE.

The drastic changes of modern technology development have posed a challenge to all stakeholders, particularly teachers who need to ensure that classroom technology integration is highly considered, with the understanding that creativity is deeply rooted to the issue of technology integration in the 21<sup>st</sup> century (Zhao, 2012; Holstein, McLaren, & Alevan, 2019). Besides, there is a necessity for teacher education to focus on creativity to infuse this skill in classrooms. Therefore, it is important that teacher training should

support the repurposing of technologies in the classroom and teaching approaches that will creatively engage learners with content (Henriksen, et al., 2016).

Garrett Dikkers (2015) reveals that despite the increased attention to creativity in education, there is still little understanding of how to infuse and support CTS in the current TE classroom context. Furthermore; teachers are still faced with the question of how to successfully infuse CTS into teaching practice, and at the same time, they must consider the integration of technological tools in their teaching and learning process.

Considerations for the development and impact of learning technology should not be in isolation, but rather heed to opportunities for creative thinking education. The current education system does not provide risk-taking platforms and the freedom for learners to explore (Henriksen & Mishra, 2013; Fishman, et al, 2016; Cych, et al., 2018).

### **1.3 Purpose of the Study**

The purpose of this study is to explore ways in which CTS could be enhanced/infuse in Grade 9 Technology classrooms. Hence, the research questions framed to guide the study consist of the main research question that is accompanied by subsidiary questions aimed at assisting the study to operationalise the inquiry; the following main research question was asked:

#### **3.1.1 Main research question**

The main research question in this study was: How can teachers support learners to develop creative thinking skills in a Grade 9 Technology classroom?

To address the main question, the following Subsidiary questions were posed:

### **3.1.2 Subsidiary questions**

- Which approaches do Technology teachers apply to support Grade 9 learners to develop CTS?
- What opportunities does CAPS provide for fostering CTS in a Grade 9 Technology classroom?
- What are the teacher's experiences when attempting to support learners to develop CTS?

### **1.4 Role of Theory in the Study**

The theoretical basis of this study it is well resonated by Bandura's Social Cognitive Learning theory (1977). Bandura (1986) further describe how humans behave, and individuals develop, which is intertwined with themselves and other influences they receive from the environment. The relationship between individuals and the environment on how it affects people's behaviour is explained through a model of causation involving triadic reciprocal determinism. The model of reciprocal causation, behaviour, cognition, other personal factors and environmental influences all operate as interacting determinants influencing each other bi-directionally (Bandura, 1989).

Social Cognitive Learning Theory led to the development of self-efficacy theory. Bandura (1993) indicates that what teachers do and say in their classrooms is govern and determined by the perceptions teachers have of themselves as individuals and of their personal and pedagogical strengths. Furthermore; teachers' beliefs in their proficiency to motivate and promote learning affect the types of learning environments they create and the level of academic progress their learners' success. According to Donohoo (2016) people's beliefs in their accomplishments as more vital in deciding how to behave than their beliefs in their knowledge or skills.

Bandura (1997:469) defined collective efficacy as performance capability of a social system as a whole and to people's shared beliefs that they can work together to

produce effects Bandura (1997) supported the concept of collective efficacy as similar to self-efficacy in that it focuses on the amount of effort and persistence dedicated to a task, and the perception of the success of that task and is likely related to self-efficacy since the perceived sense of group efficacy is related to the individual perceived efficacy of the members of the group.

Teachers play an increasingly pivotal role in many aspects of the care and management as well as the education of their pupils (Louis, & Murphy, 2017). The success of learners is embedded in teachers' self-efficacy, moreover also demonstrates a positivity of collective efficacy on learners' achievement. (Burić, & Moe, 2020).

## **1.5 Definition of Key Concepts**

### **1.5.1 Technology education**

Technology Education is also known as the Study of Technology or Technological Studies. Technology Education is a study that focuses on a broad spectrum of technology, dealing with innovation, change, or modification of the natural environment to cater perceived human needs and wants, and how technology accomplishes this through the interrelated disciplines of math, science, engineering, and other disciplines. (Manichander, 2020).

### **1.5.2 Creative thinking**

According to Sternberg (2018a), Creative thinking is classified as the type of thinking that is novel and produces ideas of value to society hence it noted is a crucial skill to be successful in society today.

### **1.5.3 Design process**

The design process is a process that foresees precisely production, invention, manufacture and the planning of relevant product aimed at benefiting the entire society. Furthermore, it is a process that seeks for perpetual refinements of creating a product (Hill, 1997: 35; Sheikheldin, 2018).

#### **1.5.4 Divergent thinking**

Divergent thinking is defined as a process of generating to generate new ideas, employing various combinations of cognitive processes to produce many and varied ideas (Runco, & Acar, 2010; Beaty, Thakral, Madore, Benedek, & Schacter, 2018).

#### **1.5.5 Creative process**

The creative process is a process that is embedded in a succession of thoughts and actions leading to original and appropriate productions (Lubart, Mouchiroud, Tordjman & Zenasni, 2015; Glăveanu, 2018).

### **1.6 Significance of the Study**

It is 15 years plus since the introduction of TE as a subject in schools, yet South Africa is still faced with the same challenges that existed before it was introduced. DBE (2011) clearly states that TE was introduced to spur the production of engineers, technicians, and artisans needed for the ever-changing world. A study exploring how to enhance CTS in a Grade 9 TE classroom. The will help a great deal concerning the full understanding of the processes that enhance creative skills, it is of bigger interest for individual and organisations (Shen, & Lai, 2018).

In TE, little attention has been given the arena of creativity and that might be brought by several reasons (Oghalaiee, & Bandarian, 2018). Creativity is an integral and vital part of the engineering DP, without creativity in design, there will be a lack of ability for innovation, and this is where creative ideas are applied (Richardson, & Mishra, 2018).

In ensuring that the purpose of the subject as outlined in the policy document is fulfilled, the study will add value to the government/Department of Education, curriculum implementers (CI), teachers of TE and the learners. It will give all the stake-holders involved the fundamentals on how to enhance CTS in a technology classroom without any compromise. Moreover; it will assist in preparing learners who will be adaptive to

the modern world of technology. This will ensure that the systems of education produce the kind of learners who best complement the country's needs and that of the world.

### 1.7 Outline and organisation of the study

This study is constituted by five (5) chapters. Table 1.1 provides an outline and organisation of the study

Table 1.1: Outline and organisation of the study

Chapter	Heading of chapters	Description of chapters
1	The study orientation	Outlines the background and rationale for the study, the purpose of the study, problem statement, research questions and explanation of key terms.
2	Literature review	An overview of the literature concerning Creative Thinking skills
3	Research design and methodology	Describe the methodology used in the study, research design is detailed. Furthermore, population, sample, data collection instruments, and data analysis are explained as well as the standard of rigour for the study and the ethical considerations.
4	Discussion of the findings	Discussions based on the findings are done, and data interpretation.
5	Summary of the findings, limitations, discussions, recommendations and conclusion	A summary of all the previous chapters is provided. Furthermore, the recommendations and conclusions of the study are done. Lastly, a presentation of the limitations of the study as well as future research recommendations are presented

### 1.8 Summary of the Chapter

In this chapter, the background of the study is provided concerning TE as a subject. Furthermore; the research problem is outlined as to what has spark interests to conduct a study in TE regarding the development of CTS. The role of the theory that will allow the flow of the research study trying to respond to the research questions is also

outlined. Questions to guide the study are also provided in this chapter, as well as definitions of key concepts. Furthermore; details on the significance of the study are also provided. Lastly an outline and organisation of the study is also provided in form of a table (Table 1.1).

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## CHAPTER TWO: LITERATURE REVIEW

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### 2.1 Overview of the Chapter

This chapter presents a review that is made regarding the topic at hand, “**An exploration of Creative Thinking Skills in the Grade 9 Technology Classrooms**”. It presents an overview of the literature regarding Social Cognitive Learning Theory (SCLT) concerning CTS in TE. Furthermore; a review on thinking as a foundation of any other type of thinking such as CT, then after of which CT is discussed in details, it also touches on issues of Creative Process (CP) as a model of creativity, creative environment as a key aspect in the deployment of CTS.

Furthermore; in this Chapter, because we live in a technologically advanced world, the role of new technologies in TE, particularly in CT is examined. Design Process (DP) is also discussed informed by the fact that it is the cornerstone of teaching and learning TE, which provides teachers with an opportunity to enhance the CTS of learners through practical assessments tasks (min-PAT) as stipulated in CAPS document.

In light of the above, these will potent the selection of literature to be reviewed, mainly articles or kinds of literature dealing with CT, and the other aspects relating to the development of CTS mentioned above will be reviewed. These processes will assist the study in the sense that one will have a broader view as to what other scholars are saying about CTS as skills required for one to succeed in the real world. Again, one will get to understand what goes with CT for a learner to be well equipped with the necessary skills as stipulated in the CAPS document.



## **2.2 Social Cognitive Learning Theory**

According to Bandura (1986), Social Cognitive Learning Theory explains human agency based on the interdependence of determinants making use of three-point model named triadic reciprocal causation. Based on studies conducted over several years, in 1986 Albert Bandura decided to rename his Social Learning Theory (SLT) to Social Cognitive Learning Theory (SCLT). In other words, the Social Cognitive Learning Theory (SCLT) best defines SLT.

Social Cognitive Theory is based on the assumption that people are purposeful, goal-directed beings who are primarily motivated through their beliefs of self-efficacy and outcome expectations driven from their actions within particular social contexts. The model visually resembles a triangle with the following points interacting and mutually influencing each other: personal factors (P), which include cognitive, affective, and biological events; environment (E); and behaviour (B) (Bandura, 1986). As learning progresses learners must be made conscious of the interrelationship between technology, society and environment, moreover they should be constantly enlightened of the different coexisting knowledge systems (DBE, 2011: 10).

Social Cognitive Learning Theory is the learning theory which has come out on open suggesting that people learn by observing what others do, and that human thought processes are central to understanding personality, hence in the 1980s, Bandura moves towards a more holistic approach, by giving a more comprehensive overview of human cognition in the context of social learning. Therefore, an expansion of SLT became eminent to become to the now known SCLT (Bandura, 1999).

The then SLT and now SCLT champions that, to a particular extent, a person's behaviour is potent and maintain over a particular period without being forceful stimulated by an external factor for them to independently think (Bandura, 1977:161). In agreement with Bandura, Carkett (2004:473-474) indicates that ideas allow learners to develop their reasoning skills in a social environment.

Bandura (1977:164) uncovered that whenever a person come across unfamiliar practices/tendencies between facts and one's thoughts, they tend to interpret the facts rather changing their way of thinking, during outcomes that show a high level of development in intrinsic motivation or the desire to know and acquire more knowledge about the social world, allowing them to progress in a higher level of thinking/reasoning. Therefore; learners should be encouraged to continue to reflect on their progress against certain criteria and to modify their solutions based on encountered problems, by so doing the learners progress should able to demonstrate increasing accuracy and skill, better organisational skill and safer working practices (DBE, 2011: 12).

Social Cognitive Learning Theory is referred to one's confidence for participating in specific activities, leading to the fulfilment of specific goals (Bandura, 1997). Furthermore, SCLT places a heavy focus on cognitive concepts, by focusing on how children and adults operate cognitively on their social experiences and how these cognitions bring about in influencing their behaviour and development (Greifeneder, Bless, & Fiedler, 2017). Learners should be in a position to consider the impact of technology, in both ways negative and positive on people's lives or the society as a whole. Moreover; they should be made aware of the bias in technology so they can express their point of view explaining how particular groups in society be negatively or positively affected by a technological product (DBE, 2011:10).

Social Cognitive Learning Theory is also used for assessing learning outcomes through two variables: self-efficacy beliefs and self-regulated learning in academic planning. A self-efficacy belief refers to one's confidence in partaking in specific activities that contribute towards progress to one's goals and by self-regulated learning refers to the process of learners actively taking charge and responsibility for their learning (Bandura, 1997). The grade 9 learners must be able to identify and explain a problem, need or opportunity from a given real-life situation (DBE, 2011: 12).

In SCLT the human behaviours may be in a variety of settings that include risk-taking (Roberts & Fillmore, 2017). The social learning environment provides opportunities for learners to develop the social-cognitive skills (SCS). For both teachers and learners that

have developed SCS, they will show desirable procedures of tackling technological problems, simultaneously analysing the information (Resnick, 1987: 41).

In the next section, the nature of thinking is discussed as a foundation of creative thinking leading to clearer discussions of creative thinking.

### **2.3 Thinking**

Thinking is described as a type of skill that requires a very high level of intellectual competency, which is also potent by experience, whereby the lack of experience could mean that there is no platform for the development of thinking (Dewey, 1934). According to Ratner (1939), thinking is a continuous occurrence of uncertainty being experienced and that is provocative to one sense of beliefs, its purpose is to develop knowledge and constitute an unwavering state of equilibrium. Furthermore; thinking is an overall search for solutions and requiring a thinker to develop a structured way of conducting an enquiry.

Lewis (2006:4); Ohemeng-Appiah (2014) indicate that it is important for technology teachers to always provide learners with activities that timeously provoke them to think, meaning an authentic problem that will stimulate the thinking of learners should be developed by teachers, challenging learners to apply themselves to provide solutions to technological problems.

Mirroring Vygotsky's work Holzman (2006) agree that one idea is never enough to provoke creative thinking, meaning that technology teachers should provide the necessary support for learners to be able to generate as many ideas as they can, examine the ideas until they come up with the best suitable idea. Thinking in technology classroom is a vital process that affords learners with the opportunity to be in a position to simplify a technological problem for understanding after of which learners will be able to forestall possible solutions to the problem presented before them (Lewis 2006:41).

Moving forward in the next section CT is discussed at length, this is the part that technology teachers are expected to be familiar with; hence they are at the centre

where policy meets implementation. So it will be important to see how much teachers know and how they go about in instilling CTS in a technology classroom to produce the kind of learners needed to survive in the ever-changing world of technology as stipulated in the CAPS document.

## **2.4 What is Creative Thinking?**

One needs to understand that the field of creativity exists today, it emerged largely as a result of the pioneering efforts of J. P. Guilford (1950). In his classic 1950 presidential address before the American Psychological Association (APA), Guilford appealed on behalf of making creativity a more focal point of psychological inquiry, seeing that it was receiving less attention (Guilford, 1950). Many psychologists heeded to the call and have seen creativity research booming in the 1960s and early 1970s leading to today.

Guilford's contribution was the ability to specify the distinctness but the intriguing notion of creativity according to discrete defining individual creative thinking. The constructs of creative thinking take into considerations fluency, flexibility, novelty, synthesis, analysis, reorganisation and redefinition, complexity, and elaboration. Suddenly, the appealing but nebulous concept of creativity had scope, depth, and breadth that could be measured and explored.

Creative Thinking is more than using imagination to crack out lots of innovative ideas, but more of a lifestyle, personality trait, way of perceiving the world, of interacting with other people, and a way of living and growing. Hence there has been increasing educational research supporting the importance of creativity in teaching and learning (Henriksen & Mishra, 2015). Creativity is defined as a process and a product that is thought of as the production of useful solutions to problems, or novel and ideas that are effective (Simonton, 2018).

Creative thinking is the type of thinking that allows learners to apply their imagination to generate ideas, ask questions, develop hypotheses, experimenting with alternatives and to evaluating their own and their peers' ideas, final coming up with a product (Kampylis

& Berki, 2014: 6). Creative thinking is a development of ideas, objects that are new novel, interesting, effective, and have a certain aesthetic sensibility as a system (Mishra, Henriksen, & the Deep-Play Research Group, 2013).

According to Murillo-Zamorano, et al. (2019) creativity is greatly desired quality of thinking often a vital aspect of innovation and change. Creative thinking is increasingly important for goal attainment in our complex, interconnected world (Strom, & Martin, 2017). Creative thinking is characterised by originality and uniqueness of ideas. However, Originality of ideas does not entirely represent creative thinking, but they are only a part of the cognitive and complex phenomenon of creative thinking (Runco & Acar, 2012).

Barlex (2011:9) defines creativity is an active process necessarily involved in innovation, it is a type of learning habit that requires skill as well as an understanding of the contexts in which creativity is being applied. To be creative, one needs to be able to come up new ideas, analyse these ideas, and sell the ideas to others, meaning that it possible that one may have synthetic, analytical, or practical skills but not be able to apply them where it is necessary; for instance, in problems that potentially involve creativity (Sternberg, 2018b; Pollard, Hains-Wesson, & Young, 2018).

The fundamental idea is that creativity can take different forms, depending on how it propels existing ideas forward. During the development of creativity, different forms of creativity can be developed, ranging from minor replications to major redirections in thinking (Ucus, & Acar, 2018). Zhao (2012) indicates that school systems need to move away from homogenisation through external standards that seek a single right answer for all things, but being creative means being novel and coming up with novel solutions to fit unique contexts. Moreover; if educational systems place value on standardized practices, knowledge, skills, facts, and outcomes, certainly creative thinking is devalued.

Teachers' challenges are that they do not know how to promote creativity within learners. Moreover; they lack the experience and the knowledge about the creative process, which makes it difficult for them to teach and encourage creativity in their

learners (Richardson, & Mishra, 2018; Harris, & de Bruin, 2018). Creativity is rapidly becoming a central aspect of scholarly discourse, research, and education practice. Hence; creativity is being understood, nurtured, and linked with industry, and how sites of education interpret and prepare learners for futures shaped by creative and innovative challenges, as they are emerging as significant aspects of the ways approach creativity across the education life span (Hung, Ng, Koh, & Lim, 2009; Shah, 2020).

Creativity is a vital aspect of teaching and learning that is influencing worldwide educational policies and teacher practices, and re-shaping the possibilities of 21st-century learners. Moreover; if creativity is well understood, and nurtured, in such a way it is linked with real-world problems for emerging workforces that are significantly changing the ways contemporary scholars and teachers are now approaching creativity in schools (Harris & De Bruin 2018).

Abegglen, Burns, Maier, and Sinfield (2020) argue that it is important to develop learners' creativity in higher education for personal, economic and social reasons. In recent years, research has revealed that the most powerful attained, innovative people in various fields are highly creative even in areas outside their professional spectrum, by actively drawing on outside interests and creative ways of thinking to improve their professional practices (Cheng, 2019).

Increasingly research in creativity education is turning to the school, workplace experiences and conditions that include dynamic teacher practices, spaces, environments, and learning atmospheres, and how these impact on the embodied practices of collaboration and knowledge exchange in climates of imagination and productive risks-taking (Harris & De Bruin 2018).

Studies have shown the in the recent years the importance of collaborative constructing, defining, interpreting, and communicating of activities as they are being accomplished as fundamental building blocks towards developing creativity (Innes & Booher, 2018). The diverse applications of creativity within education systems continue to foster

countless investigations pertinent to creative and critical thinking in learners (Runco & Jaeger, 2012).

Creativity depends on the convergence of numerous factors including disciplinary competencies, process relevant factors guiding the direction, the progress of the creative process as well as social and environmental features that ensure a supportive environment that allows learners have confidence, be motivated and able to take risks in their learning (Lille, & Romero, 2017). Creative thinking is difficult to study/examine as a lone model due to its complexity. Therefore; creative thinking is examined as a process through thinking strategies, knowledge base, or by combining these two aspects and problem-solving considered as a creative thinking process (Wechsler, Saiz, Rivas, Vendramini, Almeida, Mundim, Franco, 2018; Runco, & Pritzker, 2020).

Creativity is characterised by four aspects mainly: person, product, process, and environment. The creation of an enhancing, harmonious and meaningful environment can contribute to the development of creative potential (Wang, & Kokotsaki, 2018; Tien, Chang, & Kuo, 2019). Creativity does not occur in isolation, because in society there is always the influence of cultural, economic and political times affecting the creativity of a person (Sternberg, 2018a; Runco, & Pritzker, 2020).

According to Richardson and Mishra (2018); Cremin and Barnes, (2018) creative thinking is dependent on the other attributes such as environment and technologies, it also requires reflection, encourages engagement, and develops confidence and responsibility. The skill and inclination to be creative are essential to living a fulfilled and successful life, and it is valued in higher education and the workplace (Harris, de Bruin, 2018). There are many other benefits of maximising one's own creative potential such as physical and psychological health improvements, improved resilience in the face of difficulties and even lower levels of aggression (Snape, 2017; Jefferson, & Anderson, 2017).

In light of the above, it is without a shadow of the doubt that creative thinking skills are very important skills in the 21<sup>st</sup> century. Vital as they are, they can be taught and they

can be learned, but one needs to understand that creative thinking does not exist in isolation. For the development of CTS, there are other aspects to consider such as Creative Process, environment, New Digital Technologies, etc.

Blamires and Peterson (2014) in reviewing the movements in teaching for creativity in the UK, and discussing the support for teachers in developing learner's creativity within the classroom, eight enablers were synthesised in nurturing creativity in the classroom:

- To design assessment activities that provoke learners' imagination
- To develop a culture for risk-taking, exploration beyond the rules, and non-conformity and fostering a safe classroom environment where students' ideas, interests, and opinions are respected
- To recognize the curriculum space and schedule where the teacher is a co-creator of creative learning
- To recognise that there is a minimum threshold of knowledge needed to be creative in any field
- To develop creativity through collaborative and social environments with learners supporting one another's creative development
- To recognise that effective teacher education and professional development and support are needed in developing pupils' creative capacities
- To harness technology to teach
- To capitalize on the necessary tools, including space, resources, and networks, to provide virtual and real interactive opportunities and structures for learning and teaching

In the next section creative process is discussed in details, it is where one will get insights on what role does it play in teaching and learning creative thinking skills in technology? It will also provide information on how to go about as it is a vital process that is aimed at developing learners' creative thinking skill in TE.



## **2.5 Creative Process**

The CP is a process of traditionally following different stages from problem definition to information gathering, followed by conceptual combination then leading to an evaluation of new ideas (Montag, Maertz Jr, & Baer, 2012). The creative process is an important facet in enhancing creativity. Moreover; it is a process that goes beyond classic logic in encouraging people to think diversely and innovatively (Cefkin, 2010). The CP involves freedom from functional rigidity in driving unique solutions to a problem (Kim, 2006).

The CP is a process that requires time and collaboration; therefore, the creating time for creative thinking activities is vital. In using of flipped classroom approach for example, where learners prepare content and do written exercises preparing for lessons in advance at home, allows teachers to plan for higher-level creative thinking activities during class time (Lo, & Hew, 2017).

One aspect of the CP that makes it powerful is that it requires not only knowledge and understanding of the domain being investigated, but also a willingness to question and not be constrained by existing knowledge. Meaning learners need to have an understanding of their questioning/challenge existing knowledge, for them to have their understanding, and imagination playing a vital role (Robinson, Neergaard, Tanggaard, Krueger, McCracken, & Matlay, 2016).

The second aspect is that assists learners to make connections across topic areas and understand the discipline as a whole is spaced delivery of content in lessons, this will mean teachers revisiting related subject matter over a period to avoid each topic as a separate entity (Laurillard, 2013). It is hard for a person to think creatively while lacking the knowledge required thinking creatively because it represents a balance between knowledge and freeing oneself of the knowledge (Sternberg, 2012:4). An inclusive design practice can place the user within the design process to facilitate an authentic experience; they caution that many such examples fail to authentically capture the needs of the user (Best, MacGregor, & Price, 2017).

A creative learner should be in a position to develop and apply a set of skills to be used in the creative process. It includes being able to do the following:

- Clarify, analyse and re-define the problem or question to reveal new perspectives
- Ask thoughtful questions
- Identify connections between seemingly unrelated subject matter
- Challenge known knowledge through questioning: of how can this be improved?
- Recognise available options possibilities
- Look at things from a different point of view

The Development of learners learning experiences should be embedded in the design process and be supported by the process of purposive design, which is creative and interactive (Goodyear & Retalis, 2010). The CP includes teaching and learning; therefore, creativity is often hidden in the processes of teaching and learning. Blamires and Peterson (2014) argued that CP is a process that usually takes place within subject disciplines as creativity requires knowledge and skills to cater it with a purpose. In the creative process, the process is as important as the final product (Fürst, Ghisletta & Lubart, 2012).

Relative to the above information it is clear that the CP is very important in teaching and learning particularly in infusing CTS of learners. It provides necessary insights to teachers in particular with the know-how in preparing learners to acquire the correct set of skills to be creative. The next section creative environment will be unpacked in details as to what role does it play in the enhancing of CTS in the technology classroom.

## **2.6 Fostering of creative thinking and factors influencing creativity**

Fostering of CTS early attempted through training and given more attention in the mid-twentieth century, psychometric researchers Guilford, Torrance, put efforts in extending and measuring an individual's creativity. Furthermore, it was uncovered that like most behaviour, the creative activity probably represents to some extent many skills that are

learned. Moreover, there may be limitations set on these skills by heredity; but through learning one can extend the skills within the existing limitations (Guilford, 1952).

There are several factors, (for example, motivation, self-initiative) that are important to the development of creativity. Motivation is one of the factors that is viewed as a driver for creativity in the classroom (Sternberg & Lubart, 1996; Starko, 2013; Agnoli, Runco, Kirsch, & Corazza, 2018). Creative Thinking Skills are developed through higher levels of intrinsic motivation that comprise of challenge, freedom, resources, group work features, supervisory encouragement and organisational support (Amabile, 2018; Vejjan, Kamarudin, & Kadir, 2016).

According to Morrison, Ross, Morrison and Kalman (2019), most teachers would start by suggesting proper techniques, such as giving learners a design journal, make them draw more, let them explore rather than forcing them to take one single approach. These techniques may lead to an increase in learner's level of creativity, but the bigger picture should be on what causes one to improve or develop in creativity? Knowledge, mastery of that knowledge, and motivation from within the learner and the classroom, and the ability to be able to interrelate this information and explore cross-disciplinary relationships (Copeland, Furlong, & Boroson, 2018).

Amongst other factors, motivation is seen as the main driver of factors influencing creativity; motivation focuses on how creativity is developed through higher standards of intrinsic motivation. It comprises of six strategies, namely, challenge, freedom, resources, work-group features, supervisory encouragement, and organisational support (Barak, 2010; Amabile, 2011; Zhao, & Zhu, 2014). Details of these strategies are summarised as follows:

- *Challenge*

Challenge is said to be a method for developing the five essential qualities that enhance creativity among learners, namely, tolerance of ambiguity, perseverance, willingness to grow, openness to experience, and willingness to take risks (Sternberg & Lubart, 1996).

- *Freedom*

Freedom in creativity is viewed as a process that allows learners to handle problems in such a way they can exercise their expertise and CTS to their best ability (Amabile, 2018; Jones, 2019). Through teaming, sharing, compromising, and decision-making, learners will be able to ascertain their process and re-organised their previous knowledge, new expertise, and new cognitive skills to solve the problem (Csikszentmihalyi, Montijo, & Mouton, 2018). Instead of teaching learners using strictly designed problems, learners must be provided with the platform to identify their problem to be solved to allow them to exercise their creativity (Amabile, 2018).

- *Resources*

An environment needs to be conducive to the learners' learning or working style, despite working individually, in pairs or a group. Besides, it is vital to provide learners with a physical space needed to work comfortably (Amabile, & Kramer, 2011). Holistically, an environment can include the political atmosphere, the interpersonal relationships, the physical space, the equipment and the supplies available for a project (Sternberg & Lubart, 1995). Importantly, the simplest and most vital resource of all is the time factor. Teachers should afford learners with the opportunity to explore ideas, but not for too long that the project idles. They need to strike a balance for the need of exploration taking into consideration the costs of this time (Amabile, 2018).

- *Workgroup features*

Hawlina, Gillespie, and Zittoun, (2019). Diversity and conflicts in groups are some factors that bring about dynamic and productive ideas. Comparatively, if members of a group are drawn from different backgrounds to confront a problem, the outcome will be more original than that of a group of members with similar backgrounds (Glăveanu, 2011).

In most cases groups that are made up of learners who think alike, the likely wood is that conclusions will be reached quicker and learners be content about it, but failing to debate and explore ideas (Amabile, 2018). Diversity in a group means various, expertise, creative thinking styles and cognitive abilities will come to play a key role in

creativity and this allows the flow of dynamics and discussions as well as encouraging sharing of ideas and exploration of divergent ideas (Runco, 2014).

- *Supervisory Encouragement*

The supervisory engagement can be conducted in various ways, for instance offering feedback, which will provide a proper structure to learners who seem overwhelmed by a task. Therefore; to successfully develop creativity, teachers should ensure that they encourage curiosity, exploration, confidence, risk-taking and balance among learners (Molderez, & Fonseca, 2018).

- Curiosity and desire to explore are the most vital factors to build towards creativity; the first step in achieving creativity is the cultivation of creativity (Csikszentmihalyi, et al., 2018).
- Teachers should always provide support to their learners and reward exploration to enhance creativity (Molderez, & Fonseca, 2018).
- Self-confidence helps learners to be mentally strong and resilient, ad this enables them to master their perception and work while acquiring confidence, concurrently. Learners who lack confidence and are fearful in abilities, usually fail to produce creative work. Therefore, it is important to continuously encourage learner's contributions through feedback, which bring about the sense of safety for risk-taking without any fear making mistakes (Frey, Fisher, & Smith, 2019).

A teacher's pedagogy is often a primary driver of how learners develop and learn; therefore, teachers who always model creativity tends to enhance support and develop the trends in their learners (Glăveanu, Ness, & de Saint Laurent, 2020). Striking for Balance of a classroom should always be considered by teachers to encourage creativity; the amount of support being provided should be informed by the learners' needs for spontaneity and imagination; however, it must be noted that not only oppressive environment that can kill the drive of creativity in a classroom, there are numerous factors involve (Sawyer, 2019).

In enhancing CTS in TE classroom, the focus should include the stimulation, rewarding curiosity, providing opportunities for choice and discovery and the teaching techniques about the strategies enhancing creative performance. Research indicates that teachers' beliefs about subject matter, learning, teaching and technology influence the way they approach to practice (Kim, Lee, Spector & De Meester, 2013).

While creative teaching is a complex and open-ended arena, incorporating effective uses of technology for teaching is also complex on its terms. Therefore; due that, it becomes rather more complex when these two intersect. Mishra, Koehler, and Henriksen (2011) argue that the best uses of educational technology must be grounded in a creative mind-set that embraces openness for the new and intellectual risk-taking; hence this is a tremendous challenge for any teacher.

## **2.7 Creativity techniques**

According to Mastria, Agnoli, Zanon, Lubart, and Corazza (2018); Amabile (2018) creative techniques are procedures that inspire originality of ideas and divergent thinking, depending on the techniques, some learners may accomplish tasks individually and some in pairs or groups. However; these methods may include word games, written exercises and any different type of improvisation.

In agreement with Nickerson's work (1999); Cremin (2018) provides an outline of the order of creative techniques for both industry and academia as follows: establishing the purpose and intentions; the building of basic skills; encouraging the acquisitions of domain-specific knowledge; stimulating and rewarding curiosity and exploration; building motivations; encouraging confidence and willingness to take risks; focusing on mastery and self-competition; promoting beliefs about creativity; providing opportunities of choice and discovery; developing self-management; teaching techniques and strategies for facilitating creative performance; and lastly provide a balance.

Guilford (1956) further suggested divergent thinking was the factor most associated with CT. Divergent thinking is a type of thinking which is often referred to as ideation, and the evaluation of those ideas through convergent thinking (Guilford, 1950; 1967). Mirroring Guilford's Williams (1969) creative production is usually categorised through the divergent nature of human thoughts and actions. The divergence is often shown by abilities to generate various, complex ideas. Moreover, for creative production and attributes associated with creative problem-solving abilities, there are eight elements of commonality. These are outlined in the Table below:

**Table 2.1: Williams's eight elements of commonality (taxonomy)**

<b>ELEMENTS</b>	<b>DESCRIPTIONS</b>
<b>Fluency</b>	The ability to come with numerous ideas, so that there are high chances to come up with a possible solution
<b>Flexibility</b>	The ability to generate a variety of categories, for a variety of ideas on the same problem.
<b>Elaboration</b>	The ability to add to, exaggerate or to build on an idea
<b>Originality</b>	The ability to create new, exclusive, not known, and different ideas/products
<b>Complexity</b>	The ability to conceptualise difficult, complex multifaceted ideas
<b>Risks taking</b>	The will to courageous, fearless, and taking high risks to stand apart
<b>Imagination</b>	The ability to dream, innovate, generate pictures of products
<b>Curiosity</b>	The zeal to ask questions, investigate, being able to look at things beyond, and knowing more about a subject matter

In line with William's taxonomy outlined in the above table; creative, techniques rely on both divergent and convergent thinking (Acar, & Runco, 2012). Divergent thinking is the generation and free-flow of new ideas and it calls for the considerable discipline, which is aided by the introduction of rigorous techniques of filtering and focus to identify the ideas that have truly innovative value, to converge on an appropriate solution (Vogel, 2014). Guilford (1957) found the divergent production characterised by fluency, flexibility, originality, and elaboration is important to creativity.

Kim (2006); Runco and Acar (2012) are in support of the idea that CT and divergent thinking are related by indicating divergent thinking ability is a meaningful predictor of future creativity. Divergent thinking is defined as the processes to generate new and novel ideas (Lewis, & Lovatt, 2013). According to Amabile (2018) both divergent thinking, convergent thinking is an accurate description of creativity, and play a significant role in creativity. Divergent and convergent thinking are complementary stages of a procedure because of divergence assists in pushing towards various alternatives and possible solutions before convergence on a more appropriate solution (Studer, Daly, McKilligan, & Seifert, 2018).

Traditional approaches or standards-based teaching have often squeezed creativity out of the curriculum or areas of policy and assessment (Henriksen, Mishra, & Fisser, 2016b). This could be because, it is said that creative teaching alone is a complex and open-ended arena, yet the integrating and effective uses of technology for teaching is also complex on its terms (Mishra, Koehler & Henriksen, 2011). Briefly, what it means is that teaching and learning become more complex when these two intersect, as they must in 21st-century classrooms. However, the best uses of educational technology must be grounded in a creative mind-set that embraces openness for the new and intellectual risk-taking (Mishra, Koehler & Henriksen, 2011).



## **2.8 Creative Learning Environment**

Creative learning environment (CLE) is an environment that is supportive and rewarding of creative ideas, having all the internal resources needed to think creatively is not sufficient, but some environmental support is crucial, for instance; a forum for proposing ideas, so that the creativity that a person has within can be un-leashed (Sternberg, 2006:89; Hong, Lin, Chen, & Chen, 2019).

Creativity always learns upon the surroundings of the environment and the beliefs and ideologies held by the people within it (Wei, 2011). An environment that is good for both teaching and learning is an important aspect concerning the enhancement of CTS. Creative Learning Environment should be an environment that is supportive and rewarding of creative ideas (Sternberg, 2006:89; Singh, Yeh, Singh, & Agarwal, 2015).

Moreover; availability of all necessary internal resources needed to think creatively alone without some environmental support might hinder the thinking capability of a person to display some creativity (Apiola, 2013). A positive and supportive attitude toward creativity enhances the development of CTS. Again, a positive atmosphere alone is not enough to support the growth of a creative person. Creative learners need support and encouragement from their parents and teachers. The environment should be inspiring and accent freedom (Davies, Jindal-Snape, Collier, Digby, Hay & Howe, 2013).

Fostering creative learning would be to alter the design of learning environments in the content areas, to ensure that knowledge acquired by learners better prepares them to engage creatively with that knowledge. For instance, a mathematics classroom should be designed such that learners prepared to think creatively within the context of mathematics, instead of demonstrating mastery of existing content of mathematics, if it is a Science classroom it should be designed such that learners are better prepared to identify research questions, to propose a wide variety of possible hypotheses, or be able to design experiments that would be appropriate to a specific question(s) (Sawyer, 2012:7; Sawyer, 2015; Richardson, & Mishra, 2018).

In an environment where creativity is highly promoted, successful schools when inducing creative learning seeks to address the following:

- Valuing and celebrating learners' creative and innovative contributions
- Do not overcrowd the curriculum, their main focus is on the depth and broader view, time is managed effectively, providing opportunities for learners to explore, concentrate for extended periods, reflect, discuss and review. Moreover, learners are expected to reflect deeply on the material that they are learning and to make connections between subjects and topics
- Promoting and broadening curriculum balanced curriculum, to widen the learners' experience in a range of subjects and activities
- Developing codes of behaviour and classroom procedures that value and encourage creativity
- Encouraging considerable risk-taking

An environment that fosters creativity and is likely to produce positive results in an educational setting that should realise the inclusion of the following components: allowing time for creative thinking; rewarding creative ideas and products; encouraging sensible risks; allowing mistakes; imaging other viewpoints; exploring the environment; questioning assumptions (Sternberg & Williams, 1996; Richardson, & Mishra, 2018).

There are two ways to design creative learning environments. The first way is to design a learning environment that would help learners to master creative relevant skills; it should be skills that would be generally applicable to all subject areas. For example, a school could add a class to their curriculum that would provide learners with creativity exercises and techniques, which they would then be encouraged to use in their other classes (Binkley, Erstad, Herman, Raizen, Ripley, Miller-Ricci, & Rumble, 2012).

According to Sawyer (2011); Sawyer, (2015), a creative learning environment is embedded in three variants, which are teaching paradox, learning paradox, and curriculum paradox. These must be negotiated by schools and by teachers who wants to foster creative learning.

- The teaching paradox: educator expertise must prevail, a broad knowledge base of planning, routines, and structures, within improvised classroom practice that responds to the unique needs of the space
- The learning paradox: In an effective creative classroom, learners are afforded with platforms, which are loose structures that are designed carefully to guide the learners as they improvise towards satisfying content knowledge, skills, and deeper conceptual understanding
- The curriculum paradox: good curricula and lesson plans are vital; to guide teachers and learners down the most effective learning trajectory toward desired learning outcomes. However, the most effective curricula are those designed to foster improvisational learning within the curricula

Failure about learning environments is that they are not completely supportive and accommodative of the use of a person's creativity. However; CTS is increasingly necessary to accomplish goals in the modern complex, interconnected world, and that education researchers and psychologists throughout the social, emotional, cognitive, and professional benefits of possessing creative abilities (Amabile & Kramer, 2011).

Soh (2017); Bereczki, and Karpati (2018) elaborate that although children are creative by nature, their creativity can be fostered and nurtured at school by offering them a CLE in which they can learn. Furthermore; there is a need to create opportunities for learners to exercise their creativity, to refine their creativity, by creating things that matter to other people to make lives better for others, to better the world, to pursue a purpose bigger than themselves.

Wallace (2012); Bereczki, & Karpati (2018) reveal that the teacher's level of creativity and ability to offer a creative learning environment with creative experiences, will either support/limit the learning environment in the classroom. Therefore; an environment in which, learners strongly support and encourage individual differences, with a variety of activities, experiences, and the pursuit of novel solutions should be strongly encouraged. In truth, creativity specific classroom designs are required as well as teacher behaviours.

Beghetto and Kaufman (2010) the emphasizes is that the significance of encouragement in nurturing creativity in a positive learning environment should encourage learners to exceed their expectations and they should be rewarded. Numerous researchers with one voice talk about the open, safe learning environment and atmosphere aimed at helping learners to enjoy school and achieve better results (Beghetto, & Kaufman, 2014). Creating a climate in the school by providing an environment that supports innovation can be very powerful (Veziroglu-Celik, 2018).

Concerning the above information, it is unequivocal that an environment is one important aspect of creative teaching and learning. The creative learning environment can bring about positive learning in enhancing creative thinking to learners. In moving forward, the next section will be detailing the role of digital technology in creative thinking teaching and learning in enhancing the creativity of learners.

## **2.9 Creativity and Digital technologies in Education**

Living in an uncertain and complex post-industrial world, which is constantly transformed by new digital technologies (DTs), it is therefore vital for teachers to mould learners' potential as creative problem solvers and engaged citizens who can re-imagine and shape their futures. Failure to embark on such a journey, the kind of learners produced will be challenged in future, being bypassed as irrelevant, and even redundant (Arvanitakis & Hornsby, 2016).

In the 21<sup>st</sup> century, the rapid pace of digital technologies has presented a challenge for classroom technology integration (Zhao, 2012; Henriksen, Mishra, & Fisser, 2016). Digital technologies are viewed as a set of tools which can be used as and when they are appropriate during a creative process. Furthermore, arguments are that the characteristics of DTs can make a classifiable contribution during the unfolding of the teaching and learning processes, providing new tools, media and environments for learning to be creative and learning through being creative (Srinivasan, 2018).

The advancement of technology has increased exponentially; changing the ways of communicating, teaching, and learning. Moreover, it also revises aspects of the creative systems in which new work emerges and diffused, that brings about possible implications and new questions for education. The questions are not necessarily fully known yet, but it is a vital and open set of emergent issues for consideration and discourse (Henriksen, et al, 2016:105).

However; creative teaching alone is a complex and open-ended arena, and incorporating effective uses of technology tools for teaching is also complex on its terms, more complexity is brought about when these two intersect, as they must in 21st-century classrooms (Henriksen, et al., 2016: 30). Furthermore; the effective integration of digital learning technologies within an already complex design task can bring about more difficulties (Laurillard, 2013).

Enhancing creativity through the use of new technologies where there is an understanding of, and opportunities for, the variety of creative processes in which learners can engage. The fundamentals are that creativity in education includes the understandings of “creativity”; the aspects of DTs which allow learners to be creative; the creative activities which are already going on and the contexts in which learners can realise their creative potential (Cremin, & Barnes, 2018; Philip, 2018). Creativity is deeply connected to issues of technology integration, so these issues of creativity and technology can be considered in tandem (Henriksen, et al., 2016:27).

Modern DTs often brings new possibilities and opportunities for people to be more creative. In a classroom setting teachers must understand there are numerous ways in which technology can be used to a lesson presentation creatively, and see how this intersects with different pedagogies. As technologies rise above and shift non-stop, a tool-based focus is akin to a moving target. Creative real-world approaches to teaching might allow us to also consider how technology helps us view and learn content in original or compelling ways, and it allows us to create content rather than summarise it and repeat it (Henriksen, et al., 2016:30).

Digital technologies can be used for supporting imaginative expression, autonomy and collaboration, fashioning and making, pursuing purpose, being original and judging value by both teachers and learners. Furthermore, it can offer opportunities to be creative in authentic contexts in ways which have not been as accessible immediate without new technologies (Sawyer, 2019).

Contemporary technologies and discoveries have been a constant factor of growth and development through human history, DTs rapidly scale up the technological growth, an incredible blooming of creativity and innovation fuelled by the capabilities of such technologies has been observed in the recent years (Henriksen, et al., 2016). To be precise from Google to Facebook, from cloud computing to YouTube channels, digitalism has changed the course of living, working, socialising and connecting (Mishra & Henriksen, 2013).

The accessibility and flexibility provided by DTs, however, put forth challenges to the teachers, the schools and all stakeholders in confronting present models of resources, timetables, curriculum and assessment requirements, which can inhibit learners' engagement with creative processes (Toby, Tricarico & Simona, 2019). There have been consistent developments in new technologies throughout human society. However; in recent years a comparative explosion of DTs has realised and playing an important role in creative thinking. The rate of change and technological growth is characterised by radically reshaping, how people work, think, and act in the real world (Mishra, Koehler & Henriksen, 2011:23).

New technologies have taken over in reshaping the creative landscape of the world, for understanding, it is important to consider a fundamental existing model for how creativity emerges and is situated within contexts, systems, and domains (Henriksen, Hoelting & the Deep-Play Research Group, 2016:102). Having developed in an increasing number of formal and informal settings in recent years, creativity is considered as a process that could be supported by the diverse digital technologies, such as robotic components (Peppler, Halverson, & Kafai, 2016). A learning-by-making that drives the maker movement, is known as a creative computing approach aiming to

pursue the learners in the construction of digital and palpable artefacts through using of technologies (Kraus, 2017).

In reflecting on the impact of technology on creativity, Zhao (2012;) indicates that it is with a doubt that technology has aided creativity and helped ideas become a reality by providing the relevant infrastructure for human innovation. For instance, movie-making or in writing, because there are devices that allow for trial and error with very minimal cost. Furthermore, digital technology has also provided the means to make creative processes much easier. Digital technologies are important because it is easier to create content/knowledge, share, and discovering is more quickly and easily (Henriksen et al., 2016:31).

The infusion of new technologies for developing and sharing content has transformed how culture, art, and knowledge emerge within fields of interest. However; there are still experts in traditional domains that may question the validity of these new creative displays, and communities of practice still have gatekeepers those who decide what is and is of worth to be included or excluded in the field and diffusion more broadly (Henriksen et al., 2016:31).

The argument is that new technology platforms allow producers to by-pass traditional gatekeeping processes, providing the opportunity to showcase creative skills and also to redefine a field's classification of what is high quality or creative work, such a rethinking of the systems believe that the view of creativity can have implications for the use of digital technologies in education (Henriksen, Hoelting & the Deep-Play Research Group, 2016:103).

Creativity also requires us to consider aspects of current models of education and how well these are suited to the ever-changing world and times. For instance, is the current standards-based education models preventing learners from unleashing creative thinking skills, turning these standards into amorphous gatekeepers that impede creative production and thought? At a broader level, all of this may suggest that learners and teachers can find ways to bypass the traditional gates and use DTs in new and

creative ways (Henriksen, et al, 2016:105a). It is therefore important to understand the CTS in teaching and learning are often highlighted as a skill essential for success in the 21st century. Yet creativity has not been given the attention it deserves to measure the course of demand (Csikszentmihalyi, & Wolfe, 2014).

Relating to the information above it is clear that DTs has a very important role to play in teaching and learning particularly in the development of CTS. It is also important to note that the education system needs to keep up with the pace of the rest of the world; hence the world is rapidly evolving through digital technology. The next section failure is unpacked concerning creativity.

## **2.10 Failure as a Key to Creativity**

Failure is an integral part of the creative processes. Particularly the failure that leads towards ultimate success; or reflections on failure where struggling with uncertainty leads to contemplation and an ability to manage ambiguity. Moreover, failure is acceptable as a mean to maximising creativity or coming to a better understanding of the creative process as a whole (Smith & Henriksen, 2016:3).

Creativity is considered as a fundamental 21st-century thinking skill. However; many people are hesitant to self-identify as “creative,” or are uncomfortable with intellectual risk-taking and open-endedness (Henriksen, Richardson, & Mehta, 2017). There are lots of fears regarding failure; however, it is not often that good original work comes together for the first time. Therefore; embracing failure is an important pedagogy for creativity in a classroom, to instil more Creative Thinking skills in learners (Smith & Henriksen, 2016).

Aversion to risk and failure has consequences for growth and learning, which can be seen (Smith & Henriksen, 2016). Such openness to failure allows these teachers to come up with new, interesting and effective approaches to teaching (Henriksen & Mishra, 2015). Robinson and Aronica (2015) indicate that for some time have closely studied the steady way of diminishing creativity, that has been occurring in recent



decades. In recent years, standardised/high-stakes testing and rigid curricula or policies have prevailed, there is less motivation built into the system for both teachers and learners to be more creative or to promote creativity (Bray & Tangney, 2017).

According to Torrance (1972); Bakkenes, Vermunt, and Wubbels (2010), teaching learners to be creative is a task teachers do not like to take because most teachers only heed to approaches for teaching for the best learning results rather than teaching for the discovery of new knowledge and creative ideas. Hence; it is important to prepare teachers to recognize the process of enhancing creativity to promote creative thinking in their learners.

If Maths, Science and Technology continue to be taught in a way that doesn't foster creative thinking and problem solving, then no amount of creativity training education can assist. Rather; it will be necessary to transform the ways that each subject area is taught, to ensure that the knowledge acquired by learners' fosters CP and behaviour all round (Sawyer, 2015).

According to Beghetto, and Kaufman (2010); Beghetto, Kaufman, and Baer, (2014) evaluation, competition, restricted choices, conformity pressure, frequent failure and rote learning can destroy creativity in school. In a study that included interviews with National Teacher of the Year award finalists, it was revealed that a wide range of examples and cases where innovative and accomplished classroom, the teachers discussed the vitality of exploring new things, taking risks, and embracing failure, as a key to their creativity in the classroom (Henriksen, 2011).

In light of the above, it is clear that failure is a key component in teaching and learning creative thinking skills. Fear to failure can impede creativity, so in harnessing creativity it is important for teachers to encourage learners to embrace failure and build on it. The next section design process is detailed; clearly explain its role in teaching and learning TE particularly creative teaching.

## 2.11 Design Process in Technology Education

The nature and philosophy of TE suggest that innovative products are designed and constructed to find new solutions to problems through the implementation of a technological process known as the “design process”. A technology DP provides the learner with ways and means of solving problems, through which understandings are developed (Warr, Mishra, & Scragg, 2020).

The DP in TE refers to as a process of devising something through, interactive and open-ended process of producing and developing components, systems, and processes. Moreover; it is experiential components that are characterised by problem-solving (Boud, Ajjawi, Dawson, & Tai, 2018). The DP in TE is a disciplined process of using knowledge, skills and resources to meet human needs and wants by designing, making and evaluating products and processes (McLain, Irving-Bell, Wooff, & Morrison-Love, 2019). The DP is a process followed to construct an artefact at the same time taking into cognisance the scientific information and application of technical skills (Beyers, 2010;).

The DP is a method of teaching and learning of TE and it is often referred to as the technological processes (Mapotse, 2012:63). The technological Processes are creative human activities of developing technological solutions to satisfy human needs and wants, e.g. manufacturing, design, repair, restoration (DBE CAPS, 2011). The design process is the on-going endless procedure used to develop a product creatively (Cheng, 2019).

The DP is a process which comprises of Investigating, Designing, Making, Evaluating and Communicating (IDMEC) forms the backbone of TE as subject and at all-times must be considered to correctly structure the delivery of all the learning aims of TE in a classroom (DBE, 2011:12). In line with the DP, learners should be exposed to problems, needs or opportunities as an initial stage. Furthermore, be engaged in a systematic process that allows them to develop solutions are aimed at solving problems, rectifying design issues and satisfying needs, (CAPS, 2011).

The DP is a cognitive procedure that engages on a high level of thinking during the construction of an artefact. Moreover; DP is a process seeking to allow future technology developments in analysing and looking for possibilities at the same time solving socio-technological problems (Stanton, Salmon, Walker & Jenkins, 2017).

In the real world; DP is a significant process in the development of Technology across various disciplines ranging from engineering to architecture, and from an educational point of view, it is an ideal methodology to use as a vehicle to achieve the desired level of competencies. However; not all practitioners are confident in their ability to design for and implement creative learning outcomes (Haik, Sivaloganathan, & Shahin, 2018).

After having reviewed various sources seeking information on what DP is all about, it is without a shadow of the doubt that the DP in TE is a vital aspect of teaching and learning TE in schools. A clear consideration of DP as stipulated in the CAPS document provides learners with the platform to strongly present all information of an artefact, to modify if necessary before the manufacturing of the final product.

The DP provides learners with an opportunity to make judgments as to whether to continue with manufacturing or not. In the process of applying DTs, the CTS are being developed. The set of skills to be required, the CAPS document indicates that every learner should be provided with a Mini Practical Assessment Task (min-PAT) as a form of assessment (DBE, 2011:13). The Table below represents IDMEC as outlined in the CAPS document:

<b>Table 2.2 CAPS (2011:74) IDMEC-Design Process</b>	
<b>The process</b>	<b>Activities</b>
<b>Investigate</b>	Search for relevant information Carry out proper investigation Apprehend concepts and gain insight Coming up with new techniques
<b>Design</b>	Design brief Discuss possible solution Draw ideas Graphics 2/3D Decide on the best solution and justify the choice
<b>Make</b>	Use of tools and equipment's Building, testing and modifying of the product Safety and health environment
<b>Evaluate</b>	Evaluating actions, decisions, and results Evaluating solutions and steps followed Proposing improvements Evaluating constraints
<b>Communicate</b>	Presentation Record of the process Advertise

In the table above “**investigation**” is indicated as the first stage of the DP, what it entails exactly is that learners must first search for information, conduct informed

research, apprehend, gain knowledge about the topic at hand to come up with new numerous ways to solve the problem. According to DBE (2011) for every activity given to learners, the teacher needs to provide learners with a scenario describing the context whereby the technological problem solving resolve a need. The investigation can occur at any time during the design process, it should not be taken as the stage that is to be completed before the DP (DBE, 2011:12).

The second stage of the DP on the table is “**design**”, this is a stage whereby learners after being provided with a scenario they are required to write a design brief that indicated what they intend to do to deal precisely with the problem at hand. It is a stage where learners are expected to think with a pencil, generate numerous ideas that could be solutions to the technological problem on paper, draw rough sketches were it is required. No product has ever been produced or manufactured that did not undergo development without the design stage (DBE, 2011:11).

The third stage on the DP indicated in the table is “**make**”, it is a stage in the design process where learners are expected to engage with tools/equipment to build the model/artefact and taking into consideration precautions measures as some of the tools, the equipment can of danger if they are not well handled. The teachers are expected to encourage learners at this stage to continue reflecting on their progress and modify their solutions based on the problems encountered. This enables the learners to increase in accuracy and skills, better organisation and safer working practices (DBE, 2011:12).

The fourth stage on the design process in the table is “**evaluate**”, at this stage learners are expected to evaluate what they have done concerning actions taken, decisions made and the results obtained through the DP. It is the stage where both existing and design products are evaluated against predetermined criteria.

The fifth and last stage of the DP in the Table are “**communicate**” this stage is an integral of the whole DP. At this stage learners should be in a position to provide evidence of all the stages in the DP, recording and presentation progress in form of

writing and graphic forms from start to finish, hence they will be expected to provide a portfolio when submitting the artefact (DBE, 2011:12).

An examination of design and technology done in the United Kingdom schools, finding is that the subject provides the learners with opportunities to create what does not exist, helping them improve on their higher-order CTS (Surahman, Wedi, Soepriyanto, & Setyosari, 2018). Moreover; the generation of learning design is a creative act on itself, as is the adaptation and implementation of learning design (Koh, Chai, Wong, & Hong, 2015).

It is revealed that for the DP and Technology curriculum in the United Kingdom, there are steps in a prescribed linear problem-solving approach that are used as units of assessment to which learners were held accountable, and these steps tend to repress the creativity of the learners. (Richards, 2013:13). Teachers are afforded theoretical in-service training rather than hand-on training, as a result, the majority of teachers have little or no understanding of the technological process (Tallvid, 2016).

Niiranen, (2019) indicates technology Education as a mean, is aimed at developing learners' creative potential, through design and inventive activities. The subject provides a variety of avenues by which learners can employ cognitive resources not ordinarily taxed by the academic curriculum. Teachers need to decide how much to rely on models that spell out stages in design. (Lewis 2009: 265; Sanchez-Martin, Alvarez-Gragera, Davila-Acedo, & Mellado, 2017). The next stage presents the conclusion of the study, what has been found and what are the gaps.

## **2.12 Conceptual Framework**

The purpose of this study is to explore how teachers enhance CTS in Grade 9 technology classrooms in supporting learners to solve technological problems concerning the design process. The conceptual framework of this study is strongly influenced by the work of Guilford (1956) indicating that Fluency, Flexibility, Originality, Elaboration are used for supporting creativity within education and contains the

essential abilities for persons to gather information. In consideration of these four stages of the creative process better known as FFOE model about the IDMEC design process as stipulated in the CAPS document (DBE, 2011:68).

In the early 20th century creativity was thought as a talent that individuals were born with; moreover, creativity was most closely related to arts but over time it grew in other subjects as Science, Technology and other disciplines (Sternberg, 2018a; Runco, & Pritzker, 2020). In the 21st-century creativity is increasingly perceived as a distributed and collaborative process of communal sense-making and problem-solving, as a result, understanding of innovation and creativity has progressed and broadened over time (Woodgate, 2018).

Williams, Runco and Berlow (2016) indicate that the survey of themes and the impact of creativity research over the past twenty-five years suggests a broad trend from descriptive to more recently applied predictive research themes that characterise a maturing and more refined creativity research paradigm. Prevailing concepts of creativity detail the connections between the individual, the environment, self and others, the creator and culture, and also emphasising the role of the sociocultural context within distributed notions of creativity.

**Table: 2.3** Robert Sternberg and Wendy Williams (three levels of thinking) to create diverse activities aimed at assisting learners to explore aspects of creativity.

<b>Analytical Thinking</b>	<b>Synthetic(Creative) Thinking</b>	<b>Practical Thinking</b>
<b>Analyse</b>	Create	Apply
<b>Critic</b>	Invent	Use
<b>Judge</b>	Discover	Put into practise
<b>Compare</b>	Imagine if ....	Implement
<b>Evaluate</b>	Suppose that...	Employ
<b>Assess</b>	Predict	Render practise

Sternberg and Williams (1996); Melard and Stassart (2014) argue that creative activity consists of the application and melding of three types of thinking, all of which they assert that it can be learned or enhanced. Hence they define creative work/activity as a balance between three abilities/skills that can be learned and practised as indicated in Table 2.1 above.

Analytical thinking skill - it is the type of thinking skill that allows one to think convergent and it requires critical thinking and appraisal as one analysis and evaluation of thoughts, ideas, and possible solutions. This type of thinking is vital in the domain of creative work/ activity, simply because not every idea is a good one, some ideas may need to scrutinise. In creativity, this type of thinking is used in considering implications and project possible responses, problems, and outcomes.



Synthetic (creative) thinking skill - it is a type of thinking that involves divergent thinking as it is the ability to think of or generate new, novel, and interesting new ideas. At the same time, it spontaneously makes connections between ideas or grouping of things

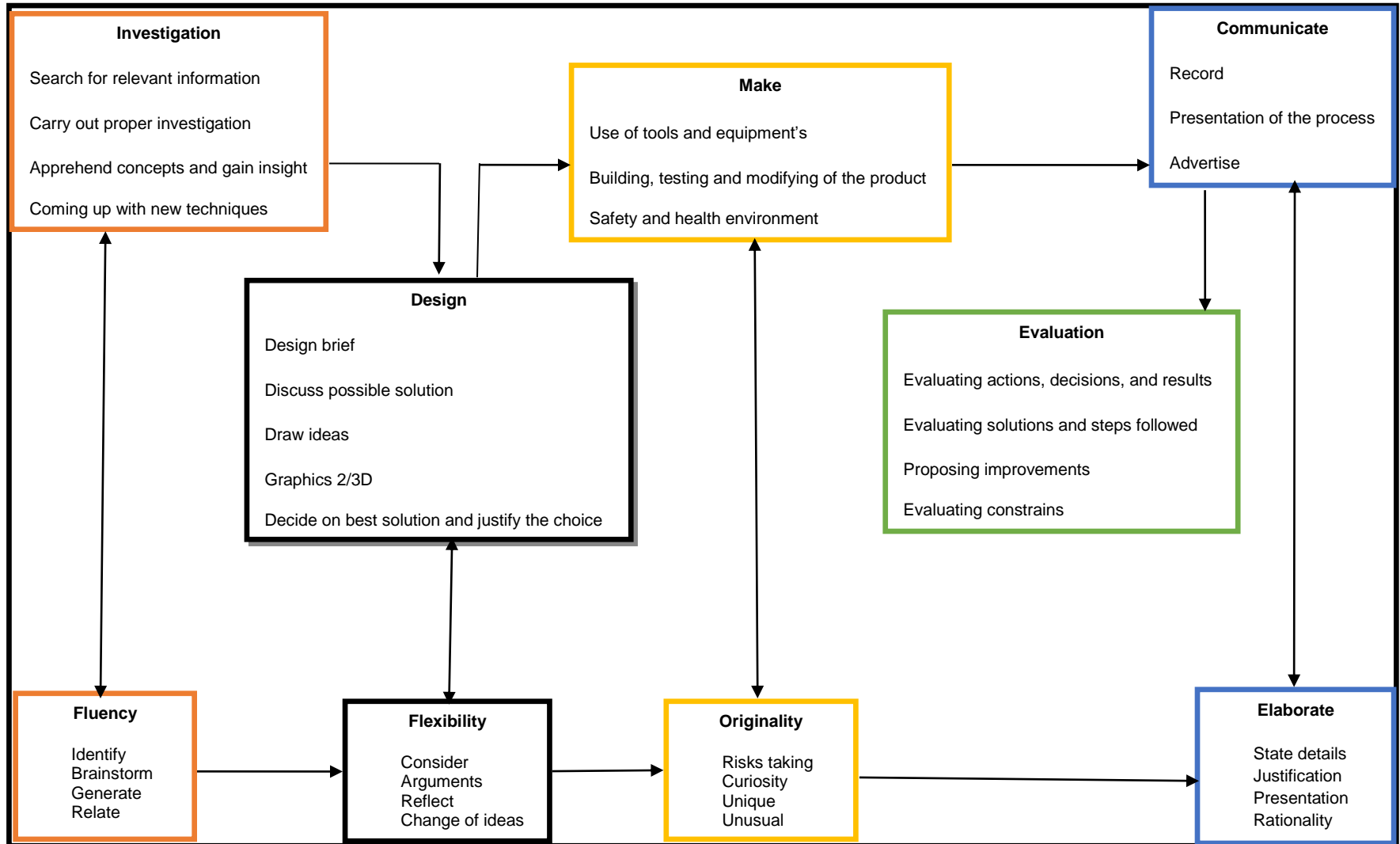
Practical ability- in the world there are many people with good ideas, as well as ones who can pick ideas apart. But failure to employ practical thinking skill can be detrimental to a creative activity; because this is where one can translate abstractions and theories into realistic applications. This is the skill used to sell/communicate one's ideas to others so that they believe that the ideas, can work/products are valuable, unique and important, innovative, worthy of consideration. This type of thinking is considered to be creative because it allows one to find a potential audience for one's creative work.

Creative learning will require a change away from the instruction model that is dominant in schools today. Such a change faces immense institutional, administrative, and political challenges, but designing creative learning environments is inherently challenging, both theoretically and conceptually, and would be a challenge even if the institutional, administrative, and political climate were completely supportive. This is because creative learning necessarily involves emergence; the theoretical and conceptual challenges of creative learning are, ultimately, challenges that must be understood using a theoretical framework based on emergence (Sawyer 2012:10).

No product has ever been manufactured nor produced without following a process of design, the design process is the cornerstone of in teaching and learning technology based on the South African Curriculum (DBE, 2011:12). Moreover; DP uses various fields such as engineering, architect, industrial designing, etc., when developing original new ideas in trying to meet the needs, wants and to solve problems in the society (DBE, 2011:68).

In light of the above the DP was robbed into part of the conceptual framework of the study, hence figure 2.1 below is showing the relationship, therefore.

**Figure 2.1. The Four steps of creative process (FFOE model) VS the Design process (IDMEC)**



The figure above represents the conceptual framework of the study, which is supported by Guilford (1956) concerning the DP (IDMEC) as it stipulated in the Technology CAPS document (BDE, 2011:74). These characteristics/elements of creative production they strongly prevail as learners are being taught through the guidelines of the design process. In the next section of the study, a conclusion is drawn in light of the information taken from previous research about the development of CTS.

### **2.13 Summary of the Chapter**

In totality, this study provides an empirical ground to determine how curriculum and instruction integrate with the environment, design process, digital technologies for CT about teaching and learning technology as it is desired in the 21st-century classrooms. Moreover; the nature of creativity in education can have a vivid understanding that creativity can be taught within the knowledge and skills of the subject domain.

Furthermore; the role of DTs was detailed as to how it relates to teaching and learning TE, particularly the CTS. It is without a shadow of the doubt that DTs have changed the cause of teaching and learning for the better. Moreover, DTs has a crucial role to play in TE particularly in the teaching of essential skills such as CT.

The next chapter presents the methodology of the study. All steps on how the study was conducted are detailed.

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## CHAPTER THREE: METHODOLOGY

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### 3.2 Overview of the Chapter

This chapter provides an outline of the research methods that were followed in the study. It provides information on the participants, that is, the criteria for inclusion in the study, who the participants were and how they were sampled. The researcher describes the research design and the research paradigm that was chosen for this study and the reasons for this choice. The instrument that was used for data collection is also described and the procedures that were followed to carry out this study are included. The researcher also discusses the methods used to analyse the data as well as the quality criteria. Lastly, the ethical issues that were followed in the process are also discussed.

### 3.3 Research Approach

Qualitative and quantitative methods are the two main types of research design. In this study qualitative approach was selected guided by the topic that was being investigated and how it is to be measured. Qualitative research is referred to by its objectives of accepting some facet of a social lifestyle; and its tools, which produce words in the findings rather than statistics as data for investigation (Ravitch, & Carl, 2019).

The qualitative approach always provides descriptions on people's experiences, feelings and explanations about their behaviours, beliefs and opinions. The qualitative approach can expose information that cannot easily be accessed through other different approaches for instance use of questionnaires in quantitative approach. People tend to interpret the meanings of their actions every day considering their feelings and use narrations (Yanow, & Schwartz-Shea, 2011; Tashakkori, Johnson & Teddlie, 2020).

Bhattacharjee (2012); Cohen, Manion, and Morrison (2013) define qualitative research approach as an instrument in research that supports a researcher to focus on the behaviour of their participants, through the use of small-sized samples. Qualitative research was chosen for this study. The researcher explored the teaching and learning of Creative Thinking Skills in the Grade 9 Technology Classrooms through qualitative research, furthermore, the researcher was able to understand the preparations and measures that teachers do to manage their classrooms and to foster CTS in technology.

Park (2012) reveals that qualitative methods effectively identify other societal factors such as social norms, socioeconomic status, gender roles, ethnicity and religion. Hence the aim of the study is closing gaps in research that have been studied, and to completely comprehend the intention and context of human behaviour, qualitative research is significant as it offers the researcher in-depth information.

In this study; the researcher used a qualitative approach to obtain a more comprehensive understanding of the planning process of teachers regarding the fostering of CTS into their teaching. The qualitative approach was also selected as it aided in the development of a depth of meaning where the participants and their understandings formed the focal point of the research explain qualitative research as an approach that aims for depth rather than understanding (Merriam & Grenier 2019; Tracy, 2019).

### **3.4 Research Paradigm**

Bogna, Raineri and Dell (2020) reveal that constructivism focuses on exploring the complexity of social phenomena with an aim to gaining understanding. The purpose of research in constructivism is understanding and interpreting everyday occurrences, experiences and social structures. Moreover; the values people attach to these phenomena (Kivunja & Kuyini, 2017).

Cuthbertson, Robb and Blair (2020) allude that constructivists believe that social reality is subjective and nuanced, shaping the perceptions of the participants, as well as the values and aims of the researcher. A research paradigm consists of four elements, which are; epistemology, ontology, methodology and axiology. The understanding of these elements is important because they comprise the assumptions, beliefs, norms and values that each paradigm holds (Lincoln & Guba, 1985; Vogl, Schmidt & Zartler, 2019).

Defining the qualitative research by the philosophical nature of the inquiry, based on the ontologies, epistemologies, and methodologies adopted by the researchers during designing of research projects, and the relating to assumptions made when collecting, analysing and interpreting data (Yilmaz, 2013).

#### **3.4.1 Ontology**

Ontology is a branch of philosophy that deals with the notions that are made to believe that something makes sense or is real, or the very nature or essence of the social phenomenon that is investigating (Kivunja & Kuyini, 2017). Ontology is a vital paradigm that helps to furnish an understanding of everything that constitutes the world, as it is known (Pernecky, 2016). Furthermore; ontology is essentially part of the process of constituting a life-world (Ginev, 2016).

#### **3.4.2 Epistemology**

Gholami and Husu (2010); Kivunja and Kuyini (2017) define epistemology as the study of the nature of knowledge and justification. Furthermore; epistemology is important in establishing how to go about uncovering knowledge in the social context that is investigated. Moreover; epistemology is the research of philosophy concerned with how individuals determine what is true, it is the relationship of researchers to reality and the road that they will follow in the search for uncovering the truth Biesta (2010); Silverman (2019) states that research done in the epistemological dimension is regarded as the pursuit of valid knowledge or the truth.

There is always a close relationship existing between epistemology and ontology. In epistemology, the researcher employs the open structured qualitative interview to investigate the lived experiences of these CIs as well as the grade 9 technology teachers. Furthermore, it was also informed by the assumption that what people experience, they experience in their different terms.

### **3.5 Methodology**

Dawson (2019) defines methodology as ways of obtaining, organising and analysing of data. Methodology decisions depend on the nature of the research question. In this study, methodology refers to how the research was done and its logical sequence. The main focus of this study was the Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom, through CI, teachers and learners of technology, hence the research approach was qualitative.

Abdalla, Oliveira, Azevedo and Gonzalez (2018) indicate that methodology includes the design, setting, sample, methodological limitations, and the data collection and analysis techniques in a study. Methodology refers to a coherent group of methods that complement each other and that can fit to deliver data and findings that will reflect the research question and fulfil the researcher purpose (Tracy, 2019).

According to Tracy (2019) methodology means a framework of theories and principles on which methods and procedures are based. Methodology in a qualitative study is dialectic and interpretive. During the interaction between the researcher and the research participants, the participants' world is discovered and interpreted employing qualitative method (Thorne, 2016).

The qualitative approach enquiry is adopted in the study. In qualitative research, different claims of knowledge, enquiry methods, methods of data collection and analysis are used (Creswell & Creswell, 2017). In this study, the qualitative research approach will provide a platform to explore and discover issues regarding the problem in question.

### **3.6 Research Design**

According to Creswell (2014); Dawson (2019) research design is described as a process used to answer the questions that are being investigated or studied. Furthermore; research design is aimed at assists the researcher to manage several of the obstacles faced during the research process, hence it is formed to meet the required standards of a particular study. Moreover; research method designs and approaches are vital aspects that continuously signify an outlook on research. Both researchers have detailed that the combination of research methods is also dependent on the research problem, the researcher's personal experiences, and the participants of the study being conducted.

Research design is created as a strategic framework that functions as a bridge between the research questions and the implementation of the study. Furthermore; research designs are viewed as tactics that help the researcher to take charge of preparing the requirements for the collection and study of data. However, selecting a research method must result in yielding the most dependable responses to the research question posed (Dawson, 2019).

Therefore, qualitative research methods are used to gather a general idea from the subjects, the goal is to explore, interpret and. The qualitative research methods use descriptive procedures to generate meaning and understanding of the phenomenon being studied. Furthermore; qualitative research is mainly inductive, with the inquirer generating meaning from the data collected in the field (Creswell, 2014).

This study will use the exploratory research design. This is a kind of design that always makes sure that data is valued, collected without any compromise, and it is always different it cannot be duplicated. The collection of data in this study was through interviews, observations, and document analysis. In this study, CI and technology teachers were interviewed since they are the agents of change and transformation regarding the implementation of policies and the delivery of curriculum to the learners in a classroom. Furthermore; only the Grade 9 Technology class were observed, the



observation will provide an insight as to what transpires in class during the process of teaching and learning.

### 3.7 Study setting

The setting for the study was as follows:

The CI were from Ehlanzeni District Municipality in Mpumalanga Province. This district is formed of four (04) local municipalities, namely, Bushbuckridge Local Municipality, City of Mbombela Local Municipality, Thaba Chweu Local Municipality and Nkomazi Local Municipality. For convenience reasons (for instance, the cost of travelling) the teachers and classrooms involved in the study were from schools around the Nkomazi Local Municipality (See Figure 3.1 below).

The municipality is located in the eastern part of the Ehlanzeni District Municipality of the Mpumalanga Province and is strategically placed between Swaziland (North of Swaziland) and Mozambique (east of Mozambique). It is linked with Swaziland by two provincial roads and with Mozambique by a railway line and the main national road (N4), which forms the Maputo Corridor.

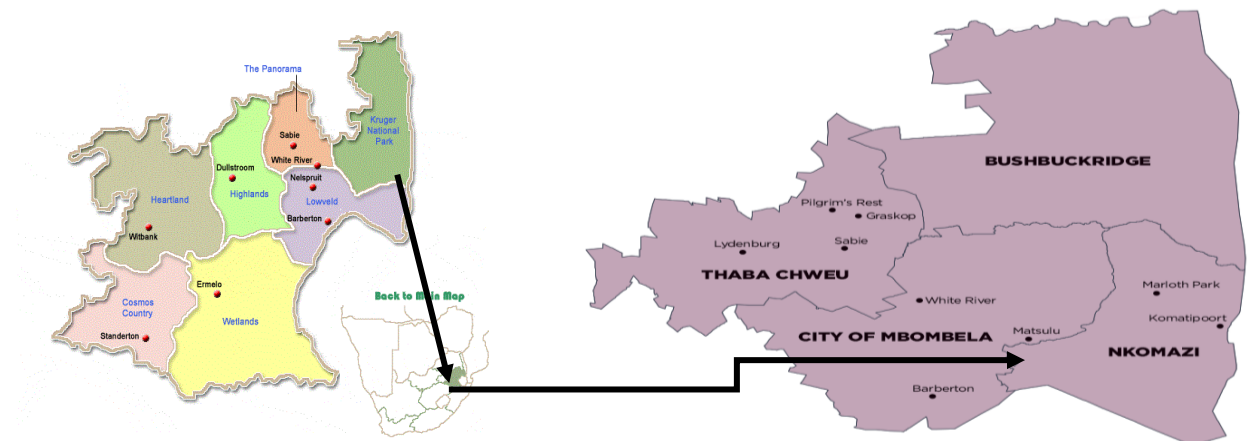


Figure 3.1: Map of Ehlanzeni District Municipality

Source: ©municipalities.co.za

### **3.8 Population and Sampling**

The population is viewed as a large group of individuals which can be sampled for an investigation to generalised findings (McMillan & Schumacher; 2010; Baydas, Kucuk, Yilmaz, Aydemir, & Goktas, 2015). Therefore, purposive sampling was employed in this study. According to Neuman (2013), purposive sampling provides proper guidelines for the selection of appropriate participants for the study. Moreover; the purpose of qualitative research is to provide a rich, contextualised description of study being investigated. It involves all participants with particular specified characteristics.

Sample size depends upon factors such as the scope of the research question(s), meaning if the research study is of a broader scope, a larger sample size may be required; the nature of the topic, if the scope is clearly defined a small sample size may be required. Lastly, the quality of the data will mean a richer the data, therefore a smaller sample size required (Campelo, & Takahashi, 2019). The Sampling process entails more than just the number of participants involved in the study; sampling is a process that incorporates the number of participants, the number of contacts per participant, and the duration of each contact. Moreover; it is also a point where the researcher determines how many contacts are required to reach saturation (Oppong, 2013).

Saturation is more concerned with reaching the point where further data collection becomes 'counter-productive', and where the 'new' does not necessarily add anything to the subject that is being investigated. Furthermore; saturation is prevalent in qualitative research enquiries and as previously noted, it is commonly considered as the 'gold standard' for determining sample size in qualitative research (Saunders, Sim, Kingstone, Baker, Waterfield, Bartlam, & Jinks, 2018).

Therefore, the study seeks to obtain quality data through saturation. Hence the number of participants is limited to two (2) Technology CIs. This is also influenced by the fact that there were only two CIs for teacher support and development in the district of

Ehlanzeni for technology education. Furthermore; to obtain quality and valid data, only four (4) technology teachers in grade 9 were interviewed and observed. The four (4) teachers interviewed/observed were from four different schools offering technology formed part of the participants. Let it be noted that the CI was interviewed in isolation, whilst the teachers were also interviewed in isolation and observed during a TE class session with learners present. The sampling of a limited number of participants also fuelled by the time factor and financial constraints. This was done particularly, to fulfil the purpose of the study. The four teachers from different schools included in the sample were conveniently selected following recommendations by the two CI based on their knowledge of the schools' performance in Grade 9 TE within the municipality. In other words, the CI acted as informants for the sampling of classrooms and by implication TE teachers. Hence; from the area where the study was conducted, two best performing schools in TE were selected for inclusion in the study, the other two will be those considered to be poorly performing or average.

In purposive sampling, the researcher selects participants with certain characteristics that are representative and informative about the topic being investigated (McMillan & Schumacher, 2010). According to Creswell (2014) this method, participants are chosen because of their knowledge and relationships regarding a research subject. The size of the sample is depended on what the researcher investigates and the aim of the research. Furthermore; in qualitative research, the size of the sample is not prescribed to follow a specific set of rules (Merriam, & Grenier, 2019).

In South Africa, a body such as South African Qualifications Authority (SAQA) is responsible for the development of the content of the level descriptors for each level of the National Qualifications Framework (NQF) in conjunction with The Council on Higher Education (CHE), Umalusi and the Council for Trades and Occupations (CTO) (SAQA, 2012:3). Participants were identified and selected as they were having a relevant qualification(s), in this case, a minimum of NQF level 5 was required with at least two (2) of experience, knowledgeable about the subject, and they were currently teaching technology in grade 9. Furthermore, SAQA has outlined ten (10) categories are used in

the level descriptors to describe applied competencies across each of the ten levels of the NQF (SAQA, 2012:3).

The NQF level 5 set as minimum qualifications for all the participants, both the CIs and teachers from level descriptor five (5) to ten (10) (Ethics and professional practice, Accessing, processing & managing information, Producing & communicating of information, Context and systems, Management of learning and Accountability) this will fulfil the objectives that the study seeks to achieve. The qualifications, experience, and knowledge concerning the subject were also considered to eliminate some contextual factors that may compromise the findings in of the study. Participants must be willing to engage and communicate their practices and views meaningfully and reflectively (Etikan, Musa, & Alkassim, 2016). The sample has been selected with a specific purpose, therefore participants are possibly more knowledgeable and informative about the teaching and learning of CTS in TE.

In light of the above, the researcher purposively selected, two (2) Technology CI and four (4) grade 9 Technology teachers from four (4) different schools around Nkomazi Municipality, at the Ehlanzeni district, in the Mpumalanga province of South Africa. In this study selected participants have the relevant qualification(s) and experience in the implementation of technology in the classroom. Within this context, the participants have been selected from the four (4) schools which are offering grade 9 technology classes. The two CI are current Technology subject advisors in the district of Ehlanzeni and the four teachers are currently teaching grade 9 technology classes in their respective schools.

### **3.9 Research instruments and data Collection**

Data collection refers to the in-depth explanation of data gathering methods for the planned investigation (Cohen, Manion, & Morrison, 2011). The collection of data started when the researcher decided where and how data would be collected. Since the study is a qualitative investigation, different measuring instruments (data collection procedures) were employed to yield credible findings from the data to be collected. This is known as triangulation according to (Carter, Bryant-Lukosius, DiCenso, Blythe & Neville, 2014).

The researcher viewed participants as a source of data and used various data collection instruments. The measuring instruments employed included interviews of curriculum implementers and teachers, observations of Grade 9 TE classrooms and document analysis for the review of documents, known as triangulation. The triangulation provided a broader understanding of the subject at hand, the researcher, use these three types of data collection procedures provided enough information from different angles to make clearly defined conclusions (Merriam & Grenier, 2019).

Therefore, to ensure effective interviews, sets of semi-structured questions were formulated and used as guidance to interview the CI and teachers, see **annexures D and E** respectively. Besides, an observational schedule was developed to provide efficiency and effectiveness when taking notes during the observation of the TE classroom sessions, **see annexure G**. Observational methods are known to have an advantage of directly evaluating learners' involvement and engagement in the learning environment. Moreover; they provide a platform in which one can explore how the learners learn, interpret, and make sense of the subject, and what they do in the case where they lack understanding of the material.

To conduct the document analysis, a checklist was used by the researcher, guided by the Grade 9 Technology Curriculum and Assessment Policy Statement Senior Phase, **see annexure F**

### **3.9.1 Interviews**

The interview is a method of collecting data through oral questioning employing using semi-structured questions (Roulston, & Choi, 2018). It is described as a conversation between two or more people where the researcher asks the interviewee questions to learn about the interviewee's views, interpretations and conducts of what is investigated (Maree, 2015). The main advantage of using interviews to collect data is that it allows direct interaction with interviewees and leads to detail and valuable feedback. The interview method can be unstructured, structured and semi-structured with participants or focus-group, depending on the need and design (Tracy, 2019). For this research study, the researcher used semi-structured interviews as discussed in the next paragraph.

Semi-structured interview the researcher used this method because it has characteristics of both structured and unstructured interviews, hence closed and open-ended questions were used. The interviewer had semi-structured questions as a guide so that the same questions were asked with each participant see annexure E and F. This method was used to collect data that the researcher could not obtain during lesson observations. The maintenance of a warm relationship between the researcher and participants is highly recommended as the interview is an interaction between two or more people (Marshall, & Rossman, 2014).

The researcher has interacted with two (2) Technology CI and Four (4) Grade 9 Technology teachers The CI had their own set of questions see annexure E and teachers had their own set of questions see annexure F. The teachers were chosen based on the fact that they are teaching grade 9 technology classes and the CI were chosen based on the fact that they are the subject advisors of technology teachers, and also

All interviews with both the teachers and CI were done face to face and the interview sessions with each interviewee ranged for 20 minutes to 30 minutes. The semi-structured interview method was used to calm the participants' emotions as they were

not attacked with questions early during the interview. The respondents were able to divulge appropriate information without fear and had the allowance to elaborate further the fundamental meaning of their answers in detail (Dawson, 2019).

The following preparation was made before the interview:

- Made an appointment with the teachers/CI
- Asked to meet in a space that will allow conducive for conversation
- Structured chairs to allow for face-to-face interview
- Informed the participants about the consent letter
- Clarified to the participants that the interview would be semi-structured and follow up questions would be determined by the responses provided
- Asked permission to record the interview if possible
- Positioned a cell phone for audio-recording in case he/she agrees

Placed questions ready so that the interview could start (see Annexure D and E for semi-structured interview questions). Before the interview began, the researcher, thanked the teacher-participant for accepting to take part in the research.

### **3.9.2 Observation**

Observation is a systematic process of taking notes and recording occurrences, the behaviour of participants without asking questions nor communicating with them (Renz, Carrington, & Badger, 2018). The researcher as an observer has collected data using observational methods on how participants interact during the process of teaching and learning. The advantage of observation method is that the researcher can evaluate participants' natural setting indirectly. However; the participants may change their conduct once they realise that they are being observed. The collected data was comprehensive enough to enable the researcher to produce the analysis that was performed.

In addition, an observational schedule was developed and used to collect data see **annexure G**, the observation schedule provided efficiency and effectiveness way of taking notes during the observation of the TE classroom sessions. In this study, the researcher observed four lessons (one in each school). McKenney and Reeves (2018) agree that observation leads to the bottom of the investigation and understanding as it provides knowledge of the occurrences in natural settings.

Observational methods are known to have an advantage of directly evaluating learners' involvement and engagement in the learning environment. The observations provided the researcher with a platform to explore how the learners learn, interpret, and make sense of the subject, and what they do in the case where they lack understanding of the material. In a nutshell, the researcher can see things that the participants are not aware cannot see.

### **3.9.3 Documents analysis**

Technology teachers are expected to have a file for the subject, and the file is expected to contain several documents that are very crucial for teaching and learning processes. The documents in the file are outlined in **annexure F**

Document analysis is part of the larger domain of documentary research methods (Wagner, Kawulich & Garner, 2012:140). To conduct the document analysis, a checklist was used by the researcher see annexure G, guided by the Grade 9 Technology Curriculum and Assessment Policy Statement Senior Phase. A thorough content analysis of all documents contained in the teachers' file using the CAPS document as the guideline. The content analysis entails an inductive and interactive process that is used to identify similarities and variances in the text that substantiate, disprove, a proposed theory (Ridder, Hoon, & McCandless Baluch, 2014).

The understanding is that all the documents in the file should be in line with the CAPS documents. Content analysis, therefore, assisted the researcher to peruse the data from



different aspects to be in a position to identify vital elements that could lead to improved interpretation of the data at hand (Bazeley, & Jackson, 2013).

### **3.10 Data Analysis**

Data analysis is defined as a process that seeks to condense, categorise and give sense to collected data (Renz, et al., 2018). Qualitative data analysis involves classifying, changing and modelling data to identify out useful data and form a conclusion (Cohen et al., 2011). It is the process that is used by individuals to clearly understand the phenomenon that is being investigated. Besides, it describes what an individual has learnt with a little interpretation (Merriam, & Tisdell, 2015).

It simply describes the method that the researcher has followed to analyse data. Data were broken-up and separated into manageable units, to enable the researcher to sort and select them according to their types and patterns. Patterns of expressions which arose from the data were presented in the participants' own words. Qualitative data was arranged in the form of voice recordings and field notes. Finally, data were summarised for meaning to be identified (see Chapter 4).

### **3.11 Quality Criteria**

Qualitative studies are often not based on standardised instruments; they are often used in smaller and non-random samples. In a qualitative study, it is important to ensure that the trustworthiness of a study is not compromised by ensuring that these for aspects are adhering to credibility, transferability, dependability, conformability (Creswell & Creswell, 2017).

Therefore, various aspects need to be considered to ensure quality. These are four elements of quality enables reviewers and end-users to evaluate qualitative research and assess the prevalence of these elements in research published in the ecology and conservation literature. Lastly provide guidelines to improve qualitative research

reporting to increase its quality and usefulness for application in social-ecological systems (Moon, Brewer, Januchowski-Hartley, Adams, & Blackman, 2016).

### **3.11.1 Credibility**

Credibility is the level at which research represents the actual meanings of the research participants, or the “truth value” (Lincoln and Guba 1985; Abdalla, et al., 2018). The credibility of the research findings that are used to make policy recommendations are vital for ecosystem management; assessing the degree at which the reader believes the recommendations are credible has implications for the anticipated success of implementation (Moon et al, 2016). Demonstrations of the Credibility can be done through strategies such as data and method triangulation, peer debriefing and member checking (Daniel, 2019).

- Data and triangulation

According to Fusch, Fusch, and Ness, (2018) to ensure credibility this how are did data and triangulation is typically a strategy for improving the validity of research by controlling bias. Note that exclusive reliance on one method of data collection may bias or distort the researcher's view of the particular slice of reality being investigating. Therefore, the triangulation strengthens a study by combining methods (Abdalla, et al., 2018).

- Peer debriefing

Peer debriefing entails disseminating the data to impartial colleagues or academics experienced in research methods and the research process, to obtain comments or advice (Howitt, 2016).

- Member checking

Member checking is a technique that actively involves participants in the research process by encouraging them to have their interpretation of the data (Birt, Scott, Cavers, Campbell, & Walter, 2016). Furthermore; member checking is a form of triangulation

and minimizes researcher biases (Creswell, 2014; Kern, 2018). All participants were allowed to view, comment on and verify the accuracy of data transcriptions after each data collection period and they all in agreed with the interpretations made.

### **3.11.2 Transferability**

Transferability is a type of external validity, refers to the level to which the findings described in a study apply to theory, practice, and future research (Lincoln, & Guba 1985). Transferability is critical to the application of research findings for policy and management depending on data, conclusions, and also the recommendations (Moon et al, 2016).

Transferability is also concerned to the extent to which the results of a particular research program is extrapolated with belief, to a wider population (Kivunja, & Kuyini, 2017). Transferability is the probability which the study findings have meaning to others in similar situations and it is also known as “fittingness” for it determines whether the findings fit in or are transferable to similar situations. Furthermore; it is the potential user that determines whether or not the findings are transferable (Gill, Gill, & Roulet, 2018).

Lincoln and Guba (cited in Polit & Hungler 2004:435) state that with purposeful samples, the selection of participants should fulfil the need of the study. The researcher approached the participants that had experience and knowledge of the phenomenon under study, i.e. teachers that were in teaching and learning of technology. The current study, transferability was ensured through the process of member checks, enhancing the possibility that the findings have the same meaning for other technology teachers.

In this study, the researcher ensured the trustworthiness of the findings by exposing the study to a colleague for constructive criticism and by sharing the findings with all stakeholders in technology fraternity. Lastly, the supervisor was responsible for examining the findings, interpretations, and recommendations and attesting that they are supported by the data.

### 3.11.3 Dependability

Dependability is the consistency and reliability of the research findings and the degree at which research procedures are documented, allowing someone outside the research to track, audit, and critique the research process (Merriam & Grenier, 2019). Dependability is a quality measure that is more concern with the ecological and conservation science applications that are in the early stages of testing findings in multiple contexts to increase the confidence in the evidence (Moon, et al., 2016).

Dependability is a criterion used to measure trustworthiness in qualitative research. Therefore, it is achieved through securing credibility of the findings (Merriam & Grenier, 2019). It is the stability of data over time and is obtained with stepwise replication and inquiry audit (Fergusson, Harmes, Hayes, & Rahmann, 2019). It is a criterion that is met through obtaining credibility and cannot be present without credibility. Furthermore, there can be no validity without reliability (and thus no credibility without dependability), a demonstration of the former is sufficient to establish the latter (Vazire, 2018).

According to Merriam and Grenier (2019) indicate that dependability is related to the consistency of findings, meaning if the study were repeated in a similar context with the same participants, the findings would be consistent. In qualitative research, the instruments to be assessed for consistency are the researcher and the participants.

Two more techniques are Guba's "stepwise replication" and "inquiry audit". The inquiry auditor examines the product (i.e. the data, findings, interpretations, and recommendations) and attests that it is supported by data and is internally coherent so that the "bottom line" may be accepted. This process establishes the confirmability of the inquiry. Meaning a single audit can be used to determine dependability and confirmability simultaneously (Lincoln & Guba 1985:332).

The supervisor is responsible for examining the data, findings, interpretations and recommendations to attest that they are supported by data. In this study, this activity would be a means of establishing confirmability of the research.

### 3.11.4 Conformability

How can one establish the degree to which the findings of an inquiry are a function solely of the subjects (respondents) and conditions of the inquiry and not of the biases, motivations, interests, perspectives and so on of the inquirer? (Guba 1981:80).

Moon et al (2016) indicate that conformability can be acquired by researchers' through demonstrating that the results obtained are directly linked to the conclusions such it can be tracked as a process, replicated. The relevance to application, ecology and Society in conformability is similar to credibility, where conformability implications for studies that provide policy recommendations.

According to Lincoln and Guba (1985:331); Onwuegbuzie, Leech, Slate, Stark, Sharma, Frels, and Combs (2012) conformability is a neutral criterion used to measure the trustworthiness of qualitative research. Meaning if the study demonstrates credibility and fittingness, the study is said to possess conformability. Its purpose is hereby illustrating that the evidence and thought processes give another researcher the same conclusions as in the context of the research.

Conformability only occurs if there are credibility, transferability and dependability (Holloway & Wheeler 1996:169). The researcher utilised the following auditing criteria:

- Collected the raw data from tape recorders
- Analysed the raw data and findings of the study through de-contextualisation. Furthermore; a synthesis of the analysed data through re-contextualisation is made
- Carefully planned each phase of the research process, research design, sampling design and data collection process
- Made sure that the conclusions of the study's findings are supported by the analysed data.

### 3.12 Ethical Considerations

Qualitative research or interpretative research can be very sensitive because it depends on information people are ready to give you. Notwithstanding, there are ethical issues involved, these issues are considered from the data collection to the conclusion of the study.

The major ethical issues in conducting research are:

- Informed consent - permission must be sought from participants before taking or recording their views, meaning that the use of cajoling, coercion and force renders your research invalid
- Beneficence - Do not harm (research should be of benefit to the population)
- Respect for anonymity and confidentiality (protection of respondent identity and expert management of information received)
- Respect for privacy - privacy is the freedom an individual has to determine the time, extent, and general circumstances under which private information is shared with or withheld from others. In research, this freedom must be respected
- Non-inclusion of vulnerable groups of people (vulnerability is a characteristic of people unable to protect their rights and welfare). So, vulnerable groups include captive populations (prisoners, institutionalised, students etc.), mentally ill persons, aged people, and children, critically ill or dying, poor, with learning disabilities, sedated or unconscious people. Any information obtained from this group of people is invalid

Ethics deal with beliefs about what is right or wrong, proper or improper, good or bad (McMillan & Schumacher 2010). This study was potentially fraught with ethical issues about the participants being observed, interviewed, and may have been potentially unpleasant and intimidating, as participants may have had feelings of being exposed or embarrassed. The researcher minimized the effects of the observations by always

acting sensitively and tactfully. The ethical requirements for conducting research were implemented throughout the study.

An application for ethical clearance was done, and granted, through the ethics committee of the Faculty of Humanities, University of Limpopo (UL) in 2019 (see **Annexure H**). Application for permission to conduct the study in Mpumalanga schools through the Mpumalanga Department of Basic Education (MPDBE) was done and permission granted (**see Annexure A**). Furthermore, a signed consent form by teachers and curriculum implementers before any interview session provided (**see Annexure C**). Letters informing parents and consent forms were also provided (**see Annexure**) since learners were part of participants during lesson observations of teachers involved in the research and to the parents of these learners. The aims and objectives and the nature of the study were communicated the aim, as well as the possible application of the findings to participants before the commencement of data collection activities to all stakeholders involved.

The letters of information, the consent forms for the for Mpumalanga Department of Education, curriculum implementers, teachers, parents and the assent forms for the learners are included in annexures A, B, C, D, E, F, G, H and I. In all instances, an acknowledgement that participation would be voluntary and informed (written) consent from participants was a prerequisite. Assurance was given that no individual's identity would be revealed to anyone other than the researcher.

During the research, every effort was made to maintain the fiduciary relationships were established with the participants. At the onset of the research, during the first meeting with the participants, it was explained that the researcher would try not to create feelings of distrust or discomfort. It was also explained that participants had the right not to answer questions or participate in research that they felt might hold negative consequences for them. The researcher constantly reminded participants of the confidentiality and anonymity of their contributions. All the CIs', teachers and the

learners were reassured that their participation would not impact on their final assessment or marks.

### **3.13 Summary of the Chapter**

This Chapter outlined how the research was conducted, illustrating the process used to select the participants, the methods used to collect data as well as the approach that was used in analysing the texts. This study aimed to understand the participants' construction of their reality, thereby illustrating one way in which the concepts under investigation are constructed by curriculum implementers and teachers in the same context. The next chapter details the analysis process and describes the findings of the research.



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## CHAPTER FOUR: FINDINGS AND DISCUSSION

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### 4.1 Overview of the Chapter

This chapter provides the necessary analysis of the data collected through various means, which are documents analysis, observations interviews. Reporting begins with profiling of subject advisor and teachers as participants of the study, revealing their professional qualifications as well their experience in advising/teaching Technology. After of which discussions of responses of the interview questions. The layout of the findings and discussion of the interviews begins with the question followed by the response of each of the interviewee, then accompanied by research references concerning the question asked. Then, the researcher drew some conclusions with regards to the responses provided and related these to previous research conducted about the subject investigated. The class observations and document analysis were carried out in details. The purpose of the study is an “*Exploration of Creative Thinking Skills in the Grade 9 Technology Classrooms*”, this study was guided by the following research question and sub-questions:

#### Main question

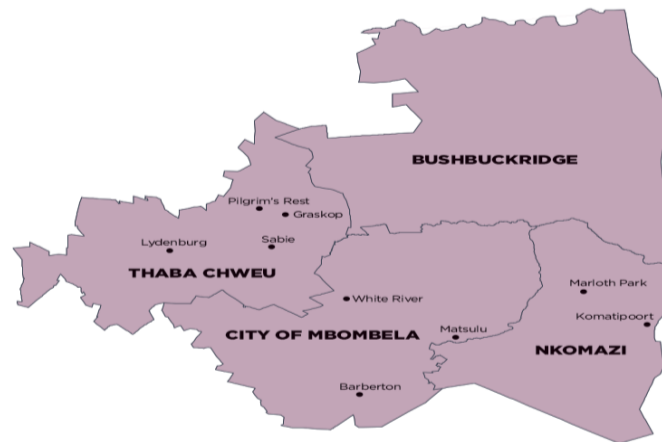
- How can teachers support learners to develop creative thinking skills in Grade 9 Technology classrooms?

#### Sub-questions

- Which approaches do Technology teachers apply to support Grade 9 learners to develop Creative Thinking Skills?
- What opportunities do CAPS provide for fostering Creative Thinking Skills in a Grade 9 Technology classroom?
- What are the teacher’s experiences when attempting to support learners to develop Creative Thinking Skills?

## Location of the study

The study was conducted in the province of Mpumalanga, Ehlanzeni Region in Nkomazi municipality. The study was conducted in four different schools stretched over three (1) different circuits, namely two schools in Nkomazi East Circuit (township, Rural), One (1) in Malelane Circuit (Town, semi-suburb), One (1) Nkomazi West Circuit (village, Rural). (See Figure: 4.1) the map below



## 4.2 Biographical Information of the Participants

Two technology CI (subject advisors) from the region of Ehlanzeni were selected to participate in the study, and four teachers from different schools teaching technology as a subject in grade 9, in the region of Ehlanzeni, around the Nkomazi municipality were also selected to participate in the study (see chapter 3, Section 3.6). Lastly in ensuring the confidentiality of the participants' nom de guerre were used.

### 3.13.1 4.2.1 Profile of Curriculum Implementers

Two curriculum implementers were selected

Table 4.1: summary of the participants' profile (Subject Advisors)

Name	Gender	Qualifications	Experience
Castro	Male	<ul style="list-style-type: none"><li>• Senior Primary Diploma in Education</li><li>• Senior certificate: Technology Education</li><li>• B.Ed. (Hons): Management</li><li>• ACE: Technology Education</li></ul>	14
Cameron	Male	<ul style="list-style-type: none"><li>• D.Ed.: Technical subjects</li><li>• National Diploma: Mechanical</li><li>• National Diploma: Electrical</li><li>• ACE: Technology Education</li></ul>	16

In Table 4.1 above is a profile of CI (subject advisors) that clearly shows how the two participants meet the requirements as per outlined sampling method in chapter 3.6 during the study the data was gathered through a structured face to face interviews with each participant at the time.

#### 4.2.1.1 Curriculum Implementers interviews

For the subject advisors/CI, a set of eleven (11) questions were formulated from the conceptual framework of the study, and the focus was embedded on creative thinking as the main subject of the study, see annexure H. These questions were divided into two sections, the first seven (7) questions were focusing on depth of the understanding of the content in the relation of the subject and the planning that goes with for a proper presentation of a lesson. The second set of questions were four (4) they were also on

CT about the subjects but their focus was on the classroom to practices during teaching and learning process.

The researcher personally conducted the interviews, making it easy to be able to clarify or simplify questions that seemed confusing to the participants at the time of the interview, making sure that the participants fully understand a question before attempting to respond to it. Findings presentation will be outlined in this fashion, the question asked first followed by the responses of the participants'.

### **Question 1: What is your understanding of Creative Thinking?**

*Castro: Creative thinking it has to do with taking theory in to practice allowing learners to do something practical that will enhance once creative thinking.*

*Cameron: Creative thinking is based on practicality, allowing learners to innovative while solving problems.*

Guilford's (1954) definition of creative-thinking abilities potentially included only the divergent production abilities as they operated on the contents to obtain products with a range of complexity. It is characterised by fluency, flexibility, originality and elaboration, it is also known as productive-thinking abilities and in a subclass of divergent-thinking abilities (Guilford, 1957: 117). Kudryavtsev (2011) and Cropley (2016) define creative thinking is an ability to develop something novel and adapt to new situations.

Looking at the responses of both curriculum implementers they both indicate that practicality is a major aspect for the development of creative thinking, however, both of them could not provide a clear definition of what exactly is creative thinking and what it entails. Furthermore, it quite concerning because these are professionals who are responsible for developing teachers and also ensuring that they adhere to policies concerning the subject.

**Question 2: Do teachers of technology have the correct understanding of what creative thinking and what it entails in TE?**

*Castro: Comparing since then and now there is vast difference previous they lacked when it comes to creative thinking, but currently most (80% to 90%) of teachers they have a deep understanding of creative thinking in technology.*

*Cameron: Yes, about 80% of teachers based on their experience, with at least two years of experience they have an understanding of what creative thinking entails, the challenge is on new teachers in the system.*

Mirror Guilford's work over the years, Amabile (1996) explain that creativity does not occur spontaneously or randomly, but happens instead when the appropriate combinations of knowledge, skill, and motivation enable an individual to generate new ideas. Therefore, creativity is a subject that has drawn a lot of interest heeding to call made by Guilford in the 50s, however; there is still lack/little understanding of how to nurture and support creativity in current classroom contexts, particularly creative teaching.

Teachers and administrators are confronted by the question of how to successfully integrate creativity into teaching practice when teachers are highly pressured but given little leeway (Henriksen & Mishra, 2013). Mullen (2020) indicates that high-stakes testing and scripted curriculums make it complex for education stakeholders to infuse creativity into teaching practices. For all its importance, creativity is a concept that has not been well understood, framed, or defined. Education department needs to develop a framework that is aimed at assisting learners and teachers develop creative thinking skills that span disciplines and use technology tools for creative solutions and outcomes (Henriksen & Mishra 2016: 28).

The responses from both CI indicated that most of the teachers have an understanding of what CT is and what it entails when comparing the understanding they had when the subject was introduced in the system. However; it is somehow difficult for the researcher to agree with what the two said. Contrary to the responses of CI, the

responses from teachers themselves, as well as the lessons observed. The teachers had shown a limited understanding of CT. Furthermore; the CI in responding to the first question they shown a limited understanding of creative thinking.

**Question 3: What are the key fixtures that ensure the teaching and learning of CTS in a classroom?**

*Castro: The design process is the key aspect of teaching and learning CTS, anytime when a learner is required to create something the design process should be the first thing to mind, which are investigating, designing, making evaluating and communicating.*

*Cameron: Creative thinking is deep-rooted on problem-solving, teachers are required to always provide learners with scenarios, to open learners' mind to think creatively and challenge them to engage at all times.*

Guilford (1957) established that divergent thinking is a major component of creativity and associated it with four main characteristics, which are fluency, flexibility, originality, and elaboration and gave the birth of the FFOE model for creativity. The FFOE model is well reflected in the design process.

Looking at Castro's response he was on point to say the DP is the first and last thing that should come to mind for a teacher when it comes to the development of CTS in a technology classroom. On the other hand, Cameron indicated that problem solving as it always provides technology teachers with an opportunity to provide learners with a scenario to tackle a technological problem. To a certain level, the research assumes that they all agree in saying that the design process key to the development of CTS of learners.

**Question 4: Do teachers have a clear understanding on how to substantiate CTS in relation to CAPS?**

*Castro: Yes, by constantly doing models/prototypes with learners every quarter.*

*Cameron: Yes, depending on the activity they are doing, about 75% is based on PAT, but there is still a lack of individual activities.*

According to research innovative people in any field are also highly creative in areas outside their professional lives. They actively draw on outside interests and creative ways of thinking to improve their professional practice (Root--Bernstein, 2003). Teacher development, in this case, is vital, as one seven roles of teachers indicate that teachers need to long-life schoolers and that main for self-development. Teachers need to enrol with tertiary institutions, they also need to part of bodies such as SAASTE. It is the responsibility of the CI to encourage or introduce them is such activities, so that teachers are always on par with current and relevant issues concerning the subject they are involved in this case technology.

**Question 5: Environments always effect on one's level of creativity, what are the aspects that teachers need to take into consideration for positive teaching and learning environment during planning?**

*Castro: Firstly, consider the background of the learners, because this will determine what types of tools or materials to be used, comparing learners from rural background and learners from suburb, giving them the same PAT may somehow affect the type of product to produce, due to the fact that their exposure is not the same, so planning for a rural learner and urban learner should always be taken into cognisant.*

*Cameroon: The learning space/classroom should always have posters that will stimulate learners mind at all times in relation to TE, and maximise the use of Digital technology (Smart Classes).*

Guilford (1950), indicates that creativity cannot happen in a vacuum, meaning while focusing on the creative production of one individual, there are other stimuli such as the environment that can affect creative production. Furthermore in support of Guilford's work; Amabile (1998) indicates that a conducive learning environment needs to be able to allow learners with different learning or working style, despite working

individually/pairs/in a group. Furthermore; it is vital to provide learners with a physical space needed to work comfortably. Guilford (1950) alluded on the importance of one's knowledge or expertise, indicating the obvious and precise effect of the environment and its impact on one's base of knowledge.

In light of the above positive learning environment is one of the vital aspects in teaching and learning particularly the development of CTS. The both CI responses mentioned the background of learners and learning space to should be highly considered during lesson planning. However, it may not be enough the environment needs to be looked at holistically not focus on a certain aspect and overlook some. The positive learning environment may include learning space, technological tools, safety, cleanliness, teacher-learner ratio, etc.

**Question 6: Curiosity and the desire to explore are critical aspects of creative thinking, therefore what kind of approach can be used by teachers to keep learners their toes.**

*Castro: A teacher must do a thorough preparations of a lesson, and good preparation is likely to translate to a learning experience that make leaners to be inquisitive, and that itself can make a learner to be eager to learn and be more creative.*

*Cameron: Guided by the fact that we live in a world of technology, to keep learners on their toes teachers need to more flexible and make use of any technological tool available to capture the interests of the learners and do away with old methods of teaching.*

Flexibility is one of the characteristics of divergent thinking is vital for the cultivation of curiosity. Flexibility, which encompasses spontaneity, adaptation, or the ability to demonstrate, leading to the production of responses that are novel and high in quality. (Guilford, 1950). Amabile (1996) Creative thinking is how flexibly and imaginatively people approach problems. Furthermore; in complementing Guilford's work Csikzentmihalyi (1996) indicates that developing CTS, the curiosity and desire to



explore are most vital factors to build towards creativity; the first step in achieving creativity is the cultivation of creativity.

Concerning the question of curiosity, Cameron indicated that teachers need to bear in mind that today's learners are very attached to new technologies, so it is wise for teachers to evolve with times and keep up with the current trends, furthermore introduction of new technology tools in lesson delivery may assist in arresting interests and provoke the curiosity of learners simultaneously. Castro, on the other hand, recognises thorough preparations of lessons as a critical aspect to handle efficiently and effectively with the creative development of learners in mind, meaning if preparations are done correctly activities given to learners will prove learners' curiosity to develop their creative thinking. It is no doubt that learners should always be kept inquisitive at all times, learners should have the zeal to learn, and it remains the responsibility of teachers to ensure that the curiosity of learners is well cultivated which will translate to the development of learners' CT. Trough relevant strategies this can be possible. Teachers need to pay attention to key aspects of teaching and learning in ensuring that they unlock the curiosity of learners using relevant strategies.

**Question 7: self-confidence is an important factor in creative thinking whereby learners need to have a sense of safety in risks taking without the fear of faltering, how to support/encourage learners to take risks?**

*Castro: Always appreciate efforts of leaners, never scold a leaner if front of other learners if they have not done well/correct, be professional at all times.*

*Cameron: By making appreciation of attempts/efforts, give learners the freedom to explore, show them shortcomings were they lack.*

Learners with self-confidence are mentally strong and resilient, and this allows them to master their perception and work while acquiring confidence simultaneously, the lack of confidence leads to learners being fearful of making mistakes and unable to produce the creative product. Teachers need to play their role in encouraging learners, provide

feedback in due course, which will build their sense of safety for risk-taking without any fear of faltering (Frey, et al., 2019; Zacarian, & Silverstone, 2020).

Both participants alluded that it is important for teachers to always appreciate learners' effort no matter how little it may seem, this will in a way encourage them to believe in themselves and what they do. Positive feedback and positive comments to learners' is important it always helps to develop their confidence. Moreover; it will play a crucial role in the development of CTS during teaching and learning process.

#### **Question 8: Do teachers employ any technological tool when teaching?**

*Castro: Yes, some do but a very small percentage; about 90% they do not use it. The few who are employing DTs are teachers in the former model c's schools, because they have smart classes.*

*Cameron: No, and I don't exactly blame them because only few schools have access to DTs particularly in rural schools, and again few that has it very difficult to access due to tight school policies that instil fear to teachers and learners.*

New technologies need teachers to be creative in coming up with new ways of thinking about technology, particularly for teaching specific content. Most of the digital tools available today (be it Facebook or a smart-phone or any other tool) are not meant for educational purposes. However; teachers can take advantage of what is thereby creatively repurposing the existing tools to fit educational purposes (Koehler, Mishra, Bouck, DeSchryver, Kereluik, Shin & Wolf, 2011:150).

South Africa is a third world country, and the fourth industrial revolution is imminent. Therefore, teachers must keep up with such developments, if teachers acknowledge the power of new technologies and exploit effectively to enhance the teaching and learning process, they stand to positively benefit, and learners stand to benefit. It remains the responsibility to ensure that the integration of new technologies is implemented in schools. Looking at the responses of both CI it is clear that we still have a long way to go in.

**Question 9: Are learners allowed to use technological tools that will enhance their creativity and concurrently capture their interests in class?**

*Castro: No, learners' access to DTs is limited to smartphones. However; be that as it may school policies stops learners to bring phones at schools if found with a phone is confiscated particularly in Mpumalanga, because provinces like Gauteng they do have flexibility with regards to smartphones. Such policies make learning and teaching complex.*

*Cameron: Given the availability of resources teachers would allow them to use DTs, however school policies remain a barrier to use these tools efficiently.*

Both teachers and learners they need to have a vast of experiences in which they can engage, play and familiarise themselves with the distinctive contributions that new technologies can contribute to their creative practices which other media and tools do not offer. (Sawyer, 2004). New technologies have changed the course of teaching and learning drastically, with innovations and affordances for creating and sharing ideas and content. Therefore; the development and impact of learning technology should not be entertained in isolation, but rather alongside opportunities for creative education (Henriksen & Mishra 2016:27).

Looking into both responses it is clear that in schools' teachers and learners are still challenged when it comes to the use of new digital technology. This may as a result of fear by teachers who are lacking the skills, knowledge and information concerning new technologies on how to integrate it with the teaching and learning process. Again it may be as a result of school policies that forbid learners to bring technological gadgets to school and it may be a result of lack of resources in schools particularly technological tools.

Therefore, it imperative for the department and school administrations to deal with such challenges. Teachers need to be timeously trained on how to use new technologies and how to integrate them to the teaching and learning processes, school policies need to be timeously revised to suit and benefits the needs of the learners as they are the

primary responsibility of the schools and department. Lastly, relevant and adequate resources must be made available for teachers and learners to use when needed. This will ensure the production of learners with the relevant knowledge, skills and information needed to survive in the 21<sup>st</sup> century.

**Question 10: Considering motivation as the main driver to creativity, what type(s) of motivation can be used by teachers to ensure that learners are always on their best performance?**

*Castro: Teachers can motivate learners by putting incentives, applauding to a learner who has made positive contributions, provide lunch to a learner whose performance is good and he/she is in need.*

*Cameron: Appraisal of learner's efforts, through giving encouraging words, advertise learners' work, give certificates for best performances, allow them to exhibit their projects, from school level (Science expo).*

Intrinsic motivation is a motivational state generated by the individual's reaction to properties of the task itself, and not generated by outside factors. Intrinsic motivation is a type of motivation that comes from within an individual, satisfaction, excitement and enjoyment of work etc. (Amabile, 1996:90-91). In support, Guilford's work Amabile (1983) has shown the importance of such motivation for creative work and has suggested that people rarely do truly creative work in an area unless they really into what they are doing and heed on the work rather than the potential rewards.

Considering motivation, expectations and emotion, to be a vital aspect influencing the creative actions of individuals. Moreover, domain-related skills were seen as the basis of creative performance, related to the domain-specific characteristics of given tasks (Ford, 1996). Both in their responses, the CI have shown the importance of motivation in creativity development. However, they seem to have limited knowledge concerning a broader understanding of types of motivations. Guided by the fact that this is the very professionals who are entrusted with the responsibility to support and develop teachers,

to keep them on the loop concerning teaching and learning it very concerning considering their knowledge on motivation.

**Question 11: Would you say teachers have an understanding of what it entails to foster creative thinking skills and the resources to teach CTS to produce the kind of learners as stipulated in the CAPS document?**

*Castro: Yes, but resources remains a challenge, not only for schools the department as whole.*

*Cameron: Yes, teachers have what it takes, but the lack of resources is a serious challenge.*

The creative person tends to show certain personality traits such as dependence of judgment, self-confidence, and attraction to complexity, aesthetic orientation, risk-taking, openness to experience, tolerance of ambiguity, impulsivity, lack of conscientiousness, and high energy. Creative persons may differ depending as to whether they are internally challenging externally oriented, person-oriented or task-oriented, and explorers or developers (Gabora, 2013).

In light of the above, both CI alluded that over the years they been working closely with teachers they have seen great improvements, hence they all believe that teacher has an understanding of what creative thinking is all about. However; in light of what was gathered on both curriculum, it showed that they have a limited understating of CT and what it entails, so their response on this question was somehow clouded and questionable as to how is that so? On the second part of the question, they both indicated that the issue of resources is still a challenge in most schools particularly in rural schools, teachers are still expected to navigate their path to bring about good practices of teaching and learning. Schools and the Department must provide teachers with resources.

### 3.13.2 4.2.2 Profile of Teachers

Four grade 9 technology teachers were selected

Table 4.1: summary of the participants' profile (Teachers)

Name	Gender	Qualifications	Experience
Jill	Female	<ul style="list-style-type: none"> <li>Diploma in Education</li> <li>ACE: Technology Education</li> </ul>	3
Joy		<ul style="list-style-type: none"> <li>B.Ed. Degree</li> <li>ACE: Technology Education</li> </ul>	6
Paul	Male	<ul style="list-style-type: none"> <li>B.Ed. Degree ( Mathematics &amp;Electrical technology)</li> </ul>	4
Blade	Male	<ul style="list-style-type: none"> <li>Diploma in Education</li> <li>Technology Education</li> </ul>	16

In the Table, 4.2 above are profiles of teachers showing how the four participants meet the requirements as per the outlined sampling method in chapter 3. During the study the data was gathered through semi-structured face to face interviews with each participant at the time, lesson observations, and documents analysis.

#### 4.2.2.1 Teacher Interviews

In this study for the teachers, a set of sixteen (16) questions were formulated from the conceptual framework of the study, and the focus was embedded on creative thinking as the main subject of the study, see annexure E. These questions were divided into two sections, the first seven (7) questions were focussing on the depth of the understanding of the content concerning the subject and the planning that goes with for a proper presentation of a lesson. The second set of questions were nine (9) they were also on creative thinking concerning the subjects but their focus was on the classroom to practices during teaching and learning process.

The researcher personally conducted the interviews, making it easy to be able to clarify or simplify questions that seemed confusing to the participants at the time of the interview, making sure that the participants fully understand a question before attempting to respond to it. Findings presentation will be outlined in this fashion, the question asked first followed by the responses of the participants'.

#### **Question 1: As a technology teacher what is your understanding of Creative Thinking concerning the subject?**

*Jill: Allowing learners to express themselves in different ways through a Mini-PAT.*

*Joy: Creative thinking means coming up with something new and unique in solving a problem.*

*Paul: Creative thinking skills are the set of skills that allow a learner to be able to design in order to solve a societal problem through innovation.*

*Blade: technology as a subject in relation to creative thinking it gives one a chance to think out of the box, learners are given projects to solve problems in an innovative way.*

Over sixty decades ago Guilford (1950) as a pioneer of defined CT in terms of two criteria: originality or novelty, and appropriateness/adaptiveness, i.e. relevance to the

problem to be solved. Creative Thinking in technology involves the generation of new ideas or the recombination of known elements into something new, providing valuable solutions to a problem (Studer, et al., 2018). Creative thinking is a disciplined manner can play a vital role in innovation. Both creativity and innovation comprehend each other, guided by the fact that creativity generates the basis of innovation, which, in its development, raises difficulties that must be solved once again, with creativity. It is not possible to conceive innovation without creative ideas, as these are the starting point (Isaksen, Dorval, K. B., & Treffinger, 2010; Runco, & Pritzker, 2020).

In light of the above, the teachers showed some bit of understanding of what CT is all about and what it entails in TE. They all indicated that it is a type of thinking skills that are embedded in innovation. However, it is concerning that has over 15 years since Technology was introduced in the South African school curriculum. The purpose of the subject is to stimulate learners to be innovative and develops their creative and critical thinking skills. To teach them to manage time and material resources effectively provides opportunities for collaborative learning and nurtures teamwork. These skills provide a solid foundation for several FET subjects as well as for the world of work (DBE, 2011:8). The lack of understanding of teachers of CT makes difficult to achieve what the policy is aiming to achieve.

**Question 2: Research has shown that creativity is not a talent but a skill that can be taught, during planning what are the key fixtures that are taken into consideration to ensure the teaching and learning of CTS in a classroom?**

*Jill: To do proper demonstrations whilst you teach and avoid theorising of content.*

*Joy: Always give practical work; moreover, give learners the freedom to explore.*

*Paul: Creativity comes after a learner has been taught will be able to design soothing responding to a social problem, coming up with a solution, it can be a new invention or an innovation.*

*Blade: Is the design process*



Creativity is greatly influenced by divergent thinking which is characterised by these four factors; fluency (word, associational, ideational, expressive), flexibility (spontaneous, i.e., the flexibility of initiative, and adaptive, i.e., striking out in new and unusual directions), originality (produce unique ideas, purpose, and meaningfulness in a situation) and elaboration (think through, make informed decisions, outline details, carry out idea) known as the FFOE model of creativity (Guildford,1950).

Heeding to a call made by Guildford in the 50's Amabile (1996) further alluded that the role of the teachers and classroom settings is an important influence upon learners' beliefs and development of their creativity. Furthermore; when all variables that influence creative development are taken into consideration, most factors are classroom-related. Creative teachers don't fear to try new things, give real-world activities, and use cross-disciplinary approaches DP is the cornerstone of teaching and learning of TE as it is stipulated in the CAPS document and it strongly complemented by the FFOE model by Guildford.

In this case, only one teacher who seemed to have a clear understanding of what exactly needs to be done to develop the CTS of learners. The other teachers do have the picture that TE is a subject that is more practical when it comes to skill development such as CT, however; it is not clear what aspects they take into considerations in ensuring the development of CTS concerning policy.

### **Question 3: How are your CTS substantiated concerning CAPS?**

*Jill: By making sure resources available to enhance teaching and learning.*

*Joy: Attend content enrichment workshops organised by the department on quarterly bases; do research to keep up with current issues in relation to the subject.*

*Paul: Participate in educational bodies such as SAASTE, to be on par with current issues relating to the subject, and attend content enrichment workshops.*

*Blade: CAPS in my understating it's all about sharing of knowledge, meaning sometimes a learner can come up with something that is not known by the teacher. So my CTS substantiated by the fact that I'm always prepared to share information and also have the will to learn a thing or two from my learners.*

Creative thinking skills could be taught using various strategies. Training of teachers in creative problem solving can enable them to be skilled to facilitate the process of teaching and learning as they are expected to, moreover developing learners' creativity for them to be able to resolve problems efficiently (Fryer, 1996:5).

Craft (2005) deduce that CTS have their unique concerns, such as the relationship between creativity and knowledge, curriculum, and appropriate pedagogical strategies to foster creativity in the classroom. Furthermore; the views of creativity this approach adopts are pivotal to educational values and settings. In recent research, creativity is embraced as a multi-dimensional and developmental construct; for that is noted that CTS is a developmental shift and a lifelong process for all teachers (Craft, 2001).

Change is inevitable, change is forever present, so it important for teachers to embrace change. For the teachers to be forever relevant a need of continues development is of great importance. Teachers should always attend content enrichment workshops planned by the department, enrol with tertiary institution for further development and be on par with current issues. Participating in technology expo be part of bodies such as SAASTE, which will provide them with the platform to be able to share information, learn new things in their line of work. Looking at response of the teachers above it is clear that the teachers are struggling in substantiating their skills for the teaching and learning of technology particularly for the development of CTS of learners. The struggling of the teachers may be fuelled by a number of factors , such as lack of policy understanding and adherence, lack of understanding of what creative is all about and all its important to a learner's life and to the society at large.

**Question 4: Environments always affect one's level of creativity, what is the aspect that you take into consideration positive teaching and learning environment concerning creative thinking during planning?**

*Jill: I normally use grouping in class that will allow me to attend each and every one of them in their respective groups.*

*Joy: I group them in class, always teach them in context so they are able to relate, allow them to share information and embrace diversity.*

*Paul: An environment is one of the main aspects of creativity, it is a hard one to deal with because currently we are faced with overcrowding in the classes. So the current environment is negatively affecting the level one creative thinking. To create an environment that will at least boost their creative thinking to some level were by during their brainstorming they will come with different ideas debate them to find common grounds.*

*Blade: For positive teaching and learning when planning projects do not come with projects that are far-fetched from learners, let it something that they can relate to, something that can touch or see or feel.in simple terms contextualise your planning.*

Creativity research has covered numerous areas since Guilford's time, such as the creative thinker's cognitive processes; the creative personality, behavioural elements of the creative thinker; and recently the broad environmental context that interacts with and supports creative work in the development of creative thinking skills. Latest research in support of Guilford's work further indicates that classroom/school settings, an environment can greatly influence learner's thinking styles, meaning learners who work in a more favourable environment are generally happier, thus more willing to take risks, to be innovative and to be persistent in trying different ways of solving problems.

Amabile as one of the advocates of creativity in creative research in complementing Guildford's over the years he revealed the importance of motivation for creative work and has suggested that people rarely do truly creative work in an area unless they love

what they are doing and focus on the work rather than the potential rewards, therefore Intrinsic motivation it is the type of motivation that is vital for the development of creative thinking skills (Amabile, 1983).

In the question of environment, the teachers often prefer to group the learners, one reason may be that classes are overcrowded. The way they have responded to the question it is evident that teachers nor the department pay attention to details of during their planning they pay little or no attention of the importance of environment as a vital aspect of teaching and learning of TE. To ensure that the issue of the learning environment is addressed schools/department should make sure that a designated teaching venue with a Technology teacher is available in all schools as stipulated in the CAPS documents. Furthermore; ensure that the required stipulations are met, for instance, Technology classrooms must be secure, with doors that lock, and with burglar-proofing if possible. Enough cupboards should be available to store and lock away all resources (DBE, 2011:13).

**Question 5: Curiosity and the desire to explore are critical aspects of creative thinking, therefore what kind of approach do use to keep learners on their toes?**

*Jill: By creating awareness to the learners in relation of what they are being taught and what is around them.*

*Joy: Always to relate the lesson to their daily bases experiences.*

*Paul: Timeously asking them thought provoking questions.*

*Blade: Todays learners are into digital technology, learners are very attached to their cell phones. So it is important to broaden their use of the cell phones because most the use for calling, social networks, taking pictures but they don't see it a tool for learning. Linking what their interested in with their learning process will keep light up their curiosity and the desire to learn.*

Torrance is one of the advocates of creative research and for many years worked very closely with Guildford developing creative models. According to Torrance (1963),

learners learn through questioning, inquiring, searching, manipulating, experimenting, and even aimless play. Learners explore out of their curiosity, which is a natural phenomenon to humans. Torrance also connected learning and teaching by suggesting that during the learning process, learners' creative skills and methods are required; while at the same time the learning context, which is filled with curious problems to explore, stimulates spontaneous learning and flexes the capacities for learning and thinking creatively.

Furthermore; the pedagogical strategies of teaching for creativity that facilitate learner's agency and engagement, such as strategies of learning to learn, or to exploring more new possibilities, often seek to be inventive to provoke curiosity and learning motivation (Cropley, 1992; Torrance, 1963). The core objectives of a creative thinking process are to take thinking to a level beyond existing boundaries, to provoke curiosity, to break away from rational, conventional ideas and formalised procedures, to rely on the imagination, the divergent, the random and to consider various solutions and alternatives (Jordanous, 2012).

Concerning curiosity, it vital to keep learners interested in their learning, so it is important for teachers to always give learners activities that will provoke their thinking capabilities of learners, the freedom to explore without fear. The teachers, in this case, do employ different strategies, but it is not enough. Blade on the other hand has hit the nail in ensuring that learners are always interested in their learning arousing their curiosity. It is there important for teachers to know the interests of the learners that will help the teachers during their lessons planning. Linking or integrating of learners interest in lessons is vital to arouse the curiosity of learners and the development of CTS.

**Question 6: Self-confidence is an important factor in creative thinking whereby learners need to have a sense of safety in risk-taking without the fear of faltering; how do you support/encourage learners to take risks?**

*Jill: Giving the learners new topics more often to research on, and do presentations in class either as groups or as individuals.*

*Joy: To instil belief in learners, to make them to believe in what they do at all times, as long as they be able to back it up.*

*Paul: I encourage them to always believe in themselves, and in what they do.*

*Blade: Parental and teacher involvement is very important is important for risks taking for learners. Parent and teacher support eliminates all fears because during any activity whether is home activity or class activity they will know where to run to if something does go their way.*

Fluency is the ability that enables learners to generate as many ideas as possible that are relevant and adhere to specified requirements of the societal problem at hand (Guilford, 1957). Studies suggest that teaching for creative thinking is worthwhile moreover; some learners do not gain from conventional instruction, but they may gain from the kinds of expanded instruction that can be offered (Sternberg, 2006:95).

Meaning a problem is put forward, a learner who has a high fluency can be able to develop as many solutions as possible to solve the problem rapidly. It fluency that emphasises the number of ideas generated over the quality of the ideas generated (Guilford, 1957). Learners need to be afforded with opportunities to actualise their creativity and freedom to explore their ideas and instruction. Furthermore, allowing learners to commit mistakes is an approach for supporting learners to come up with new ideas and develop their creativity. Moreover; positive thinking and reflecting on their mistakes are important skills that teachers need to encourage learners. This act will boost their confidence in continuing to work hard and improving their creative works (Gnezda, 2011).

Teacher's beliefs about creativity and technology are very important. Teacher's beliefs about the subject matter, learning, teaching and technology influence the way they approach to practice (Kim, et al., 2013). In light of the above teachers need to understand that learners' self-confidence is vital in teaching and learning, different methods by different teachers are employed in ensuring that learners always have a sense of belief in themselves and in what they do. It is important for teachers to always

appreciate learners' efforts/ideas no matter how little it may seem and help them to build on them. In short teachers, in this case, they all agree that it is important to instil a sense of belief to boost their confidence as it no doubt that it one important aspect for the cultivation of CTS.

**Question 7: As a technology teacher, what are your strengths in teaching Creative Thinking Skills (CTS) in a technology classroom?**

*Jill: Always giving them more work to learners, I always do demonstration to give a stronger lesson presentation and provide more practical work to learners.*

*Joy: I'm good in drawings, designs, and calculations. I'm also good in lesson presentation.*

*Paul: Having a broader perspective of what creativity and technology is all about, since I have done technology at university from first level to the final level*

*Blade: I have been teaching technology since its inception, I have a vast of knowledge in the subject, and I'm a researcher, always on par with current issues particularly in relation to technology education*

Creativity in individuals is embedded in multiple components such as cognitive abilities, personality factors, cognitive styles, motivation, knowledge and the environment (Guilford, 1950; Amabile, 1983; Csikszentmihalyi, Sawyer, 2014). In complementing Guilford and others Sawyer (2004) explain that teaching creatively, the teacher needs to employ improvisation by living in the moment and acting spontaneously. For an example, the teacher may have planned the lesson one way, but a creative teacher dares to take the ideas that have arisen during the interaction with the learners and alter the lesson to finish it in another way (Sawyer, 2006).

Relating to the above research studies, teaching for the development of creative thinking skills, a teacher needs to know his or her strengths to put it into good use when it is needed. A teacher needs to have some level of flexibility to accommodate learners' ideas during teaching and learning process. A teacher needs to have a

repertoire of skills and abilities for creative teaching in the modern days. In their response in relation to strengths in teaching and learning of technology, seemed to be not sure what exactly their strengths in relation to teaching of technology are.

**QUESTION 8: The world we live in has evolved with digital technology, during planning/ teaching and learning do you employ any digital technology tool?**

*Jill: Yes, sometimes and that is due to the fact that DTs resources are very limited.*

*Joy: Yes, I do use a laptop and projector sometimes since they are the only available DTs resource I have access to present a lesson or to make demonstrations.*

*Paul: No I use the old method of teaching due to the scarcity of resources*

*Blade: I do use DTs; I have my own projector, laptop, and other gadgets. Using DTs always assist to capture the attention of the learners at the same time eliminating ill-discipline issues.*

J. P. Guilford's 1950 address to the American Psychological Association (APA) on creativity has inspired the Now-thriving field of creativity research. His work alongside with others has influenced the research carried out since, however it has left a gap for future creativity researchers to pursue (Guilford, 1950) the role of DTs. Since the 50's more attention was given to enhancing creative development, and since then several trends of creativity in education has surfaced to take into new horizons (Craft, 2001; Shaheen, 2010). Hence today new digital technologies often bring new possibilities for learners to be more creative. In a classroom setting teachers must understand the range of ways in which technology can be used to present content creatively, and see how this intersects with different pedagogies. (Henriksen, et al., 2016: 30). The best uses of educational technology must be grounded in a creative mind-set that embraces flexibility and freedom for the new and intellectual risk-taking (Mishra, et al., 2011).



It is no doubt that new technologies afford new ways of constructing, representing, communicating, and sharing knowledge, providing opportunities for creative output by and between learners that were not possible before (Henriksen, Mishra, et al., 2016: 31). Digital technology has changed the course of teaching and learning. However, it is still difficult for teachers to embrace it. The teachers' responses strongly indicate that teachers are still far behind in taking advantage of this digital tools to enhance the teaching and learning process, particularly the development of CTS and this may be as a result of the department not providing the necessary support to teachers and learners to keep up with the rest of the world.

**Question 9: What are your traits that better allows you to teach Creative Thinking Skills?**

*Jill: Always eager to learn, I'm a researcher, and open for more training.*

*Joy: Drawing skills, calculation skills and moreover strong presentations skills.*

*Paul: I am a young teacher, still eager to learn, a researcher and very good in calculations*

*Blade: Researching a lot through reading books, internet, watching TV programs such as network/trends. Doing that allows me to evolve with times and be more innovative.*

According to Guilford (1950: 446) creativity is a continuous trait in all people, and that those with recognised creative abilities simply have a little bit more of what all of us have. Guilford's choice of focus on the traits, motivations, and behaviours of the creative people slanted the way that creativity has been conceptualised. Therefore, teachers need to evolve with times, meaning that teaching practice can only be creative when it's always evolving. Furthermore; teachers can become intellectual risks takers if they are always eager to try new things in the classroom as often as possible. This doesn't mean teachers can't have some tried--and-true activities that always are a part of their practice (Henriksen & Mishra, 2013).

Self-development is vital for teachers; we live in a world that keeps on evolving for the better. Self-development can either mean enrolling for short courses or honours concerning TE, this will mean they will read a lot, do research timeously and be on par with current issues concerning the subject. Based on the responses provided by teachers, it clear that teachers see the importance of keeping up with the current issues. A formal enrolment with a tertiary institution for self-development would be for them to be always relevant in the space they are occupying.

**Question 10: Do you allow learners to use technological tools that will enhance their creativity and concurrently capture their interests?**

*Jill: Yes, I do allow them particularly when I have given a topic to research on I encourage to use their smartphones to access internet and I also when they are doing investigation for min-PAT.*

*Joy: Yes, I encourage them to use smartphones, laptops to access internet during an investigation of min-PAT and also use community facilities as the community library.*

*Paul: I normal at times give activities that will channel the learners to use a technological tool be it a phone, laptop and etc.*

*Blade: Off course I do; forth industrial technology is eminent.*

Guilford (1957) as a pioneer of creative research made an important assumption for creativity is not one abstract concept but rather multi-facets, living it open for other researchers to look at creativity with a whole new perspective. Drawing inspiration from Guilford's work, the current trends in enhancing creativity resumed in the 90's due to the intense social, economic, and technological changes in the current days (Craft, 2001; Shaheen, 2010). Furthermore; Henriksen, et al. (2016) allude that in the modern days the presence of digital technologies, content, knowledge or information can be created, shared, and discovered much more efficiently and effectively. Moreover; digital technologies have changed the cause of teaching and learning if correctly exploited it always yields positive results more effectively and efficiently.

Given the responses by the teachers, what is done in this aspect is not enough. In the era we live in, technology has taken centre stage in everything, teachers need to play their part by always using DTs tools in teaching and learning to prepare our learners for the world we live. In developing CTS of learners' DTs is a vital aspect to produce the kind of learners envisage by the CAPS document.

**Question 11: How do you encourage your learners to analyse of their augments and ideas?**

*Jill: I encourage them to use different source of information, such different textbooks, internet, after of which I allow them to discuss their findings and debate them in their respective groups.*

*Joy: first I encourage them to do individual research, thereafter come and have group discussion and based their arguments based on facts rather than opinions and try harmonise their findings and eventual coming up with one idea or solution.*

*Paul: Debating based on facts, meaning I expect all learners to do some form of research given a topic or scenario*

*Blade: I encourage them to debate issues with facts that they have research in relation to a given topic, and then consolidate them in order to find common grounds.*

Guilford (1957:112) explain that convergent production is a process where items/ideas are harmonised towards one possible answer/idea and whereas divergent production is a process where different items/ideas are being generated as possible answers in responding to a problem to be solved. Furthermore; it is revealed that convergent production and divergent production occur together. Elaboration as a divergent thinking ability is elaboration which identifies a person's/group ability to add details to products, ideas, or creative solutions. Elaboration occurs after an idea has already been generated and embellishments are added to the original idea. It is a process were a

chosen idea is modified through making complementary elements, allowing a group/person to develop more creative products.

The teaching for creativity always encourages learners to ask questions, argue, discuss their thoughts and actively engage in their learning, it also aims for creative learning and the development of creative learners (Craft, 2005:42). In Guilford's terms, this is the stage where convergence meets divergence for creative production. Two/more minds are better than one, learners need to be able to work with others as a team. A team will always have different ideas to a problem, but what is important is to arrive at one solution. The responses of teachers, in this case, have shown that debating is a proper way of harmonising ideas and arguments, however it is important for learners to respect each other's ideas and argue with facts to come up with a best suitable solution to a problem.

**Question 12: How do you give provision to allow learners to play around new/innovative ideas and eventually coming up with one idea?**

*Jill: Allow and encourage learners to communicate their ideas in groups to find common grounds when doing min-PAT.*

*Joy: Brainstorm as groups and do discussions as groups.*

*Paul: Debate and respect one's idea at all times*

*Blade: Encourage learner to come up with a product that be able to exhibit at school and in programs such Science Expo at circuit level up to national depending of their success on the project.*

Fluency is one aspect of creative thinking skills to be developed amongst learners under the umbrella of divergent thinking which is the foundation of creative thinking. Fluency provides the learners with the ability to rapidly-produce a variety of ideas that fulfil stated requirements; the ability to generate a list of ideas, each of which is associated with a problem at hand; ability to organise or harmonise the ideas into one suitable idea to the problem waiting to be solved (Guilford, 1959).

Teachers should provide enough support and motivation for learners encouraging them to come up with solutions and answers for problems presented to them. The best solutions or answers learners discover will ultimately be developed into innovation and unique ideas (Shively, 2011; Sharples, De Roock, Ferguson, Gaved, Herodotou, Koh, & Weller, 2016).

In relation to the above information it is important for one to understand that invention/innovation require risks taking, for learners to be able to come up with one innovative idea needs to be encouraged to take risks without fear failure, give the freedom to play around ideas and be motivated all the times. Responding to this by the teachers, encouraging learners to always discuss their findings to find common grounds is important.

**Question 13: As a teacher who fosters creative thinking in a technology classroom, how do you assist your learners to reach common ground when they have multiple ideas or opinions?**

*Jill: Encourage them to debate their findings with facts and find common grounds.*

*Joy: Create awareness for learners to be able to respect each other ideas, always debate with facts in order to find common ground.*

*Paul: Debate issues with fact based on their individual research*

*Blade: Let them debate issues based on facts, consolidate their findings eventual come up with one suitable idea.*

Convergent thinking was originally defined by Guilford (1957) as the process of harmonising different ideas obtained during the divergent thinking process where items are converging toward one right answer/idea. Furthermore; convergent thinking is looked at as the “production of singularity”. Convergent thinking often viewed as the opposite and the complement of divergent thinking (Guilford, 1967; De Rooij & Vromans, 2020).

During creative idea generation, for instance, the various set of material/ideas that are generated through divergent thinking can form the basis for deriving a single best solution through the process of convergent thinking. Divergent and convergent thinking can, therefore, support the generation of ideas that are both original and effective in resolving a societal problem (De Vries, & Lubart, 2019; Puccio, Burnett, Acar, Yudes, Holinger & Cabra, 2020).

According to Amabile (2018) most often than not creative acts occur in a collaborative context. Groups' offers a sufficient pool of knowledge, experiences, and views to produce an optimal outcome at each stage of the problem- solving process (Moirano, Sánchez, & Štěpánek, 2020). Cooperative orientation, promoting the exchange of resources and information, and transparency to each other's ideas, could be induced by creating a common task requiring group collaboration. Furthermore; group task that has a high-level task interdependence leads to a greater sense of collective ownership and responsibility (Graesser, Fiore, Greiff, Andrews-Todd, Foltz, & Hesse, 2018).

It is always good for a group to have a multiple of ideas/solutions to a problem, but narrowing the ideas to one idea/solution might be a daunting task, if not well handled it can temper with the self-confidence of learners, it can also demotivate learners hence teachers have to be careful when dealing with such. During the process of convergent thinking, monitoring and supervision of by teachers need to be at an appropriate level not to hinder with the development of learners' creativity. Responses of teachers indicate that it was vital to always encourage learners to exchange information, present facts when debating to harmonise their ideas to one solution.

**Question 14: Learners are likely to make errors in any activity; how do you encourage your learners to correct their errors?**

*Jill: Make corrections, by identifying the errors and correct them.*

*Joy: Give them remedial work and provide clarity were necessary*

*Paul: I encourage them to consult with fellow peers, then after of which I will come in as teacher to provide further clarifications if needed.*

*Blade: I will always give remedial work to my learners, provide supervision all the time if they are errors clarify and allow them to redo the work.*

Originality is the single dimension of divergent thinking that is often most related to the construct itself. However, originality only measures the degree to which an idea is uniquely different from ideas that would have been generated by others (Guilford, 1967). According to Shively (2011), originality is the foundation of innovation and without taking risks is not achievable. Therefore, to support originality within the learners' creative thinking process, it is a vital exercise for teachers to allow mistakes and problems to occur. Originality can be obtained by generating the idea or through elaboration on a previously generated idea or using flexible thinking to alter a previously generated idea. Individuals that are better at producing original ideas will generate more creative products. It is expected that the same process is true at the group level (Guilford, 1967).

In any activity that is aimed at developing CTS of learners, learners should be given the freedom to take risks and in the process, they will make mistake, it therefore important that teachers understand that mistake/errors are part of the learning process. Learners should be motivated to take risks, allowed to make mistakes and learn from their mistakes. Responding to the question all the teachers seemed to have an understanding that mistakes or errors during any activity is part and parcel of the learning process. Moreover; it is important to provide a platform for learners to falter without fear and allow them to rectify their own mistakes in creating the best product or coming up with the best solution to a problem.

**Question 15: Considering motivation as the main driver of creativity, what type(s) of motivation do you use to that ensure learners are always at their best performance?**

*Jill: Applauding if one has done impressively, share encouraging words, have positive talks.*

*Joy: Have motivation talks in class or talk to individuals, praise them for good performance.*

*Paul: Other than praising them for a good performance I have no other forms of motivations.*

*Blade: Provide the learner with intrinsic motivation; allow them to have the satisfaction*

One of the pioneers of creative research further supporting Guilford's work, Amabile (1996) defines creativity as the intersection of a person's domain-required skills, creativity- required skills, and motivation. Furthermore, motivation enables an individual to generate new ideas. Emphases on motivation are essential for creative performance and have a great potential to propagate a person in the pursuit of unachieved goals during the creative process (Amabile, 1996). The period of creative behaviour is a process that begins with the arousal of motivation and resulting in a finished product (Runco, & Pritzker, 2020).

Intrinsic motivation, for instance, a person's passion and personal interests, are important aspects to assist learners to make progress in developing their creative thinking skills (Sternberg, 2006; Rheinberg, & Engeser, 2018). A Freedom and a supportive environment are the extrinsic motivation that engages learners in developing creative work. Intrinsic motivation is drawn from within a person's, satisfaction, enjoyment of creation. It is characterised by six managerial practices namely challenge, freedom, resources, workgroup features, supervisory encouragement, and organisational support (Amabile, 1996).



In developing CTS of learners motivation is one of the vital factors to be used to ensure that is achieved. So it important for teachers to always motivate learner when they have achieved something doing their activities. They are many forms of activities that teachers can always employ to motivate learners to be always interested in achieving more in their learning. However; responses showed that teachers have limited forms of motivation they seemed to be familiar with supervisory encouragement, which is all about recognitions, cheering, praising, etc. Blade indicated intrinsic motivation as the key to creativity. However, he could not explain further what intrinsic motivation is and what it entails.

**Question 16: Last question: as TE teacher in Grade 9 would you say you have the clear understanding of what it entails to foster CTS and the resources to do so, to produce the kind of learners needed for the future of the country as stipulated in the CAPS document? Elaborate**

*Jill: Yes I do have what in entails, I'm a researcher, I always provide learners with the platform to express themselves to the best of their abilities, I give assessment tasks in form of tests or min-PAT after each and every chapter. Resources to teach the subject are not adequate.*

*Joy: I partial have what entails, the challenge is that some topics are challenging due to shortage of resources and adequate training.*

*Paul: Some tools are available but not enough to allow leaners to interact or be able to do on their own to boost the creativity in class, demonstrating is not enough to rouse their creativity than for them to do it themselves. As a teacher yes I have what entails to forester creativity I have a high level of what creative thinking is all about.*

*Blade: Yes, I do due to the number of years teaching technology, the resources sometimes available, but we are faced with problem that limited as they are learners tend to break them during learning, a more Technological approach is required.*

The current education climate can make risk-taking difficult. It is the responsibility of the school administrators to ensure the establishment of a climate that accepts thoughtful experimentation, and also the empowering of teachers to be innovative and try new things in the classroom, school leaders must be open to listening. If a teacher has an idea or wants to try something new, a leader should be always willing to listen, discuss, and collaborate on ways that idea might be implemented (Henriksen, & Mishra, 2013). In light of the teachers' responses on this question, they all indicated that the issue of resources is a serious challenge in schools in South Africa. Therefore; the issue of resources is quite a thorny issue that needs the Department of Basic Education to heed to and deal with it precisely. Teachers must be provided with all the necessary resources to put their maximum skills into use in ensuring the teaching and learning process is not compromised.

### **4.3 Observations**

The observation was used to collect data as one of the data collection methods as explained in Chapter 3 paragraph 3.7.2. The researcher observed one lesson from each school to explore the development of creative thinking skills concerning teaching and learning of Grade 9 technology. The researcher collected and recorded data in the following manner:

- The researcher sat at the back of the classroom throughout the lesson presentation, recorded the presentation, and took notes.
- The researcher observed the teachers' practices and application to enhance the creative thinking skills of the learners during the teaching and learning situations.
- The main purpose of the lesson observation was to answer this question: how can teachers support learners to develop CTS in a Grade 9 Technology classrooms? Data were collected using the observation sheet (see annexure H).

The teachers are expected to bring along a lesson plan to class with them. This should be covering not less than 60 minutes. As per policy, the lesson plan should clearly outline everything to be done in class. It should be noted that the lesson plan is expected to always have 30 minutes of the 60 minutes for practical work covering the technological process or some parts of it, as it is the cornerstone for teaching and learning of technology. The technological process/DP provides the platform for the development of CTS. Other than the lesson plans the teachers are expected to bring with them all the required/necessary resources as per their preparation plan, e.g. Textbooks and apparatus for demonstrations or practical activities to be done in class.

Moving on to the observations; the researcher managed to observe three of the four lessons were to be observed as indicated in chapter 3. The reason(s) let to that was due to the disengagement (go slow) of teachers in the area of Nkomazi at the time of data collection, which resulted on one of the teachers not getting the learners to make the lesson observation as per agreement. The three observed classes the teachers were on different topics, the reason being some teachers fail to honour their agreements with the researcher. Hence the researcher had to make other arrangements with other teachers who were willing to be participants in the study falling at different times and topics.

*The first class to be observed was:*

*Paul*

*He took with him to class a textbook. He taught about gear ratio showing learners how to calculate it as well as the mechanical advantage. After of which learners were given a class activity to do that did have timeline for completion, after 20 min he then started with marking of the activity. The class was dominated by the teacher for duration of 60min. the researcher was hoping to see some practical activity in the last 30 min of lesson were one will be able to clearly see how the teacher goes about in fostering creative thinking skills to the learners.*

*The second class to be observed was:*

*Jill*

*She took with her a textbook with the teacher's guide, the topic was electrical and electronic components, on her previous learning she gave the learners subtopic to a group presentation in class. Two groups were able to present, but more could have presented if time allocation was done properly, however the presentations done by the two groups showed some interesting insights, it showed some of the design process were captured such as investigation evaluation and presentation. Moreover; through interaction with teacher after the lesson the researcher on went to see a project completed by the learners (min-PAT) on electronics. The learners created a day light system, it was clear that the learners were provided with a scenario for the completion of this project. That complemented the presentations made by the learners in class. Jill's class all in all it a learner centred class of which it was good, the participation of the learners was maximum. However; the class did not have practical demonstration it was too theoretical, the mini-PAT as a formal assessment tasks were supposed to have been completed it in class under the supervision of the teacher as stipulated in the CAPS document. Doing it in class step by step that would have given Jill the opportunity to correct take the learners through the design process allowing them to exercise their creative thinking to the best of their ability.*

*The third class to be observed was:*

*Joy*

*Her lesson presentation was on orthographic drawings, reasons are that she was already finished with the third term work, so she felt doing revision on orthographic will assist learners since they are straggling. Joy like Jill she did not bring the lesson plan to class, with her she had copies of activities that she distributes before she could start teaching. She posed a question for learners to define orthographic learners responded well to the question, she then took the learners step by step on how to go about in a 3D drawing after of which she gave them an activity to complete in class and they in the time frame indicated by the teacher. Looking at the nature of technology which problem*

*based learning, Joy should have provided learners with a scenario that will channel learners to follow the design process in order to gain the necessary skills needed in the modern society in this it would be CTS.*

*The design process is the corner stone of technology education therefore it is imperative for teachers to understand that in every activity given to learners it should seek to enhance the teaching of the design process and subsequently lead to the acquiring of vital skills such as CTS.*

*Blade*

*His class could not be observed due to the on-going dis-engagement by the teachers in the region of Ehlanzeni at the time.*

At the end of lesson observations, the researcher deduced numerous incidences occurred or not properly carried out by teachers that compromise the process of teaching and learning particularly hindering with the development of CTS. The researcher noted that none of the three (3) observed teachers seemed to heed to policy stipulations. The three teachers none of them brought with them the lesson plan/lesson preparation to class nor apparatus/material of any sorts to be used for demonstration or practical activities. The importance of bringing the lesson plan in class provides the teacher with a referral document for guidance throughout the lesson. Hence; the CAPS for technology clearly states that 30 minutes of the 60 minutes of the lesson should be allocated to practical activities promoting the teaching and learning of the design DP. It is the DP that unlock learners' mind to CT.

The displayed behaviour has nothing to do with a shortage of resources. The researcher is a technology teacher and is ware that the Department of Education in the province of Mpumalanga provided all schools with technology kits in a mobile box. The kit provides teachers with apparatus and relevant material to carry out practical activities or demonstrations. During the lesson observations, the researcher also learned that

teachers are able to provide learners with the mini-PAT as required by CAPS, but all the teachers seemed to have it wrong or not familiar with certain stipulations of the subject policy. The policy outlined that all mini-PAT as a formal assessment is to be done in class under the supervision of a teacher. The teachers on these aspects will give learners the Mini-PAT to do by themselves at home and then submit later on a specified date. Trying to establish the reasons behind this unethical behaviour, the researcher learned that it is common practice and is done by teachers who seem oblivious of the fact that this is not in compliance with the policy. This act by teachers not only compromises the teaching and learning of technology, but it hinders with the development of CTS of learners. The development of CTS is embedded on the DP, therefore if Mini-PAT is done in class according to policy stipulations, it provides a platform for teachers and learners to engage the DP step by step, moreover cultivate the development of CTS.

#### **4.4 Document Analysis**

Documents analysis was done using a checklist of documents that are expected to be in the teacher's file see annexure F. The first four (4) documents on the checklist are the vital documents (CAPS document, subject school policy, work schedule and annual teaching plan) with regards to the facilitation of the teaching and learning process. All the four documents complement each other, but the CAPS document as the main document or reference point for all the other documents. Hence, these documents were not up for scrutiny. These are the documents that are provided by the school/Department. All teachers are expected to have these documents in their files and are also expected to timeously refer to them for anything they do concerning the teaching and learning process of the subject.

After lesson observations, all four teachers were requested to provide the subject teachers file to do the data analysis. Three of the four teachers had all the necessary required documents as per checklist, and one of the four had all the other documents

excluding lesson plans. Analysing the contents of the documents the following was discovered:

### **3.13.3      4.4.1 Personal time table**

The teaching time for Technology is two (2) hours in a week. This subject includes practical work that is allocated 60 minutes of the two hours should be one continuous period for practical work, e.g. one double period comprising two periods of 30 minutes. Schools using alternative period lengths, or a cycle system, must ensure that they protect the subjects teaching time by making sure the time allocation is sufficient and there is time allocated for practical sessions (DBE, 2011: 13). There personal time tables for all the four teachers showed adherence to policy concerning the time allocation of the subject, two hours a week on each time table was reflected.

### **3.13.4      4.4.2 Lesson Plans**

Lesson planning refers to as a pre-active decision making that takes place before instructions. It is a process whereby teachers, consciously and unconsciously make decisions that affect their behaviour and that of learners. Cognisant decision making, such as lesson planning, involves teachers' conscious efforts in developing a coherent system of activities that promote the development of learners' cognitive structures (Orgoványi-Gajdos, 2016).

All the three teachers who had lesson plans in their file during the analysis of the documents, they used the same template, but not only that even the contents of their documents were the same, but the researchers later discovered that it was because the teachers were under the guidance CI operating in the district of Ehlanzeni. The CI normally organise content enrichments workshops before the beginning of a new term and with the teachers do the lesson planning for the coming term and the formal and informal assessment tasks.

The lesson planning showed to be well-orchestrated with the policy document (CAPS). All aspects of the lesson seemed to be well covered, starting from time allocation, topic and sub-topics to be covered, outcome to be achieved. However; the lesson plans did not clearly show the 60 min for practical activities of the two hours a week as prescribed in the CAPS document, and that can lead to a serious blow in teaching and learning since technology is more a practical subject. Such a blow can have a detrimental impact on the development of CTs since these are the skills emended on teaching and learning of the DP. The understanding is that the practical activities provide both teachers and learners with the platform to engage with all the steps of the DP continuously and simultaneously develop CTs.

### **3.13.5      4.4.3 Formal assessment tasks**

Formal assessment provides teachers with a systematic way of evaluating how best learners are progressing in a particular grade and a particular subject and gives insight into the success of the teaching strategy and methodology. Formal assessment for Technology will consist of the Mini-Practical Assessment Tasks and pen and paper tests or examinations a term/quarterly. Furthermore; 40% out 70% Mini-Pat marks per term must be attributed to Practical work. (DBE, 2011:39)

#### **4.4.3.1 Tests**

A standardised Test makes up 30% of each term's assessment. A test for formal assessment should cover a substantial amount of skills and content and should be set as follows: Grade 9 technology test should be written over 60 minutes, marks allocation for tests is not prescribed but should be determined by the teacher taking into account the volume of the content covered and the time available. Only one test per term, this may take place either just before or just after the mini-PAT and must be planned in the school assessment programme (DBE, 2011:45).

In technology, the value of memorising by rote learning has little weight in a subject requiring innovation, creativity and problem-solving skills. The ability to think laterally



and to develop original and appropriate solutions is a vital aspect of learning Technology. Furthermore; learners should be able to investigate various sources, demonstrate their ability to draw in a specific style, write a design brief, give specifications and constraints, select appropriate materials for a model, plan the sequence of manufacture of a product, evaluate a design objectively, analyse a system using systems diagrams and communicate their solutions using a range of techniques. Questions that integrate knowledge, skills and value have more value in technology than mere recall of knowledge facts. (DBE, 2011:45).

The test as a formal assessment must cater for a range of cognitive levels and abilities of learners. The tests should have low order question (recalling) at 30%, Middle order questions (understanding & application) at 40% and high order questions (analyses, synthesise, & evaluation) also at 30% (DBE, 2011:41). Tests were given every term as part of formal assessment, adherence to the policy was on point all cognitive levels were well covered, but not only the levels also the time allocation as well as the mark allocations as it is stipulated in the policy. Furthermore; all the tests provided to learners have their memorandum as a marking tool to meet the required standard.

#### 4.4.3.2 Mini-PAT

(DBE, 2011: 13) Mini-PAT: A short Practical Assessment Task which makes up the main formal assessment of a learner's skills and knowledge application during each term. It may be an assignment covering aspects of the design process, or it may be a full capability task covering all aspects of the design process (IDMEC).

Technology as a subject has a significant practical nature. Therefore; it is important to develop and assess the skills and values together with the associated subject knowledge. In Technology, knowledge without the skills that are needed to implement a practical solution has little/no worth. Similarly, skills cannot be taught without the knowledge needed to design solutions to problems or to satisfy needs, which is the essence of the Technology subject (DBE, 2011:38).

In all the three terms learners were given a Mini-PAT as part of formal assessment tasks, marked and recorded. However; the researcher discovered that the teachers in all Mini-PAT given to learners did not provide a marking tool nor rubric. The preferred tool to be used for assessing learner performance in a Mini-Practical Assessment Task is an analytical rubric. Teachers must assess skills and values using analytical rubrics which should have clear descriptors for each level, meaning that a descriptor should say why achievement is deemed to be, say, 'meritorious' or 'elementary' (DBE, 2011:42). Another thing that seemed odd was that teacher will give learners a Mini-PAT to go and do it as a home activity which is totally against the policy stipulations. Learners are required to do the Mini-PATs for formal assessment under teacher supervision at all times (DBE, 2011:42). Work done outside/after school without the direct control of the teacher should normally not form part of the formal assessment records (DBE, 2011:40).

A Mini-PAT is the main form of assessment that actualise the teaching and learning of the DP. They need to understand that the DP process is the core in teaching and learning of technology in achieving the aims and objectives of the subject is vital to teachers and CI. Therefore; teachers must be familiar with the policy with regards to Mini-PAT because it the type of formal assessment that strongly caters for the development of CTS through the DP.

#### 4.4.3.3 Mark recording sheet(s)

According to DBE (2011:38) recording is a process in which the teacher documents the level of a learner's performance per assessment task. It indicates learner progress towards the achievement of the knowledge as stipulated in the Curriculum and Assessment Policy Statements. Records of learner performance should provide evidence of the learner's conceptual progression within a grade and her/his readiness to progress or be promoted to the next grade. Records of learner performance should also be used to verify the progress made by teachers and learners in the teaching and learning process (DBE, 2011:46).

All mark recording was properly done by teacher and validation of marks recording was duly done. All information needed to appear on mark recording sheet was available e.g. the subject, percentage composition of formal tasks, name and surname of the learner, gender, etc.

#### **4.5 Summary of the Chapter**

In this Chapter, a detailed presentation of the data analysis collected through document analysis, observations, and interviews were provided. The chapter firstly outlines the profile of teachers sampled to participate in the study. Furthermore; findings and discussions of the document analysis, observations, and interviews of teachers are also presented. Following the discussion and findings of data collected from teachers, a profile of curriculum implementers sampled to be participants in the study is also outlined, followed by the discussions and findings of the interviews.

Looking at the findings it is quite concerning that after 15 years plus since the introduction of technology as subjects, the teachers are still lacking the understanding of CP because technology as a subject was introduced to develop CTS of learners. To cater to the needs of the country, which is the shortage of engineers and artisans. Moreover; the CAPS document through the help of the teachers, expect learners to acquire and develop creative thinking skills necessary to compete in the world we live in.

The understanding of the concepts of creative thinking skills and what it entails is vital to technology teachers, which will enable them to be in a position to make adjustments in their teaching strategies towards helping learners to develop CTS in technology as it envisages in the CAPS document. It is vital for technology teachers to well inform with skills such as creative thinking skills to able to enhance its development in a technology classroom.

Creative thinking skills are skills that clearly outlined in the CAPS document informed by its importance for its development, however; the findings indicated that teachers are paying less attention to its development.

In the CAPS document for technology, the DP is viewed as the cornerstone for the development of CTS. As stipulated in the CAPS document a mini-PAT is given to learners as a form of assessment every quarter, it is a form of assessment that allows the teacher to ensure that learners follow all the steps of the DP in developing the CTS. However; based on the findings teachers are failing to ensure that is realised because instead of doing every step of mini-PAT in class as stipulated in the CAPS document, they instead give learners to go and do home by themselves and submit in a particular day.

In this Chapter, it is shown that the participant was not able to give clarity on how they go about in supporting the learners to engage with aspects of CTS such as fluency, flexibility, elaboration, originality, complexity, risks taking, imagination and curiosity. It all boils to the fact that when the participants were required to provide an operational definition of creative thinking they all showed a limited understanding and what it entails in a classroom about the development of CTS. It was also evident with their lesson delivery when they were observed they could adhere to the CAPS policy, as stipulated in the document, technology is allocated two hours in a week and 60 min of two hours should be of doing practical activities which were not the case. The practical activities/Min-PAT allow the learners to engage with the DP, which pivotal for the development of CTS.

In the next chapter presentation, discussion, conclusions, will be presented and also provide the recommendations of this study for future research.

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## CHAPTER FIVE: SUMMARY OF THE FINDINGS, RECOMMENDATIONS AND CONCLUSION

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### 5.1 Introduction

This chapter presents a discussion of the primary findings, conclusions, limitations, and recommendations based on the results of the research. This study also reflects on the experiences of Grade 9 Technology teachers as well as the curriculum implementers in the Ehlanzeni district around Nkomazi Municipality. The study aimed to deepen the understanding of teachers' professional development experiences, from their point of view, when they are involved in strategically designed formative assessment activities. The objectives of this study were to explore, analyse and describe the circumstances, instances and strategies that these teachers used in developing the creative thinking skills of learners in a grade 9 classroom.

The findings and conclusions presented in this chapter, therefore, serve to answer the major research question, namely:

The main research question in this study was: How can teachers support learners to develop creative thinking skills in a Grade 9 Technology classroom?

To address the main question, it was then broken into three subsidiary questions:

- Which approaches do Technology teachers apply to support Grade 9 learners to develop CTS?
- What opportunities does CAPS provide for fostering CTS in a Grade 9 Technology classroom?
- What are the teacher's experiences when attempting to support learners to develop CTS?

Accordingly, this final chapter focuses on the following:

- A discussion of the primary research findings and the conclusions drawn from the findings (with regards to the study aimed at providing answers to the research questions);
- Recommendations (derived from this study and for further research);
- Limitations that reflect the shortcomings of this study; and
- A brief conclusion that summarises the study as a whole

## **5.2 Overview of the study**

Chapter One: The purpose of technology education in the South African curriculum was clearly outlined, its purpose is to support the learners to develop creative and critical thinking skills. The importance of creative thinking skills was well dealt with and it was also deduced that in the CAPS document lacks the proper guidance as to how to execute the development of creative thinking skills in a technology classroom. Informed by the lack of proper guidance by the CAPS document concerning the development of creative thinking skills the research main questions were posed as follows: “How can teachers support learners to develop creative thinking skills in a Grade 9 Technology classroom?”, accompanying the main question three subsidiary question was developed to conduct the study comprehensively. In conclusion Chapter one, pertinent key terms were defined.

Chapter Two: presented a theoretical framework and literature review. The chapter was categorised into the following themes: Social cognitive learning theory, thinking as a foundation of Creative thinking, furthermore Creative thinking was also discussed in more details. The creative process, learning environment and digital technology as important aspects of creative thinking were also addressed. The design process as the cornerstone in teaching and learning technology in developing Creative thinking skills through problem-solving was also dealt with, pointing out that the design process as

stipulated in the CAPS document provides ample opportunities for the development of creative thinking skills. It is therefore vital for technology teachers to identify and explore these opportunities in CP in a technology classroom setting.

Chapter Three: presented the research methodology employed in this study. The data collection techniques used to collect data were: Interviews, lesson observations and document analysis. Furthermore; these three instruments used for data collection in this study were described and they all yielded similar results. It was then followed by the description of how data was analysed. Ethical considerations were also addressed in this chapter.

Chapter Four: dealt with the presentation, analysis and interpretation/discussions of the data of the study. The study started with the biographical information of the participants of the study in terms of their academic qualifications, experience and current role in the education system.

Chapter five: presents the summary of the findings, recommendations and conclusions.

### **5.3 Summary of the findings of the study**

In this study, several findings were established that all stakeholders need to heed to. The findings of this study are categorised into three sub-divisions as described below:

- The first finding is that all the participants have shown little or no understanding of CT is and what it entails in teaching and learning of technology education. All the participants when they were required to define CT they all provided shallow definition. Furthermore; in responding to other questions relating to the development of CT, for instance on the environment, curiosity, self-confidence, new digital technologies, motivation and aspect of CP. They were unable to provide an answer that shown understanding and relation of these concepts.
- The second finding is that teachers have shown a lack of adherence to policy. In lesson planning of all the teachers did not clearly outline the practical activities to be done in 60min of the 120min allocated to technology per week as required by

policy nor during the delivery of the lesson. Again as per policy, the mini-PAT is a formal task that is given to learners every term and it must be completed in class that allows the teachers to explore some of the opportunities provided by the CAPS document. However; the norm is that the mini- PAT is given to learners to do on their own in their respective homes, which totally against policy, moreover hinders the opportunities for CTS development. The mini-PAT affords teachers with an opportunity to embody the practical aspect of technology through the DP as it is the cornerstone of teaching and learning of technology for the development of skills such as CTS. All four teachers give mini-PAT as formal assessment tasks; however, it was not completed in class as per policy, to some level compromising the development of learners' CTS.

- The third finding is that all the participants lack the understanding of the DP as the creative model acknowledged by the DBE as a mind map to navigate the cultivation of CTS in TE. All participant when asked about the aspects of the lesson planning when aiming for creative teaching and creative learning. Their responses were somehow concerning, because only one of the teachers and one CI mentioned they DP of the backbone CTS development, even they could not further elaborate in more specific details.

## **5.4 Recommendations**

### **3.13.6      5.4.1 Recommendations for teacher development**

Given the findings of the study that teachers lack understanding of the concept of creative thinking and what it entails, lack of policy adherence, and failure of keeping up with current trends that always influences the cause of teaching and learning for the better, there are recommendations for consideration:

Firstly, teachers need to have a fundamental understanding of CT as a concept concerning CTS development. Teachers are expected to provide the necessary support to learners to be able to follow the DP (investigate, design, make, evaluate, and communicate) as outlined in the CAPS document during any problem solving or when



they are doing mini-PAT as part of their assessment. It is also important to understand that all the steps of the design process are pivotal for the development of CTS. Therefore; all steps should fully exhaust since it is the cornerstone for the development of CTS. Supporting learners to develop the skills embedded in the DP, will help learners to acquire CTS that will of use in the world we live in, as it is envisaged by the CAPS document.

Secondly, teachers of technology should acquire the relevant knowledge, experience, understanding, and skills on how to teach for the development of CTS of learners. This will allow the teachers to employ the correct techniques to develop the CTS of learners through curiosity, inquisitiveness, and enthusiasm within a proper learning environment and employing necessary technologies to enhance the development of CTS relevant in the twenty-first century and to be on par with rest of world.

Lastly, technology teachers need to be familiar with CAPS document for technology, as it serves the guidelines on how to embark on the process of teaching and learning to release its purpose. Being familiar with the policy document will enable teachers to carry out the relevant instructional strategies that will ensure the maximum development of CTS of learners. It will also enable teachers to provide learners with the relevant activities, and form of assessments that will allow for the full exploitation of the DP as a model that is defined by the DBE in the CAPS documents to be the main pillar for the development of CTS in TE.

### **3.13.7      5.4.2 Recommendations for future research**

The focus of this study was on teachers and curriculum implementers for technology education as they are at the centre of policy implementation concerning teaching and learning of technology in developing of needed skills such as CTS. A study for the exploration of creative thinking skills mainly focusing on learners is recommended. In this study, it was revealed that both teachers and curriculum implementers lack the understanding of CP. A study focusing on the level at which teachers of technology cater to the development of CTS is recommended. All the teachers interviewed in this

study were from a rural school, a study focusing on former model C is also recommended

## **5.5 Limitations**

The limitations of the research are discussed concerning the literature review and the empirical study.

- Due to lack of funds, the study was confined within the Nkomazi municipality Schools, meaning only schools within the municipality were sampled. That has also led in sampling only rural schools, if urban schools “former model C” were sampled might have influenced the findings otherwise, given the fact that they have better infrastructure and well resourced.
- In terms of this empirical study, the sample size of six participating teachers and curriculum implementers in one district was not big enough to generalise the results to refer to a larger group of teachers. However, the findings are compelling enough to make a case for a wider study to be conducted.
- The data was collected in term 2 and 3 meaning class observations were done in different topics, due to fears of teachers to be interviewed and observed, another factor was that teachers were embarking on a disengagement campaign for the district to meet their demands. So during these times teachers were knocking off and going to the nearer circuit office for picketing.
- Important features have been left out, e.g. what teachers do in the classroom to assess their students (the domain of practice), nevertheless rich data were provided to contribute to knowledge about teacher growth in other domains, as outlined by the selected framework underpinning this study (see Figure 5.1).

## 5.6 Conclusion

In summation, this study investigated how teachers go about in developing CTS of learners in grade 9 as stipulated in the CAPS document. It is vital for teachers to fully grasp the concept of CT and what relates to it. Moreover; for the development of CTS, teachers need to provide the necessary support to learners to be able to evaluate statements, interpret information and analyse information. Furthermore; learners must be able to draw valuable overlapping of concepts, explain where it is due. These set of skills will enable learners to develop CTS that will of use over the school boundaries.

The CAPS document is very important in process of teaching and learning of TE in South African schools. Therefore the researcher recommends that teachers need to be familiar with the CAPS documents, this will enable them to be able to adhere to the policy during the teaching and learning process of the subject. In the CAPS document the DP is clearly outlined as it is the cornerstone for teaching and learning of technology, It is therefore important that the teachers engage learners to activities that will timeously allow/channel learners to use the DP, not certain/preferred steps of the DP (investigation, design, make, evaluate and communicate), but all the steps as they are all important in the development of CTS of learners in TE.

These recommendations were made because the participants, particularly the teachers are at the centre of policy implementation and curriculum delivery have shown a serious lack of information concerning the contents of the CAPS document. It is the DP that affords learners with opportunities to solve problems using their innovation. Teachers, in this case, did not show any support in building the learners CTS through a technological solution.

In all the schools visited during class observation the researcher learned that technology does not have a designated space/classroom with the minimum required resources as stipulated in the CAPS document. It is therefore recommended that the DBE/schools should heed to such, and make sure that teachers are afforded with all the

necessary resource to teach the subject. Furthermore; teachers themselves should also remind school administrators of such.

Moreover; the teachers should also be aware with current trends so they can make correct integrations that will enhance the development of CTS, for instance in architect in past a pencil, paper, and rulers were used in making drawings and that made their creation to take longer. But today architectural drawings are created on computers using drawing programs, making creation to done within a short space of time. So it, no doubt that new digital technology has changed how people communicate socialise, do business, in a nutshell, it has changed the way of life. Therefore teachers should not remain behind because the education system is made to produce learners that are equal to the sophisticated world that we live in.

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## ANNEXURES

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### ANNEXURE A: Request for permission to conduct a research study

Enquiries: Nkosi PB  
Cell number: [REDACTED]  
Email: [praybongji@webmail.co.za](mailto:praybongji@webmail.co.za)

P.O. Box [REDACTED]  
Uthokozani  
1346  
September 2018

The Director  
Department of Education  
Mpumalanga Provinces

Dear Sir/Ms

#### REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS

As a Master's student (Student Number 200308085) at the University of Limpopo specialising in Technology Education and working under the supervision of Dr M.I. Kola, I hereby request permission to conduct a research study entitled "*An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom*".

I am writing to request your department to allow me access to the following selected schools in your province:

- Mpumalanga Province (Ehlanzeni District): Schools A, B, C and D.

As the researcher in this study, I would like to assure the Mpumalanga Department of Education that the research will be conducted within the prescripts of ethical principles for the conduct of research.

The proof is attached of my registration for the study towards my degree at the University of Limpopo.

I look forward to hearing from you about your decision to allow me to conduct this study in the selected schools.

Yours faithfully

.....

P.B. Nkosi (Researcher)

**ANNEXURE B: Request for access to conduct research letter**

Enquiries: Nkosi, PB  
Cell number: 083 [REDACTED]  
Email: [Praybonqi@webmail.co.za](mailto:Praybonqi@webmail.co.za)

P.O. Box [REDACTED]  
Uthokozani  
1346  
September 2018

The Circuit Manager  
Dear Sir/Ms

**REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SCHOOLS**

As a Masters student (Student Number 200308585) at the University of Limpopo specialising in Technology Education under the supervision of Dr M.I. Kola, I hereby request permission to conduct a research study entitled "*An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom*".

I am writing to request your office to be so kind as to allow me access to the following selected schools in the circuit:

- Mpumalanga Province: School A, B, C and D.

As the researcher in this study, I would like to assure the Mpumalanga Department of Education that the research will be conducted within the prescripts of ethical principles for the conduct of research.

The proof is attached of my registration for the study towards my degree at the University of Limpopo.

I look forward to hearing from you about your decision to allow me to conduct this study in your schools.

Yours faithfully  
.....  
P.B. Nkosi

## **ANNEXURE C: Participants' informed consent form**

**Title:** *Exploring Creative Thinking Skill in a Grade 9 Classroom*

**Researcher:** Nkosi P.B

**Date:** \_\_\_\_\_

I volunteer to participate in a research project conducted by Mr P.B. Nkosi from the University of Limpopo. I understand that the project is designed to gather information for the research topic: "*An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom*".

1. The procedure envisaged might hold some risk for the participants that cannot be seen at this stage.
2. The Ethics Committee has given its approval that the individuals may be approached to participate in the study.
3. The experimental protocol, that is the extent, aims and methods of research, has been explained to me.
4. The protocol sets out the risk that can be reasonably expected as well as possible discomfort for persons participating in the research, an explanation of the anticipated advantages for participants or others as are reasonably expected from the research, and alternate procedures that maybe to his/her advantage.
5. I will be informed of any new information that may become available during the research that may influence the willingness of participants to continue participating.
6. Access to records that pertain to participants' participation in the study will be restricted to persons directly involved in the research.
7. Any question that I may have regarding the research, or related matters, will be appropriately responded to by the research.
8. Participation in this research is voluntary and participants can withdraw their participation at any stage.



9. I indemnify the University of Limpopo and all persons involved with the above project from liability that may arise from participants' participation in the above project or that may be related to it, including negligence on the part of the above mentioned persons.

**Agreement to participate in the research:**

I have read, or have had read to me, the above relating to the study and have had an opportunity to ask questions, which have been answered to my satisfaction. I agree voluntarily to participate in the study as described.

.....  
Date

.....  
Participant's name

.....  
Date

.....  
Signature of consenting party

.....  
Date

.....  
Signature of the investigator

.....  
Date

.....  
Signature of witness

## **ANNEXURE D: Interview Guide for teachers**

### Opening

[Greetings and shake hands] My name is Bonginkosi Nkosi, a student at the University of Limpopo doing master's degree in Mathematics, Science and Technology. I am conducting research for my dissertation titled: "***An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom***". I figured it would be best if I could interview you as a Curriculum Implementer / Technology Education Teacher, so as to gather valid data for my research project and I hope to use this information for my results.

I would like to ask you some questions about your profession, your choice of study and the experiences you have while teaching TE. First, please note that you have every right to refuse to take part and, should you feel uncomfortable during the process, you are allowed to withdraw from the interview. Last, please feel free to ask questions where you need clarity about anything.

This interview should take about 45 minutes of your time; are you available, please, to respond to the questions at this time?

### Body

Transition: *Personal Information*

Let me begin by asking you about yourself

- Please could you introduce yourself

Transition to the next topic: *Education*

- When and where did you study for your higher education qualification?
- What were your major subjects?
- In which year did you start Teaching?

- In which grade do you offer TE?

Transition to the next topic: Knowledge about TE and planning

- As technology teacher what is your understanding of Creative Thinking in relation to the subject?
- Research has shown that creativity is not a talent but a skill that can be taught, during planning what are the key fixtures that ensure the teaching and learning of CTS in a classroom?
- How are your CTS substantiated in relation to CAPS?
- Environments always effect on one's level of creativity, what are the aspect that you take into consideration for positive teaching and learning environment in relation to creative thinking during planning?
- Curiosity and the desire to explore are critical aspects of creative thinking, therefore what kind of approach do use to keep learners on their toes?
- Self-confidence is an important factor in creative thinking whereby learners need to have the sense of safety in risk taking without the fear of faltering; how do support/encourage learners to take risks?
- As a technology educator, what are your strengths in teaching Creative Thinking Skills (CTS) in a technology classroom?
- Transition to the next topic: classroom practices
- The world we live in has evolve with digital technology, during planning/ teaching and learning do you employ any digital technology tool?
- What are your personal traits that better allows you to teach Creative Thinking Skills?
- Do you allow learners to use technological tools that will enhance their creativity and concurrently capture their interests?

- How do you encourage your learners to analyse of their augments and ideas?
- How do you provision for to play around new/innovative ideas and eventual coming up with one idea?
- As a teacher who fosters creative thinking in a technology classroom, how do you assist your learners to reach common ground when they have multiple ideas or opinions?
- Learners are likely to make errors in any activity; how do you encourage your learners to correct their errors?
- Considering motivation as the main driver of creativity, what type(s) of motivation do you use in order to that ensure leaners are always at their best performance?
- Last question: as TE teacher in Grade 9 would you say you have the clear understanding of what it entails to foster CTS and the resources to do so, in order to produce the kind of learners needed for the future of the country as stipulated in the CAPS document. Elaborate.

Last question: as TE teacher in Grade 9 would you say you have the clear understanding of what it entails to foster CTS and the resources to do so, in order to produce the kind of learners needed for the future of the country as stipulated in the CAPS document. Elaborate.

### Closing

Well, it has been a pleasure finding out more about you. The information that has been recorded will be used in the results of this study. I appreciate the time that you took for this interview, and I think that I should now have all the information I need. Is there anything else that you feel would be helpful for me to know? Or is there any information that you feel should be excluded from the recording?

Would it be okay to call you if there are any more questions? Thanks once again.

## **ANNEXURE E: Interview Guide for curriculum implementers**

### Opening

[Greetings and shake hands] My name is Bonginkosi Nkosi, a student at the University of Limpopo doing master's in Mathematics, Science and Technology. I am conducting research for my dissertation titled: “**An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom**”. I figured it would be best if I could interview you as a Curriculum Implementer / Technology Education Teacher, so as to gather valid data for my research project and I hope to use this information for my results.

I would like to ask you some questions about your profession, your choice of study and the experiences you have while teaching TE. First, please note that you have every right to refuse to take part and, should you feel uncomfortable during the process, you are allowed to withdraw from the interview. Last, please feel free to ask questions where you need clarity about anything.

This interview should take about 45 minutes of your time; are you available, please, to respond to the questions at this time?

### Body

Transition: *Personal Information*

Let me begin by asking you about yourself

- Please could you introduce yourself

Transition to the next topic: *Education*

- When and where did you study for your higher education qualification?
- What were your major subjects?
- Which subject is your speciality?
- In which grade do you offer TE?

Transition to the next topic: *planning*

- Do you do school or class visits? If yes, how often?
- What are the things you expect from a teacher when doing the school/class visits?
- Do you conduct content enrichment workshops? If yes, how often?
- What are the aspects/ topics that you normally look in to?
- What informs those aspects/ topic choice to be treated in workshops?
- Do you employ any technological tool when conducting workshops?

Transition to the next topic: *content*

- What is your understanding of Creative Thinking?
- Do teachers in school have correct understanding of creative thinking entails in TE?
- In your planning what are the key fixtures that ensure the teaching and learning of CTS in a classroom?
- Do teachers have clear understanding on how to substantiate CTS in relation to CAPS?
- Environments always effect on one's level of creativity, what the aspect that teachers need to take into consideration for positive teaching and learning environment during planning?
- Curiosity and the desire to explore are critical aspects of creative thinking, therefore what kind of approach can be used by teachers to keep them on their toes?
- Self-confidence is an important factor in creative thinking whereby learners need to have the sense of safety in risk taking without the fear of faltering; how do support/encourage learners to take risks?

Transition to the next topic: classroom practices

- Do teachers employ any technological tool when teaching?
- Are learners allowed to use technological tools that will enhance their creativity and concurrently capture their interests in class?
- Considering motivation as the main driver of creativity, what type(s) of motivation can be used by teachers in order to that ensure learners are always at their best performance?

Last question: would you say that teachers have the understanding of what entails to foster creative thinking skills and the resources to teach CTS to produce the kind of learners as stipulated in the CAPS document.

### Closing

Well, it has been a pleasure finding out more about you. The information that has been recorded will be used in the results of this study. I appreciate the time that you took for this interview, and I think that I should now have all the information I need. Is there anything else that you feel would be helpful for me to know? Or is there any information that you feel should be excluded from the recording?

Would it be okay to call you if there are any more questions? Thanks once again.





**ANNEXURE G: Observation schedule**

<b>Creative thinking skills</b>	<b>Challenge</b>	Tolerance of ambiguity	Perseverance	Willingness to grow	Openness to experience	Willingness to take risks	<b>Freedom</b>	Teaming	sharing	compromising	Decision making	<b>Resources</b>	Political atmosphere	Interpersonal relationships	Physical space	Equipment & suppliers
<b>Technology Design process</b>																
<b>Investigation</b>																
Investigate solutions																
Investigate the nature of the problem																
Incorporate content into the design																
<b>Design</b>																
Design specifications																
Identify constrains																
Meeting & examining individual imputes																
Deciding on a final solution																
<b>Make</b>																
Plan development																
Draw working drawings																
Authentic problem																
<b>Communication</b>																
Team presentation																
Report compilation																

<b>Creative thinking skills</b>	<b>Work group futures</b>	Embrace diversity	Different expertise	Different creative thinking	Different cognitive abilities	Willingness to take risks	<b>Supervisory encouragement</b>	Curiosity	Reward exploration	Self confidence	Striking for balance
<b>Technology Design process</b>											
<b>Investigation</b>											
Investigating solutions											
Investigating the nature of the problem											
Incorporating content to into the design											
<b>Design</b>											
Design specification											
Identify constrains											
Meeting & examining individual imputes											
Deciding on the final solution											
<b>Make</b>											
Plan development											
Draw working drawings											
Authentic problem											
<b>Communication</b>											
Team presentation											
Report compilation											

## ANNEXURE H: Ethical Clearance



University of Limpopo  
Department of Research Administration and Development  
Private Bag X1106, Sovenga, 0727, South Africa  
Tel: (015) 268 3935, Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

**TURFLOOP RESEARCH ETHICS COMMITTEE**  
**ETHICS CLEARANCE CERTIFICATE**

**MEETING:** 06 March 2019

**PROJECT NUMBER:** TREC/42/2019: PG

**PROJECT:**

**Title:** An Exploration of Creative Thinking Skills in the Grade 9 Technology Classrooms

**Researcher:** PB Nkosi

**Supervisor:** Dr Ml Kola

**Co-Supervisor/s:** N/A

**School:** Education

**Degree:** MEd. In Mathematical Science and Technology Education

  
**PROF P MASOKO**  
**CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE**

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: REC-0310111-031

- Note:**
- i) This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.
  - ii) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.
  - iii) PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

*Finding solutions for Africa*

# ANNEXURE I: Permission to Conduct the Study: Mpumalanga Department of Education



education  
MPUMALANGA PROVINCE  
REPUBLIC OF SOUTH AFRICA

Johannesburg, Government Boulevard, Riverside Park, Midrand, Mpumalanga Province  
Private Bag 27934, Midrand, 1600  
Tel: 011 752 8500/15, Toll Free Line: 0800 203 116

Uthokozani, Mpumalanga web site

Department van Onderwys

Uthokozani ka Cwekaba

Mr. F.B. Nkosi  
PO BOX 660  
UTHOKAZANI  
1246

## RE: APPLICATION TO CONDUCT RESEARCH: MR. FB NKOSI OF THE UNIVERSITY OF LIMPOPO

Your application to conduct research study was received and is therefore acknowledged. The title of your study reads thus: "An Exploration of Creative Thinking Skills in Grade 9 Technology Classroom." The aims and the objectives of the study will benefit the whole department in particular the relevant curriculum division. Your request is approved subject to you observing the provisions of the departmental research policy which is available in the departmental website and available on request. You are also requested to adhere to your University's research ethics as spelt out in your research ethics document.

In terms of the research policy, data on any research activity can only be conducted after school hours as per appointment with affected participants. You are also requested to share your findings with the relevant sections of the department so that we may consider implementing your findings if that will be in the best interest of the department. To this effect, your final approved research report (both soft and hard copy) should be submitted to the department so that your recommendations could be implemented. You may be required to prepare a presentation and present at the department's annual research dialogue.

For more information kindly liaise with the department's research unit @ 011 752 5476 or [a.baloyi@education.mpa.gov.za](mailto:a.baloyi@education.mpa.gov.za).

The department wishes you well in this important project and pledges to give you the necessary support you may need.

MR. J.R. NKOSI  
ACTING HEAD: EDUCATION

6/05/2019  
DATE



## **ANNEXURE I: Editor's Confirmation Letter**

10 June 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam

**Language edit declaration i.r.o. dissertation for a master's study by P.B. Nkosi entitled "An Exploration of Creative Thinking Skills in the Grade 9 Technology Classroom".**

As requested, this is a formal declaration that the language in the present master's study proposal underwent a professional language edit by Dr Thembinkosi E Mabila (MA English Language Studies; PhD Applied Linguistics).

Yours faithfully

A handwritten signature in black ink, appearing to read 'Thembinkosi E Mabila', with a small horizontal line extending to the right.

Thembinkosi E Mabila (Dr)