# *Grade 7 Technology Teachers' Topic Specific Pedagogical Content Knowledge in teaching Graphic Communication*

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A thesis submitted in partial fulfillment for the degree of Master of Education: Technology Education, in the School of Education and Development, Edgewood campus, University of KwaZulu-Natal.

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# DECLARATION

I hereby declare that "*Grade 7 Technology Teachers' Topic Specific Pedagogical Content Knowledge in teaching Graphic Communication*" is my own work and that all the sources I have used or quoted, have been indicated and acknowledged by means of complete references.

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# DEDICATION

I dedicate this thesis to my family, **Mrs Mcambi, Sipho, Samu, Letho and Malum'Du,** for making sure that I have all the needs and wants. I dedicate this to my extended family, for accepting me for who I am.

More specially, this thesis is dedicated to my late father **uMathaba**, who once said **"Usuyofunda ke mtanami, ufundele nathi sonke esingafinyelelanga la ofike khona"** (*go study my child, study for all of us, for we were unable to get to where you are).*

To my late brother **Lihle,** I know you are proud of me. This is also dedicated to all my friends who helped in many ways to get to the finishing line.

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## ABSTRACT

Graphic Communication (GC) is a universal language in the technology and engineering sector. In the field of engineering and the manufacturing industry, graphic communication is useful for the design, development, manufacture of products and construction of structures and systems throughout the world (Lockhart et al., 2018). Graphic communication forms the backbone of all design operations that work within a framework, ranging from conceptual design, detailing of drawing specifications, analysis, interpretation of graphic text and iterative re-design, to making working drawings prior to manufacture of artefacts, assembling of mechanical components and construction of building structures (Dobelis et al., 2019). Through graphic communication skills, learners ought to be taught, by teachers, how to read, interpret, design, and draw using freehand or instrument drawing techniques guided by the South African National Standards (SANS) code of practice. GC is one of the content topics that teachers of technology do not find easy to teach. The National Senior Certificate (NSC) examiners and moderators' reports for engineering graphics design, civil technology from 2016 to 2021 reflect learners' remarkable ineptitude regarding graphic communication skills. The diagnostic reports repeatedly highlight learners' poor performance on examination questions that test for graphic communication skills. While learners' learning and performance is related to many factors these diagnostic reports allude to the interconnection between learners' poor performance in GC to the teaching to which they are exposed. In technology education learners are introduced to GC in grade 7. This means that the GC learnt in grade 7 forms the platform for all other GC learning in the subsequent grades. Thus, it is quintessential to explore grade 7 technology teachers' topic specific pedagogical content knowledge pertaining to GC. Within the South African context, technology is a relatively new subject in the curriculum, as it was introduced in 1998. Many teachers teaching technology teach out- of -field. This means they were not trained to teach technology and lack the subject matter knowledge and pedagogical knowledge needed to teach graphic communication.

In response to the afore mentioned issues, this study sought to explore grade 7 technology teachers' topic specific pedagogical content knowledge in teaching graphic communication guided by the following research questions:

1. What is grade 7 technology teachers' subject matter knowledge on graphic communications?
2. What topic specific knowledge do grade 7 technology teachers use when teaching graphic communication?
3. Why do grade 7 teachers use their topic specific pedagogical content knowledge for teaching graphic communication in the way that they do?

This qualitative study adopted a case study design, and data was collected using questionnaires and interviews. Mavhunga (2015)'s Teachers' Topic Specific Pedagogical Content Knowledge (TSPCK) frames this study theoretically.

Findings of this study revealed that teachers have three understandings of GC: GC conveys an idea or thought via drawings or sketches. GC is a technological process that learners use to do a practical assessment task when designing to communicate ideas into paper or an article. Moreover, GC is a language spoken by architects and contractors. Regarding the way they teach GC, two themes emerged, they use a hands- on approach and the talk and chalk approach. The way teachers teach is influenced by the fact that they are teaching out- of- field and the lack of professional development. Hence the findings of this study concluded with a proposal for a continuous professional teacher development program to be put in place which will assist teachers to stay on par with all the needed information and resources regarding technology and GC.

**Keywords**: Graphic communications, Topic Subject Matter, Topic Specific Pedagogical Content Knowledge, Technology and Teachers.

# LIST OF ACRONYMS

| | |
|---|---|
| **2D** | Two dimensional |
| **3D** | Three dimensional |
| **CAD** | Computer Aided Drawing |
| **CAPS** | Curriculum Assessment Policy Statement |
| **CK** | Content knowledge |
| **DBE** | Department of Basic Education |
| **PCK** | Pedagogical Content Knowledge |
| **PK** | Pedagogical Knowledge |
| **SMK** | Subject Matter Knowledge |
| **TSPCK** | Topic Specific Pedagogical Content Knowledge |
| **TSMK** | Topic Subject Matter |

# TABLE OF CONTENTS

# LIST OF FIGURES



# LIST OF TABLES

APPENDICES

# CHAPTER 1: INTRODUCTION

## 1.1 Introduction and background of the study

Technology is a practical subject in nature that focuses on concepts and principles in the environment. It embraces practical skills and the application of scientific principles to solve problems related to the environment, to enhance the quality of life of individuals and society ensuring sustainable use of the natural environment (Department of Basic Education [DBE], 2014). Embedded in technology is graphic communication, a language that is used for visual representation and expression of ideas and concepts to design, develop, manufacture products and construct structures and systems throughout the world (Lockhart et al., 2018). Graphic communication is the pillar of manufacturing and engineering technology, and its role in the modern-day project development in related fields such as architecture, mechanical engineering, electrical engineering, and civil construction cannot be underestimated (Dobelis et al., 2019). It is the backbone of all design operations that work within a framework, ranging from conceptual design, detailing of drawing specifications, analysis, interpretation of graphic text and iterative re-design to making working drawings. Looking closely at graphic communication, learners are taught how to read, interpret, design, and draw. Graphic communication is a core skill in technology and related fields in the engineering space. Teachers have a critical role to play in ensuring that graphic communication knowledge and skills are imparted to learners, in a way that would confidently demonstrate learners' competency in understanding the purpose, design and interpretation of drawings as part of communication in the engineering sector. GC is one of the content topics that teachers of technology do not find easy to teach. While the National Senior Certificate (NSC) examiners and moderators' reports for engineering graphics design, civil technology from 2016 to 2021, reflect learners' remarkable ineptitude regarding graphic communication skills. The diagnostic reports repeatedly highlight learners' poor performance on examination questions that test graphic communication skills.

While learners' learning and performance is related to many factors these diagnostic reports allude to the interconnection between learners' poor performance in GC to the teaching to which they are exposed. In technology education learners are introduced to GC in grade 7. This means that the GC learnt in grade 7 forms the platform for all other GC learning in the subsequent grades. Within the South African context, technology is a relatively new subject

in the curriculum, introduced in 1998. Technology was introduced in the school curriculum in response to the serious scarcity of engineers, technicians, and artisans in the work field. Many teachers teaching technology teach out -of- field. This means they were not trained to teach technology and lack the subject matter knowledge and pedagogical knowledge needed to teach graphic communication. Both subject matter knowledge and pedagogical content knowledge are an integral part of a teachers' topic specific pedagogical content knowledge. Thus, it is quintessential to explore grade 7 technology teachers' topic specific pedagogical content knowledge pertaining to GC.

### 1.2 Rationale of the study

My interest in this study arises from my observation as a teacher of technology. For the past six years, I observed that teachers tend to teach the content that they understand better and neglect all the other topics that they do not understand such as graphic communication (GC). GC is a critical skill in technology and is the backbone of all design operations that work within a framework ranging from conceptual design, detailing of drawing specifications, analysis, interpretation of a graphic text, and iterative re-design to making working drawings prior to manufacture of artifacts, assembling and construction of building structures (Sotsaka & Singh-Pillay, 2020); (Dobelis, Sroka-Bizon, & Branoff, 2019). Thus, it is a skill that must be developed in learners, in technology education, which they are introduced to in grade 7. This means that the GC learned in grade 7 forms the platform for all other GC learning in the subsequent grades.

It is worth noting that the National Senior Certificate, examiners, and moderators report for engineering graphics design and civil technology DBE (2017-2020) indicates that learners perform poorly in questions that relate to graphic communication. Learners' learning is intricately connected to the teaching they receive, in addition to other factors. Many teachers teaching technology at lower grades are teaching out- of -field (Gumbo, 2013); (Pool, Rietsma & Memtz, 2013). This means that these teachers are not qualified to teach technology and they lack the subject matter knowledge and pedagogical knowledge required to teach technology. This means, that the ability of learners to learn the skills of developing and communicating ideas graphically depends on how grade 7 technology teachers teach GC when it is initially introduced to learners (in this instance in grade 7). The inference is that teachers should teach with the aim to groom learners with GC holistically. While the NSC examiners and moderators reports repeatedly refer to the poor performance of learners in GC, there is a paucity of studies

on teachers' topic-specific pedagogical content knowledge on teaching GC. Furthermore, my observation reveals that grade 7 technology teachers display a limited understanding of topic specific content knowledge and teaching strategies regarding GC. Consequently, teaching GC has been reduced to a meaningless activity.

### 1.3 Significance of the study

The findings of this study could help technology subject advisors to understand the challenges or problems faced by teachers in teaching GC thereby devising intervention strategies/training to support technology teachers. It is hoped that this study will contribute to the gap in the literature on teachers' TSPCK about GC and improve classroom practice. Moreover, learners will also benefit, by being taught by teachers who thoroughly understand what they are teaching, by using specific pedagogies when they teach GC.

### 1.4 Purpose of the study

The purpose of this study is to explore grade 7 technology teachers' Topic Specific Pedagogical Content Knowledge (TSPCK) when teaching graphics communication.

### 1.5 Objectives of the study

The objectives of this study are as follows:

i. To establish what is grade 7 technology teachers' subject matter knowledge on graphic communications?
ii. To ascertain what topic specific pedagogical knowledge do grade 7 technology teachers use when teaching graphic communication?
iii. To understand why do grade 7 teachers, use their topic specific pedagogical content knowledge in teaching graphic communication the way that they do?

### 1.6 Critical Questions

This study will be guided by the following critical questions**:**

i. What is grade 7 technology teachers' subject matter knowledge on graphic communications?
ii. What topic specific pedagogical knowledge do grade 7 technology teachers use when teaching graphic communication?
iii. Why do grade 7 teachers, use their topic specific pedagogical content knowledge in teaching graphic communication the way that they do?

### 1.7 Clarification of terms

*Graphic Communications:* According to (Kok & Bayaga, 2019) GC in all its forms is vital to society. It is a means of communicating information visually using graphics. Wang (2022) asserts that graphic communication is a form of popular art that promotes the communication of information and reflects people's visual preferences. Additionally, (Hao & Chung, 2022), envisage that graphic communication is a visual message conveyed through drawings and the use of lines. For the purpose of this study GC is construed as a form of visual communication using graphics.

*Technology Education*: is defined as the study of technology, where students practice the skills learned in class, to solve problems in and outside the classroom setting. According to (Chiliba (2019) technology education is the study of technology, where students learn about the procedures and knowledge associated with the technology subject. This suggests that learners gather the skills that they need to understand and follow the procedures of the technology subject. Furthermore, technology education shapes the way in which learners solve problems in a technological way, based on their own preferred solutions that they are expected to innovate. This is when they apply the skills and knowledge gathered from the content that is stipulated in the curriculum for the GET band. The technology subject comprises the design process, communication skills, simple mechanisms, and investigation skills in the first term. This content is developed into further topics as the term continues, however, the basic skills are the initial topics, that are applied throughout the year.

### 1.8. Limitations of this study

The research uses a case study method of inquiry. A case study method may be censured for its lack of generalization of results to any other contexts, however research findings can provide insights into other similar situations and cases, thus they can be transferrable and useful in interpreting similar settings (Cohen et al., 2017). A case study is an appropriate method of inquiry as it allows for in-depth information and rich thick description of a phenomenon within its real-world context to be provided.

### 1.9. Outline of the thesis

This dissertation comprises five chapters:

***Chapter 1***

This chapter presents the underpinning concerns and motivation for the study. It consists of the introduction and background of the study, rationale, research questions, objectives, and significance, clarification of terms, limitation of the study and an overview of the chapters to follow.

***Chapter 2***

This chapter focuses on the literature review of the study.

***Chapter 3***

This chapter presents the research design and methodological approach used to conduct the study. The chapter provides the motivation for the choice of a case study research design, and methods of data collection and analysis. It further presents details on the sampling procedures, research instruments used, trustworthiness of the study, and ethical issues.

**Chapter 4**

This chapter presents data analysis. Field data collected as prescribed in the research methodology is analysed against the theoretical framework to answer research questions posed in the study.

**Chapter 5**

This chapter discusses key findings of the study, provides conclusions, and outlines recommendations based on the findings for appropriate professional teacher development and support, and suggestions for further research.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

Teaching technology education, particularly graphic communication has proved to be a serious challenge for teachers, who have minimal pedagogical knowledge (Hlatshwayo et al., 2022). The previous chapter outlined introductory background to the study. There appears to be little research on teachers' topic-specific pedagogical content knowledge in teaching graphic communication. However, this chapter reviews the literature, which serves as the study's foundation. The review will be organized in the following subheadings:

- What is graphic communication?
- Technology curriculum
- Graphic communication content
- Teachers' experiences of graphic communication
- Teachers' experiences of teaching graphic communication in Africa
- Subject matter knowledge
- Topic specific pedagogical content knowledge
- Teacher's topic specific pedagogical content

knowledge required to teach graphic communication

- Theoretical framework

## 2.2 What is graphic communication?

According to Karal et al., (2016), Graphic communication is considered an alternative means of communication and may also be regarded as materials stimulating visual intelligence for enriching learning environments for individuals. Meanwhile, Meadows (2021, p.28) states that "graphic communication is an understanding of design elements, principles, and layout standards. Graphic design elements include line, shape, texture, color, value, and shape, while graphic design principles include balance, dominance/priority, proportion, contrast, rhythm, and harmony/unity". Moreover, Liu and Nhung (2022) state that graphic communication is, also known as visual communication design, that uses vision as a means of communication and expression, creating and combining words, symbols, and pictures in various ways to create visual expressions used to convey ideas and information. These definitions suggest that GC is factual and is used

not only within the parameters of the classroom or school setup or in technology. Visual intelligence is needed as we live in a digitalized world; it is, therefore, crucial for learners to be prepared through GC. According to Wang (2022) graphic communication is a more direct and accurate communication medium in the process of graphic communication because, it is a symbolic image in design. It plays a vital role in informing and educating people about projects, plans and information with all the needed details. It is sometimes hard to understand another person's ideas unless they are put on paper in the form of drawings. In addition, GC serves as the mediator between the thinker and the next person, which makes it easy in technology education to communicate design ideas hence learners are encouraged to use GC, instead of explaining their ideas in text.

Consequently, without a thorough understanding of graphics, one may be deprived of expressing or understanding what has been presented. According to (Oron-Gilad, Oppenheim & Parmet, 2022) the executors of GC acknowledged, add the value of GC, however, they end up 'overthinking' when using GC. Due to training, to use this ability effectively is a system of graphic symbols and projections used to deliver information that would otherwise need to be expressed in words or in numbers. Therefore, GC is a crucial concept that can be applied in different settings and vital in learners' cognitive development.

Technology, particularly GC, helps learners to keep up with the changing technological world. The usage of signs is everywhere, the ability to read those signs mostly relies on the exposure and knowledge behind GC. Most signs and symbols do not have texts, such as the road signs. Road signs are visible, for both the drivers and the pedestrians to adhere to. Many of these signs are easily readable; some need knowledge or be taught about them to understand. However, these symbols and signs are drawn or designed universally to be accessible to the majority. According to (Dong et al., 2021) GC is one of the most important introductory disciplines for developing the creative potential of learners. GC can enhance learners' thinking capabilities and imagination, as well as allowing them to think creatively, learn to gather GC knowledge from real life, and uncover new design elements. GC is an ideal discipline for practicing and creating innovative problem-solving skills.

This indicates that the teaching of GC also equips learners to acknowledge and give a quick response to GC problems. According to Alhajri (2017) GC teachers play an essential role

in encouraging their students to become active when solving problems, and independently thinking learners. GC triggers the creative element in a learners' brain which can assist them to solve many problems in a creative and innovative manner. Dong et el., (2021), state that creative thinking helps leaners find design solutions for new products or improvements for established products. It is also an important component of sustainable innovation design. They further state that it is the responsibility of the teacher to create or develop creative thinking when they teach GC learners.

### 2.3 Technology curriculum

Chiba et al., (2019) states that the curriculum determines what learners should experience in schools to prepare them for the real world. Technology enables learners to make informed decisions about engineering careers in high school and, eventually, at the university level. Technology as a subject provides learners with such opportunities through its content, practical activities, and assessments. The technology content in grade 7 is broad, but all the topics are interconnected. The introduction of new content necessitates an understanding of the other or previously learned knowledge. Furthermore, the time frame in which specific content is scheduled to be taught does not imply that the use of the content knowledge will be limited to that time or term of the year. The case of GC is also ongoing throughout the year, GC is only taught in the first term. However, its content is applicable throughout the term.

The first term begins with the introduction of technology which falls under the category of design process skills. It begins with the definition of technology and its application in the workplace. Following that is the design process. Identify, design, make, and evaluate and communicate (IDMEC) procedures are the foundation of the technology topic and should be used to govern the delivery of all learning objectives, according to South Africa's policy document, CAPS DoE (2011).

The IDMEC process, centered on drawing concepts embedded in graphical communication, is critical in teaching and learning technology subjects (Hlatshwayo et al., 2022). According to the revised Annual Teaching plan (ATP) DoE (2021):

**Investigate**: *find, use and acknowledge information*.

**Design**: *design brief, specifications, constraints; initial idea sketches; choosing the best design; selecting materials*.

**Make**: *draw plans; develop the manufacturing sequence; make the item/model.*
**Evaluate***: learners evaluate both their design stages and their final product.*
**Communicate**: *learners present their solutions; learners compile all notes and drawings into a project report in their workbooks.*

The order of design process is not linear; however, it starts from the investigation. The rest of the other steps may be done, if there is an encounter hindrance, learners may return to where the problem is, before finishing the whole process of solving a problem.

During the investigation stage, learners examine possible solutions to the problem and drawings before deciding on which design to create. According to Dong et al., (2021) GC learners can develop their sense of creative expression through prior GC teachings, in that way improving their GC skills which will lay the foundation for design practices and GC application in the future. On a smaller scale, GC is introduced during the design stage. Learners are advised to draw sketches of their potential ideas based on the information gathered from the investigation. The learners should have been taught GC in grade 7 based on the required skills to draw a sketch. The Department of Education's content planning must be followed however, there needs to be basic skills to be able to sketch, from GC. The make stage follows the design stage. According to Meadow (2020), human beings have always used drawings, sketches, paintings, and other forms of GC to communicate ideas. GC representation may take any form. To create a product in technology, it must begin with a drawing, as mentioned prior that GC can be represented anyhow, which implies that with the GC skills, any product may be created to solve any possible problem or challenge in technology (or generally). They must now choose the best plan or drawing and turn it into a product. If the drawing is clear enough, the next stage of creation becomes much easier. This is because the drawings must be specific and drawn using the proper drawing techniques, with measurements and specific information to be added to the product.

The final stages of the design process are evaluation and communication. The design process is followed when there is a problem or when learners are expected to apply GC skills. Most technology assessments require the use of GC. Learners must be continuously assessed, according to the DBE (2002) which implies that learners must use or apply the content knowledge they have been taught. Furthermore, Wong and Idris (2020) state that assessment

results are a valid and dependable measure of the knowledge, skills, and capabilities of GC learners. Prior to the Covid-19 changes, technology had two formal assessments for each term: the Mini-8Practical Assessment Task (PAT) and the examination for each term.

### 2.4 Graphic Communication content

According to the technology ATP, DoE (2021), the content is as follows: **Purpose of graphics**: develop ideas and communicate ideas. **Conventions**: outlines (thin/dark); construction lines (thin/feint); hidden detail (dashed) scale; dimensioning. **Sketch**: free-hand sketching. **Working drawings**: two-dimensional drawing of one face of an object using conventions (dark lines; feint lines; dashed lines; dimensions; scale). Graphic techniques. **3D oblique** – front view with depth at 45˚ (use squared 'quadrant' paper); oblique projection is used to assist with interpretation and draw a single VP perspective.

The content of GC mentioned above is a structure of GC. This structure is stipulated on the CAPS documents, and is designed in a manner that by the end of the prescribed time, teachers must have covered the content. This suggests that the length of time, teachers KSM and TSPCK is also not considered. According to (Williams et al., 2019) curriculum and assessments may measure how much of the material learners understood and recorded, as they experienced the curriculum. We used these two pieces of information to examine differences in assessment performance based on children's experience, age, grade, and amount of interaction with their teachers. In the actual teaching and learning experience, the curriculum and assessment may not be reliable for the examination of the performance and the experiences that learners have, based on the content. Teachers and learners are facing contextual factors (such as lack of resources, learners' learning capabilities, teachers' SKM and TSPCK), that may hinder the delivery of the content prescribed in the curriculum.

### 2.5 Teachers' experiences of teaching GC

International education systems focus mostly on ensuring that the teachers are well-trained for the subject they teach before they go to class to teach learners. In a study conducted in North Carolina in the USA, by Jung et al., (2019), about the development of the curriculum, teachers were developed to teach in accordance with the curriculum. The development of the curriculum specifically focused on the technology curriculum. Based on the needs of North Carolina, GC teaching development was also incorporated to strengthen teachers'

teaching skills of teaching GC. Additionally, according to Escayg (2019) ,the curriculum is designed for the teaching years, the document contains GC practical pedagogical advice on how to implement the goals stipulated in the curriculum. Furthermore, Erstad and Voogt (2018, p.1) state that "the curriculum expresses the educational policies, strategies, priorities, and ideas that influence an education system. At its narrowest it specifies goals to be learned. More broadly it describes the values, content and aims used to justify the program of an educational system or an institution and all of the educational processes and learning that go on within it". This indicates that teaching, generally, is guided by the curriculum, as is in technology for GC content. According to Bridges (2020) GC teachers should have a similar desire to guarantee that learners are being adequately taught with the GC skills and content knowledge areas needed for them to be doing well. Therefore, the way teachers teach GC is to make the learners understand and be able to apply what they have been taught in all activities, not only in technological activities. To ensure that, technology teachers must ensure that they have the SMK and TSPCK of GC, to reach the desirable goals, in alignment with the curriculum prescribed for them to follow.

Furthermore, a study by (Orthel & Day, 2016) emphasizes how teaching and learning activities ought to develop direct links with design thinking processes to improve design education in the USA. The design education for this instance also includes GC. Design thinking processes for learners may be irregular because in the world of technology education, learners are encouraged to create their own designs yet follow prescribed procedures while doing so.. Nonetheless, there are specific procedures to be taken before the application of GC skills. Those procedures include the whole design process (to be unpacked when discussing GC content), where learners are expected to apply all the steps and communicate their designs graphically based on how teachers have taught GC. The methods teachers use to teach learners GC, may influence how the learners apply information they have gained from the GC lessons. According to (Orthel & Day, 2016), this suggests that design-based curricular activities aim to improve learners' understanding of design and its process rather than just practicing.

However, (Orthel & Day, 2016) also mention that a paucity of literature specifically demonstrates the connection between the understanding of how learners design and how learners are taught design. Carmel-Gilfilen and Portillo (2016) assessed learners' creative thinking and gave instructions to broaden or develop the learners' creativity when

designing products. Similarly, (Magistretti, Ardito, and Messeni (2021) state that GC learners should always have skills of GC in mind when attempting to implement GC skills when solving problems. The link between GC teaching and learning, thinking and the application of knowledge and design skills to the learners, should be more direct and specific. This may allow the learners to understand design and be able to apply it when in GC activities.

A study conducted in the UK, by Walker, Boyer, and Benson (2019) states that the classroom lessons, that are used in the GC lessons, prepare learners to enter in the work space and enables them to make meaningful solutions to solve challenges or problems with the knowledge gained from GC. This study gives an insight into how technology or GC is taught in the UK, based on the changes or the developments of education. They define the content that might be mostly used in the future and the traditional content as the old, outdated content, of which its value and essence is fading, or will soon be nonexistent. This study suggests a shift and a comparison between how technology or GC was taught before and after the 21st century.

Based on the UK's technological advancements, teachers' experiences may be driven by the curriculum and move with what is popular and learner-friendly at that time, to make learners understand the content. (McLaren, 2008, p.7) states that "Technology education curriculum reviews have resulted in an increased requirement for the teaching of computer aided graphics, including computer aided drafting". To illustrate this, the technology curriculum focuses more on the future content, where the focus of most teaching and learning processes is shifting from the traditional forms (the use of drawing boards and pencils) to the digital forms (the use of Computer Aided Drafting (CAD).

Based on the constant technology developments, McLaren (2008) notes that technology teachers feel that they are teaching an irrelevant subject if they must move to CAD teaching methods and neglect the traditional methods of teaching GC. Meanwhile, other teachers still believe in the traditional method and CAD may be introduced later. To demonstrate this, it can be said that some teachers in the UK still believe that teaching GC must involve the use of the drawing instruments. To those teachers, the use of drawing instruments instills the basics of GC, which is how learners get to grasp the content practically. She

further notes that other technology teachers still believe that technology teaching methods will remain a universal controversy.

Nonetheless, technology is taught in accordance with the future content in the UK on the other hand, there have been reflections of poor learner performance standards of GC undergraduate students which implies that the teaching of GC was not assimilated progressively by the learners at the lower level of their education. This may also reflect that the methods or the way in which GC is taught, is not progressive if most learners perform poorly academically as they move to the next level of their academic lives.

A study conducted in the United Kingdom by McCardle (2002) and McLaren (2008) reveals the loss or fading out of GC in schools. According to these studies, there has been a drop in the essence of teaching GC standards in recent years. They also observe that even learners assumed to have prior experience with GC do not perform well or to the expected standards set by the UK Department of Education as they progress to the next grade. This implies that GC teaching is making less progress, which may result in most learners being unable to perform well academically in GC, engineering or technology.

Furthermore, McCardle (2002) postulates that "taking away the basic drawing skills and the formal language of engineering drawing is like making mental arithmetic redundant" (p. 126). This suggests that teaching GC traditionally is very important for the learners' understanding and applying the skills gained from the lower grades, as they may need those skills in the future. Additionally, McCardle further concludes that the value of GC lies in the development of visualization and manipulation of views of cognitive modeling and transposing images; line quality, accuracy, basic geometry involved in constructing shapes and, clarity through the application of accepted conventions. Therefore, all these developments also lie in the teachers' hands to transfer relevant knowledge, skills, and teaching to the learners, so they can use that knowledge in their technological assessments, in their current level of studies, and in the future.

Learners' achievement is significantly related to whether teachers are fully prepared in the field in which they teach. This implies that good teachers must have the needed GC content knowledge. The needed GC content may revitalize or keep GC education up to the country's expected standards. According to Walker (2019) in many technology teacher

training programs, GC is one of the foundations to providing learners with meaningful, hands-on learning experiences. Additionally, the teacher professional development training in the teaching of GC, strongly correlates with learners' achievement through frequent assessments. The learner assessments results will show the effect of the training of teachers (assessment scores) (Hanushek et al., 1995); (Darling-Hammond et al., 2005); Benseman (2008). The UK technology education study, strongly weighs learners' progress through assessment scores, just like in any other educational institution; assessment scores reflect the learners' performance, as well as the teachers' performance.

In addition, the characteristics of teaching GC productively are driven by rich pedagogical content knowledge. As Gagel (1997) explains GC is a universal graphic language that has been advanced over time and has been drenched within its aspects and knowledge of symbolic, cultural, utility, cognitive nature, much as any language, literacy and communication. This suggests that as GC advances, so do the teachers. Teachers need constant developmental workshops so they can keep up with the advancements of GC. McLaren (2008) also states that "there have been some changes to the school curriculum in Scotland to keep abreast of changing needs and attitudes of education and industry". As the changes are implemented, teachers' subject matter knowledge (SMK) and topic specific pedagogical content knowledge (TSPCK) is also expected to be aligned with the advancements, changes, and developments.

### 2.6 Teachers' experiences of teaching GC in Africa

In the African context, discussing GC without the involvement of technology is challenging, because GC is a subtopic. However, GC can be a standalone subject that is taught independently. Additionally, African education has experienced many changes, based on colonization and political diversity within the continent. According to Govender (2018), knowing the way in which South African teachers have been supported in altering and adjusting to curriculum transformation remains inadequate. This suggests that there is not enough evidence that teachers have been supported in the new curriculum, which ends up being a challenge to teach. These factors have affected the schools, teachers, and how the learners are taught in schools. Ramaligela et al., (2015) state that "the technology teacher training program plays a vital role in African countries, especially in the aspect of educational reform". This indicates that teachers in the African continent still need development to teach technology and GC progressively.

Furthermore, technology is a recently introduced subject in the African education system, and as a subject it was not included in the primary school curriculum until recently. It means that most teachers who offer it are still unfamiliar with the subject, particularly the technically oriented concepts like graphical communication Hlatshwayo (2022). In addition, most universities have not yet produced adequate teachers who specialize in teaching technology and GC falls under the shortage of those teachers. Ramaligela et al. (2015) further note that the most challenging issues in the African continent are that most teachers had not been trained to teach this new subject. Whilst the primary goal of graphical communication is to teach students how to solve problems graphically DoE (2011). A good teacher's content knowledge (CK) is required to drive the learners' activities in graphical communication content. The lack of full PCK, or adequate training and teacher development, reduces the teacher's full potential of teaching and hinges on the learners' problem-solving skills. A study by Hlatshwayo et al., (2022) which investigated teachers' PCK teaching graphical communication in a grade 8 class in the Johannesburg Central district revealed teachers are not adequately trained to teach technology subjects. Also, overcrowding in classrooms and poor infrastructure were an issue.

Additionally, in Africa, technology is more of an innovative and a development learning area that has been introduced to develop the continent. Scholars reveal that technology is a new reform that will bring new knowledge for a better Africa. Kerre (1990); Ramaligela et al., (2015); Roebuck, (1969), all discuss how technology has brought change and development in the continent. The content of GC is not mentioned by most scholars, which makes the discussion of GC critical. GC is shadowed by technology as the bigger picture.

Technology may bring developments to the continent, however, the issue of the financial constraints the continent is facing is not solved. Kerre (1990) states, "Technology has no boundaries between the rich and the poor or the young and the old nations. Technology borders on utility, a notion that all countries subscribe to". This suggests that technology is seen, taught and delivered the same across the continent, and in the whole world, despite the financial constraints.

## 2.7 Subject Matter Knowledge

According to Nnamani (2022), subject matter knowledge (SMK) is significant expertise teachers need, to make a positive difference among learners. This highlights the importance of SMK. Among all the other roles teachers play when they teach, SMK is one of the most vital. According to Shulman (1986a; 1987), it is important to recognize the value or importance of the SMK and the relationship it has to other characteristics of a teacher and its contribution to learners' teaching and learning. The contribution it has to learner's teaching and learning, makes it questionable if teachers do not have sound SMK. This is reflected when learners cannot grasp the content and must apply the knowledge they have learnt. According to Chan and Yung (2018) teachers' SMK may be identified by two categories for the experienced teachers: (a) Those who can take advantage of their previous teaching experiences and SMK to develop new PCK, and (b) those who do not. This suggests that the teachers' SMK along with their PCK, depends on the characteristics of a teacher as an individual as that is how their teaching practices are influenced.

The question is first directed to the teacher before learners are questioned. According to Even (1990), the teacher's role is to help the learner achieve an understanding of the subject matter. However, to do so, the teachers need to have compacted knowledge of the SMK. A teacher who has solid GC knowledge, is more capable of helping his/her students achieve a meaningful understanding of SMK. This will also breed great results in learners' understanding and the ability to apply their knowledge in activities.

Lederman and Gess-Newsome (1992) state that SMK is connected to a teacher's depth and breadth of understanding and conceptualization of his or her specialization area for clarification. This suggests that teachers must be specialists in the subjects they teach. Understanding their subject area is important, and they must thoroughly prepare and understand it before they go to the classroom. By doing so, their SMK will be rich which will make it easier for them to teach learners with a better understanding. This will also make the students able to comprehend the subject taught in a better manner. According to Değirmenci (2022), a teacher is a person who assists students learn. SMK comes first at the beginning of the knowledge that teachers should have to carry out education in accordance with the purpose (Uzun et al., 2013).

Moreover, Uzun et al., (2013). states that teachers who do not have sufficient SMK hinder the success of students. Teachers with a lack of SMK will not be able to assist students learn the subjects adequately by giving dubious answers to the questions of the students by not dwelling on the subjects in which he/she does not feel confident. In the case of technology, that is the challenge teachers face when they have to teach GC. The lack of SMK and TSPCK becomes a great hindrance to the flow of teaching and the understanding of the concepts GC has to offer. The teachers' lack of SMK leads to poor delivery of the GC content.

### 2.8 Topic Specific Pedagogical Content Knowledge

Topic specific pedagogical content knowledge (TSPCK) is a derivative of Shulman's (1989) PCK viewpoint. Shulman (1986) states that PCK allows teachers to deliver relatively difficult content and narrow it down to learners' understanding. Furthermore, according to Rollnick and Mavhunga (2016), TSPCK is created by teachers when they build a scaffolding framework between content of a specific topic and deliver it to learners for understanding. In addition, Mavhunga and Rollnick (2013) defined this version of PCK and named it topic-specific pedagogical content knowledge. According to Rollnick and Mavhunga (2016), they state that sound pedagogical reasoning by teachers requires both a process of thinking about their actions and sufficiently good content knowledge, principles and experience from which to reason. This leads to how they have given the definition of TSPCK as the knowledge that aids teachers to translate their understanding of content knowledge of a topic when they teach.

Therefore, good teachers have strong TSPCK. Teachers' preparation in content and pedagogy is associated with teaching practices, which in turn influences learner achievement. Pedagogical content knowledge Shulman, (1986, 1986) essentially means that teachers know, not just their content, but specific strategies for teaching this particular content. However, teacher-centered development might produce the expected results. Shulman, (1986, p.107) states that "teachers, like their students, need opportunities for learning that are differentiated, ongoing, sequential and cumulative". Teachers' teaching experiences are driven by their ongoing support, feedback, and time for implementing what they know in their teaching. Additionally, effective development occurs mostly in the classroom, when the teacher teaches then it extends outside the classroom, where learners can relate to what they have learnt in the classroom. That makes learners able to associate

the knowledge they learn from school with what they use or see daily. According to Öqvist and Högström, (2018), learners need to know the foundations of GC to utilise daily. This includes the general GC knowledge, that learners can use, even outside the classroom.

The education in different countries may serve or produce different skills for the betterment of that country, based on the needs, and skills they will need in the future. According to Snape (2017), the skills, values, and attitudes one needs to be an effective and useful citizen in today's world are more diverse than ever. Studies, by Karal et al., (2016) and Karal, Aydin, and Günal, (2010) reveal a different trend of the teaching of GC. The Turkish studies by (Gunal, 2010); (Tut et al., 2021) suggest that technology and GC, shows that GC is not only used for technological purposes, but is mainly used for better communication for learners that are not privileged enough to fully participate in a technological subject. GC in technology is directly related to needs. The scope of technology is constantly changing because needs and conditions are in constant change, however, the content may remain the same. GC is a universal language, therefore, changing its content may hinder communication where it is used. Moreover, several countries utilise graphic symbols (GC) to maintain the communication and learning capacities of learners with speech, learning, and linguistic deficiencies. Studies by Volpato, Orton and Blackburn (1985); Carmeli, and Shen (1998); Whittle and Detheridge (2001); Zainuddin, Zaman, and Ahmad (2009). According to Heller et al., (1994); Trudeau et al., (2007); ALJa'am et al., (2009); Emms and Gardner (2010) and Bunning et al., (2012), GC is used in teaching and learning of learners whose expressive or receptive linguistic skills are not adequately developed. Therefore, teaching using GC assists those learners to better communicate and understand what is linguistically taught, in a GC form or in a pictorial scale. By doing so, learners were able to participate in classroom activities, as they better understood GC symbols compared to written text. They were also able to progressively participate in communication, and express themselves, through GC. This suggests that using GC in teaching and learning may improve the progress of learner's understanding of the content, which can also include the excluded learners when graphics are incorporated in teaching. Additionally, Karal et al., (2016) state that GC symbols are regarded as resources that stimulate visual intelligence for elevating learning environments for learners showing normal development.

The US education system believes in ensuring that teachers have a rich PCK, before they go to the classroom. In 1986, Shulman conducted training for teachers to possess or develop their PCK. The training was meant to develop and advance teachers' interaction with GC in the classroom, and how teachers teach this content productively. Furthermore, Phillips et al., (2009) state that teachers' new understandings of their GC content and how these new understandings interacted with their teaching, may produce successful teaching experiences for both teachers and learners. He further states that PCK is the intersection of three knowledge bases coming together to direct the teachers' experiences: subject matter knowledge, pedagogical knowledge, and knowledge of context. If the teacher is well developed in these three knowledge bases, it is believed that learners will receive good teaching (Phillips et al.,2009).

In other countries mentioned above, they focus more on the teacher's professional development and do not consider how teachers perform when they teach GC in the classroom. Furthermore, implementation or the application of knowledge is not revealed in the literature, which serves minimal purpose for so much work and training. Additionally, Geddis, (1993) defines PCK as a set of characteristics that assists teachers transfer the knowledge of content to learners. Shulman, further highlight that the "most useful forms of representation of these ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations in a word, the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1987, p. 9).

However, teachers' teaching experiences may never be the same. Phillips et al., (2009) noted that each GC teacher has a different knowledge of specific domains spanning multiple content areas based on his or her GC teaching experience. This indicates that as much as teachers might be trained or developed similarly, their teaching experiences will be different.

However, "quality design educators have come to know the subject matter in industrial design, not only for the content itself, but also in terms of its "teachability" and "learnability" (Phillips et al., 2009). Teachers' teaching experiences of GC are driven by their PCK in the developed countries. Hence quality design educators know the subject matter in industrial design, not only for the content itself, but also in terms of its "teachability" and "learnability."

## 2.9 Teachers' Topic Specific Pedagogical Content Knowledge required to teach GC

According to Arifin et al., (2020), PCK provides an understanding of teaching, and not only the delivery of knowledge and learners but not limited to the reception of information, but rather its application. If a teacher has PCK, it is known that that teacher is prepared differently from the teacher's material knowledge. It can be concluded TSPCK makes teachers perform differently from other teachers if they have it in their respective subject. This may also impact the performance of the learners positively. This is a strong reason that the teacher is declared as a professional in the process of the concept of TSPCK.

Furthermore, Juhji and Nuangchalerm (2020) state that considering a combined and accumulated expertise in teacher teaching practices, different teachers may present TSPCK differently. The concept of TSPCK is vast in experiences, conceptual differences, and knowledge in TSPCK which is inseparable from aspects of subject matter, strategic instructional representations, student learning and conceptions, general pedagogy, curriculum and media, context, purpose, and assessment.

## 2.10 Theoretical framework

This study will use the topic specific pedagogical content knowledge (TSPCK). According to Ning et al., (2022), TPACK framework supports theoretical guidance for technology teaching in the classroom. The TPACK framework is an important framework for current teacher education because it gives a foundation, where teachers can execute the CK they have when teaching. Furthermore, according to Mavhunga and Rollnick (2011) TSPCK serves as the biggest part of the needed knowledge for the subject matter knowledge transformation in a particular topic which includes students' prior knowledge, curricular saliency, what makes a topic easy or difficult to teach, representations including teaching strategies, analogies and teaching. Abera (2021) further states that a teacher with PCK knows what the content is and how to teach specific topics within the content using various techniques and approaches. This implies that teachers are expected or assumed to have or know the PCK of the subject they teach which also involves all the topics involved in a subject. Graphic communication is the topic, that has revealed that teachers tend to have less or no PCK to teach. However, it is taught in schools.

TSPCK allows for homing into a specific topic within the curriculum, in this instance GC. TSPCK brings to the fore the technology teachers' pedagogical knowledge (PK), content knowledge (CK), knowledge of students (KS) and knowledge of content (KC), which will collectively assist the researcher to find better understanding of teachers' PCK when teaching GC. Additionally, it will assist in zooming in on all the aspects of knowledge the teacher has or lacks in teaching GC. For the purpose of this study, the following components of TSPCK, namely, students' prior knowledge, curricular salience, what is difficult to teach, representations including analogies and conceptual teaching strategies will be addressed. The researcher will be able to make meaning of the data to be collected. Furthermore, PCK is made up of sub-topics and fully makes it a complete concept. These sub-topics are there to make PCK holistic. The TSPCK, CK the five components as illustrated in the figure below, isx a perfect fit for the study. Moreover, Mavhunga and Van Der Merwe (2020) state that topic specific PCK, has emerged as the theoretical construct that allows teachers to move from 'knowing what to do' (knowledge manifesting in planning), to 'doing what you know' (knowledge manifesting in the classroom representation) with the intention to benefit learners' understanding within their local context. The focal point of conducting this study is mainly for teachers to understand know and practice what they know when teaching GC, so that the learners can benefit from the teaching and learning process.

**Figure 2. 1: Topic Specific PCK model linked to PCK model (adapted from Rollnick, Bennett, Rhemtula, Dharsey & Ndlovu, 2008, Fig 1)**

According to Mavhunga and Rollnick (2011) the topic specific PCK tool is organized according to the listed five components. Each of the components is concisely explained below to provide meaning. This study's aim is to explore teachers' PCK when teaching GC, therefore, using TSPCK will allow the researcher to explore teacher's PCK and how they teach GC. However, it will only use the curriculum saliency, what is difficult and what is easy and representation. In addition, this study focuses on one topic, GC. Mavhunga (2015) states that TSPCK reflects PCK at a topic level. GC is a topic in question,and using these three components of it will make this study more meaningful, for they directly provide a lens to be used for the anticipated findings. According to Mavhunga and van der Merwe (2020) TSPCK provides evidence in a planning-to-teach setting, translates in a classroom setting to a specific topic.

i. *Learner Previous Knowledge:* refers to students' common misunderstandings and alternative conceptions about a particular content. This is also influenced by what the learners are exposed to, and the ability to relate it to the content that is taught in the classroom.
ii. *Curriculum Saliency:* Refers to the alignment of topics taught, with the stipulated curriculum. It is the understanding of which topics are the most central and which more minor. Such understanding enables teachers to judge the depth to which a topic should be covered and hence the amount of time to spend on it. This may also be misguided, as teachers may tend to choose topics that they easily understand, and neglect those they do not understand.
iii. *What is difficult and what is easy:* The ability to identify gate-keeping concepts, within a concept that are difficult to understand, triggers dedicated awareness and possible interventions for teaching them.
iv. *Representations:* This component refers to a range of subject matter representations including examples, illustrations, analogies, simulations, and models.
v. *Conceptual Teaching Strategies Conceptual Teaching Strategies*: refers to effective instruction strategies for misconceptions, known areas of difficulty to learn, or known importance of concepts. It refers to the use of combinations of conceptual principles and rules of a topic as tools to confront potential confusion and misconception.

Maphoso and Mahlo (2015) state that teacher quality is the most influencing factor in student achievement in learning, that reflects their PCK and their required skills in the teaching process, and includes formal education, experience, subject knowledge, pedagogy studies, and certification or license. Mavhunga and van der Merwe (2020) further state that these are profession-specific modes of teaching that are associated with the teaching profession that seem to be suitable for what it means to be a member of the teaching profession. Additionally, the value of PCK is useful when teaching within the topics of a discipline (Abell, 2008). This implies the importance of PCK in the teaching profession generally.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Introduction

The previous chapters discussed the literature reviewed on teacher topic specific pedagogical content knowledge in teaching graphic communication. In this chapter I discuss the methodological approach used to conduct the research. In my discussion I pay attention to the paradigm or philosophical underpinnings of the study, the research approach and research design deemed appropriate to achieve the research goals. This qualitative interpretative study adopted a case study design of inquiry. The chapter also describes the research site and data collection methods executed, outlining the data generation instruments, sampling procedures and data generation methods. Validity and research rigour measures implemented are discussed in the light of instruments used and data analysis procedures to ensure reliability and credibility of the study. The chapter ends with a conclusion.

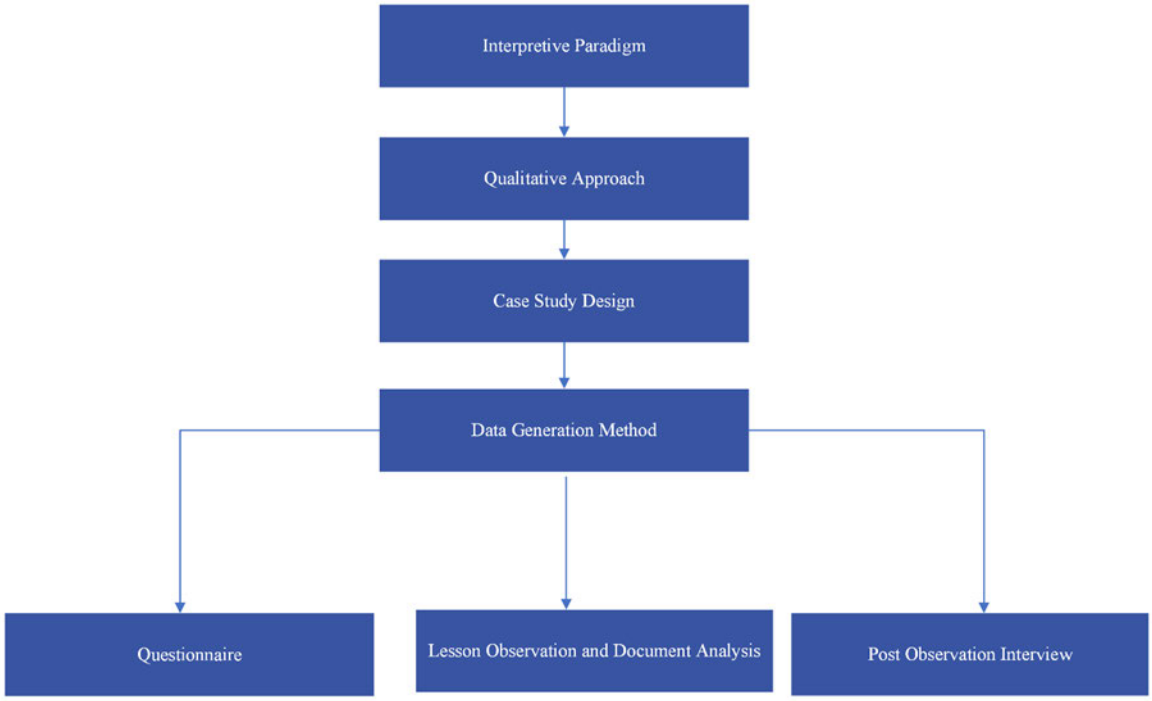



**Figure 3. 1: Research methodology**

## 3.2 Research Paradigm

A paradigm clarifies, organises and directs the thought patterns and actions undertaken in a study (Creswell & Creswell ,2017). Based on the focus of the study, which seeks to better understand and gain deeper insights into grade 7 technology teachers' topic specific

pedagogical content knowledge in teaching graphic communication, this study is guided by the interpretive paradigm.

The main concern of the interpretive paradigm is to understand the subjective world of human experience, from the perspective of the participants to derive meaning from shared experience, Creswell and Creswell (2017). To gain deep insights from the perspectives of participants, data collated was non-numeric in nature (Mertens, 1999). According to Maree and Maree (2013) in an interpretivist paradigm reality is socially constructed. Grade 7 technology teachers teach in a particular social context which influences their practice. This means that the grade 7 technology teachers' TSPCK is influenced by the realities of the practices they engage in when they teach GC, along with those of the teachers who have taught GC before, therefore, a style or pattern of teaching is inherited. The actions and practices teachers perform when teaching GC will be observed, to understand what guides them to teach the way they do. The interpretive approach tries to make sense of the phenomena, explain and demystify social reality through exploration and explanation from the viewpoint, experiences, perceptions, language, and shared values of participants in dynamic social contexts (Cohen et al., 2018).

### 3.3 Research approach

According to Creswell (2013), there are three research approaches, namely: qualitative, quantitative, and mixed methods. The paradigm of the study determines which approach is suitable for the study. Guided by the interpretative paradigm, this study embraces a qualitative approach, to obtain rich thick, detailed descriptions about grade 7 technology teachers' topic specific pedagogical content knowledge in teaching graphic communications. In addition, (Cohen et al., 2018) state that the qualitative research method includes the collection of descriptive data that may be verbal, or textual. These forms of data may be observed or recorded.

Qualitative research as opined by (Creswell & Poth, 2016), is an approach to inquiry that focuses on understanding, interpreting and making sense of occurrences in natural settings, through exploration of human perspectives and meanings that individuals or groups ascribe to social or human problems. The primary focus of qualitative research is to understand the values, beliefs and experiences of people and how they make sense of the world around them (Kankam, 2020).

This study has no interest in statistical research approach, therefore the qualitative approach will be employed, as technology teachers may interpret their own lived experiences of teaching GC in grade 7. According to (Creswell & Creswell, 2017) the qualitative research approach solely uses words rather than numbers in discovering and making meanings of individuals or groups in a social or human problem. The qualitative method "is an ever-present thought in human affairs and a persistent feature of human life" (Eisner, 2017, p. 34). The conducting of this research will be dependent on the words of the teachers who teach GC, and the documents they use.

### 3.4 Research design

The research design refers to the conceptual structure within which research is conducted. It describes a flexible set of guidelines that define the strategies of inquiry (Denzin & Lincoln, 2018). On a similar note, Kumar (2019) perceives it as a procedural operational plan that a researcher undertakes which serves as a roadmap detailing how the research process will unfold, including methods of collecting data, selection of study samples and analysing the data. The choice a of case study as an ideal research design that can provide optimal solutions to the research questions posed in this study stems from the motivation and its efficacy to explore, seek understanding and establish the meaning of experiences from the perspective of research participants in their real-world settings (Harrison et al., 2017). Yin (2018), states that a case study is a method of research that simplifies exploring a phenomenon, in its context utilising a diverse data source.

Yin (2018) defines a case as "a contemporary phenomenon within its real-life context, especially when the boundaries between a phenomenon and context are not clear and the researcher has little control over the phenomenon and context" (p. 13). This suggests that participants will have a platform, where they can share their experiences of teaching GC in their factual and natural state. According to Stake (1995), the research questions in a case study "help structure the observation, interviews, and document review" (p. 20). Moreover, Merriam (2015) sees "the case as a thing, a single entity, a unit around which there are boundaries" (p. 27) guided by the research questions, and the type of data to be collected. The case in this study is the grade 7 technology teacher, more specifically their topic specific pedagogical content knowledge on GC.

Hitchcock and Hughes (1995) and Cohen et al., (2013) further state that the case study approach is suitable when the researcher has less control over the events. This suggests that the participants will naturally present data that the researcher is looking for, without any preparation or prior briefing before data is collected. In addition, according to Cohen et al, (2013) and Maree and Maree (2013), the case study approach answers the crucial 'what', 'how' or 'why' of the phenomenon of the research and also provides full details of explanation of the explored phenomenon with its specificity.

Additionally, Cohen et al., (2013) and Robson (1993) group the following three case study approaches in this manner: Explanatory case study, Descriptive case study, and Exploratory case study. The explanatory case study aims to give new insights into the phenomenon through research and the findings. This suggests that this case study gives new information discovered from the research. The descriptive case study provides a narrative account. Moreover, this case study focuses on hypothesis testing of the research.

According to Sotsaka (2015), an explanatory case study provides a piece of new, detailed information on, or insight into, a problem or a phenomenon through the research findings. This study employs the explanatory case study method. The reason this case study is chosen, is because the new information is generated, as the participants share their TSPCK they possess when teaching GC. Furthermore, the generated data may inform the practices, policy, and methods teachers use to teach GC in grade 7.

### 3.5 Location of the study

This study will take place in the Umlazi District, which has 10 primary schools. These schools are a mix of ex-model C, public, mainstream, and special schools in this district. Umlazi district has diverse schools, some are well resourced, and many are under-resourced schools. The geography of this ward is as follows: there are suburban areas, where most ex-model C schools are located, these schools are either well-resourced or adequately resourced. They also have good infrastructure and the number of learners per class is low. Furthermore, the public schools are mostly located in informal settlements or townships. The scarcity of resources, and large number of learners with not enough floor space (infrastructure), positions these schools as under-resourced.

All the primary schools in each geographical area will be randomly selected, thus each school will have an equal opportunity to form part of the sample of this study. Each of these schools has one grade 7 technology teacher. One teacher will be approached to participate in the study. The participants will be purposively selected. The criterion for their selection is they must be technology teachers for grade 7.

### 3.6 Ethics

Ethics refers to the system of moral principles by which individuals can judge their actions as right or wrong, bad or good. Social researchers are expected to conduct their research in an ethical manner because research of any kind takes place within a social context (Creswell & Creswell, 2017). This justifies the need to introduce a moral perspective to the way the study was designed and conducted, considering the moral, legal context and boundaries placed on topics of investigation (Cohen et al., 2018). In this section, the study addressed ethical considerations as follows:

#### 3.6.1 Gatekeeper permission

Gaining access to fieldwork is critical and a prerequisite to conducting research, which involves finding and securing participants prior to the 'real' research (Peticca-Harris et al., 2016). Researchers' access to a site is determined and controlled by gatekeepers as they have power to grant or withhold access to individuals required for the purposes of the research (Clark, 2011). The study sought and received ethical clearance from the University of KwaZulu-Natal. (See appendix 1), gatekeepers' consent from the KZN DBE and school principals. This meant, therefore, that the data generation process was guided by ethical standards.

*Informed Consent*

Informed consent was obtained from each of the 10 school principals and the grade 7 technology teacher at their school with a clear indication that they could at any stage request termination or withdrawal from the research (Descombes, 2014). Participants were informed at the outset that participation in this study was voluntary (see Appendix C). The principles and rules developed by the Professional Association of German Sociologists and the American Sociological Association for ethics guided this study. These principles include, among others, the following: (1) avoid harm to participants/damage avoidance; (2) avoid misrepresentation, deception/ fidelity/ breach of confidentiality; (3) respect of privacy of participants; (4) avoid stress and discomfort; (5) avoid undue intrusion; (6) have confidentiality of data. The principle of informed consent means that research participants were provided with sufficient and

accessible information about the study so that they could make informed decisions as to whether to become involved or decline their participation (Creswell & Creswell, 2017).

*Confidentiality and Anonymity*

Cohen et al., (2018) mention that participants should be assured that they would be protected from physical or psychological harm by using pseudonyms. Pseudonyms ensure anonymity and confidentiality of participants and were used in the writing up of this study, for both the institution where the study was conducted and the participants. All responses were treated in a confidential manner. Ensuring that the ethical considerations mentioned above were adhered to, gave the participant the confidence to share their views and experiences of teaching GC. Moreover, this assurance contributed to a trustworthy environment, which allowed elevated levels of participation and openness during the interviews. As a result, participants were quite willing to be involved in the study and saw it as an opportunity to share their experiences of teaching GC.

*Data use, storage and disposal*

The data would be stored for a minimum of five years in a secure location agreed to by my research supervisor. All transcripts, collages and concept maps would be shredded using a shredding machine after five years. Audio recordings would be incinerated after five years. This written commitment was made to gatekeepers and participants.

## 3.7 Sampling and sample

Sampling is a research technique used to systematically select a relatively smaller number of representative items or individuals from a predefined population to serve as a data source, as determined by the objectives of the research work (Sharma, 2017). Additionally, (Cohen et al., 2018) state that sampling is a process of deciding about the population, settings, events that have been selected for observation.

Convenience sampling as well as purposive sampling was used for the study. According to Maree (2013) convenience sampling are “situations when population elements are selected based on the fact that they are easily and conveniently available”. In this study, the researcher resides and works within the proximity of the 10 primary schools in the Umlazi district. The research site is selected based on convenience sampling.

Each school has one grade 7 technology teacher. The selection of the research participants is guided by my research approach, and in this instance purposive sampling was used. Purposive sampling is a sampling technique where participants are deliberately chosen because of their suitability in advancing the study based on the qualities they possess (Etikan et al., 2016). It is used in qualitative research for the identification and selection of information-rich cases related to the area of study (Etikan et al., 2016). The criteria for selection of research participants considered the learning area and grade. All purposively selected participants had to be teachers of grade 7 technology. All 10 teachers of grade 7 technology at the 10 schools within the Umlazi district were invited to participate in this study.

### 3.8 Data generation methods

Data generation is a series of interrelated activities that a researcher engages in to gather relevant and significant information useful to answer research questions of the phenomenon under study Creswell (2016). The table below reflects the plan for data generation. Data was generated in three phases in response to the research question pose, as reflected in Table 3.1 below.

Table 3. 1: Data generation methods

| Research Questions | Phase | Data Source | Instrument |
|---|---|---|---|
| **1**. What are grade 7 technology teachers' Subject Matter Knowledge on graphic communication? | 1 | Grade 7 technology teacher | Questionnaire |
| **2.** What Topic Specific Pedagogical Knowledge do grade 7 technology teachers use when teaching graphic communication? | 2 | Grade 7 technology teacher | Lesson observation<br><br>Analysis of Teaching portfolio. |
| **3.** Why do grade 7 teachers use their Topic Specific Pedagogical Knowledge in teaching graphic communication the way that they do? | 3 | Grade 7 technology teacher | Post observation interview. |

The above table shows the research questions, the data source and data generation instrument.

### 3.8.1 Data generation instruments

In the section below, I discuss the instruments that were used during data generation. A wide range of instruments was used to capture data to answer the research questions posed, namely, the questionnaires, lesson observation and post observation interview. The instruments listed were used because of their suitability in collecting qualitative data as determined by the research design.

#### *3.8.1.1 Questionnaire*

A questionnaire is a data collection technique that consists of either closed-ended or open-ended questions where respondents give their opinion in written form on the phenomenon being researched (Cohen et al., 2018). (McGuirk et al., 2016) argue that qualitative research seeks to understand the way people experience events, places and processes differently as part of a fluid reality constructed through multiple interpretations, and thus questionnaires become a useful tool for gathering original data about people's behavior, attitudes, attributes, experiences, social interactions, opinions and awareness of events. Since my study sought to explore grade 7 technology teachers' topic specific pedagogical content knowledge on graphic communication, I have found using questionnaires to be one of the ideal instruments of data collection. The rationale for choosing a questionnaire was based on the understanding that questionnaires allow respondents the privacy and time to consider and develop their responses to sensitive questions. Secondly, the administering of the tool is time and cost-effective. It compresses physical distance and the burden of travelling to different research sites. Questionnaires allow for incorporation of both open-ended and closed-ended questions. Open-ended questions allow the respondent to answer and express their opinion in their own words, or rather provide free-form responses, whilst closed-ended questions restrict respondents to choosing answers from given options (McGuirk et al., 2016). A semi-structured questionnaire with open-ended questions was used to gather data about teachers' personal information and information based on professional experiences of teaching GC was administered. The questionnaire was used to elicit information about the following aspects: teachers' general teaching experience and experience for teaching. The open-ended questionnaire was designed with the assistance of university researchers and piloted with grade 7 technology teachers from the Pinetown district. The questionnaire was piloted to check the clarity of the questionnaire items, and to eliminate ambiguities or difficult wording. The outcome of the piloting indicated that the questionnaire items had good construct validity. According to (Cohen et al., 2011) a pilot study serves to increase the reliability, validity and practicability of the questionnaire. Using an open- ended

questionnaire to collect data for this study was deemed suitable because open ended questions capture the specificity of a particular situation (Cohen et al., 2011), which in this study is teachers' TSPCK on GC.

*3.8.1.2 Observations*

According to Yin (2018 p. 143) observation is "a form of 'primary data" that allows a researcher an opportunity to collect data in action, from naturally occurring social situations or events. Additionally, observation is firsthand information, with no alterations. This assists the researcher to gather data in detail, the ability to observe the way information is delivered and how the learners respond to the information that is being taught. Moreover, Sotsaka, (2016) states that observations provide researchers with first-hand experience and enables them to generate a detailed explanation of the setting, the activities, interactions, and participants' experiences. This study aims to explore grade 7 technology teachers' topic specific pedagogical content knowledge in teaching graphic communication. This makes it difficult for the researcher to observe the TSPCK itself, however, the practices teachers use to teach GC, may serve as means of observation. The lesson will be observed. This will assist the researcher, to study the TSPCK of the teachers and be able to analyse the data given.

*3.8.1.3 Document analysis*

Document analysis was used in conjunction with other data collection methods as a means of triangulation and to corroborate findings and improve credibility of the research study (Mackieson, 2019). Bowen (2009) mentioned that document analysis involves a careful study of documents to understand the depth and the meaning conveyed by the content. In addition, Yin (2014) asserts that documents can provide information which supports details from other sources. Included in the document analysis were the teachers' teaching portfolio (lesson plans and assessment tasks) to establish the teachers' instructional planning and preparation skills. This information was used to track how teachers promote active learning of graphic communication in learners This may inform the researcher more about the TSPCK of the teachers. Documented data may have added more to what is practiced, as it has the formal, structured information that can be proven, in writing. According to Cohen et al., (2018), document analysis is a systematic set of procedures, explanations and verifications of the written content of data.

*3.8.1.4 Post observation interviews*

Individual semi structured interviews were conducted with grade 7 technology teachers after the observation of their lessons. Cohen et al., (2017, p.349) defined an interview as an "interchange of views between people on topics of mutual interest that may assist in answering the research questions". The most commonly selected method of data collection for qualitative research is interviewing (Adhabi and Anozie, 2017). According to Flick (2018), a well-planned interview creates an accepting environment that puts participants at ease, allowing them to thoughtfully answer questions in their own words and add meaning to their answers. This study adopted a qualitative approach, and individual face-to-face interviews were conducted with grade 7 technology teachers after the observation of their lessons. Face-to-face interviews are useful because they allow opportunities for the researcher to probe participants' responses and for the researcher to note non-verbal cues which accompany the verbal responses Sullivan (2012).

(Creswell & Creswell (2017) explained that there are three types of interviews, namely, structured, semi-structured and unstructured. Creswell and Creswell elaborated further on these three types:

i. *Structured interview* – this type of interview is controlled by the interviewer and contains predetermined questions that have fixed wording in a specific order.
ii. *Semi-structured interview* – the interviewer utilises an interview schedule that guides the interview. The addition of unplanned follow-up questions (probes) is allowed. This type of interview is less controlled by the interviewer.
iii. *Unstructured interview* – this type of interview is flexible and informal in nature with the interviewer having a general area of interest but allows the conversation to develop.

For my study, I chose to use semi-structured face-to-face interviews which were audio-recorded. I chose this type of interview because it afforded adequate flexibility to probe responses. In this way I was able to gain a rich and in-depth understanding of grade 7 technology teachers TSPCK on GC. Semi-structured interviews allowed me to probe more deeply and to seek clarity on certain issues (Iyamu, 2018). This resonates with Alshenqeeti's (2014) view that through interviews, detailed information about a phenomenon can be elicited. Furthermore, individual face- to- face interviews would enable the researcher to elicit

information from those participants who may feel shy speaking out in groups. A semi-structured interview schedule (see Appendix D) was used to guide the interview process.

### 3.9 Data analysis

Data analysis refers to the meaning-making from data sets (Merriam, 2015). Cohen et al., (2018, p. 83) define data analysis as "reviewing each unit of analysis and categorising it according to the predefined categories". In preparation for data analysis, all audio recordings of interviews, observation of lessons, as well as interviews were transcribed verbatim.

I engaged in qualitative data analysis. Qualitative data analysis is not a linear process; it is iterative, recursive and progressive. In my study, as I analysed data from the interviews with grade 7 technology teachers, I noticed new trends and patterns that appeared in the observations, making the process iterative and progressive. When I had analysed the data from the questionnaire, I reverted to what participants had said in the interviews, and I was able to find a convergence between the two. In this way, my analysis was recursive.

The data generated in this study were subjected to content analysis. Content analysis involves the organization of the data into categories. In my study, coding was used to categorise the data that were generated. Coding is the process of identifying themes or concepts that are in the data.

I used open, axial and selective coding during content analysis defined below:

- *Open coding:* the process of breaking down, examining, comparing, conceptualizing and characterizing data.
- *Axial coding*: a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories, utilising a code paradigm involving conditions, context, action or interactional strategies and consequences.
- *Selective coding:* the process of selecting the core category, and systematically relating it to other categories, validating those relationships and filling in categories that need further refinement and development.

These three types of coding were used in my study, to look at the dynamic transactional relationship amongst the constructs of my theoretical framework. To map the transactional

interplay amongst the constructs of my theoretical framework during data analysis I traced trends and patterns that appeared in the questionnaire, individual interviews, document analysis and observations and noted them. I observed consistencies and codes that emerged inductively from the data. I searched for those codes that have "internal convergence and external divergence," thus each code was consistent but distinct from one another. I engaged in rigorous, repetitive reading and coding of transcripts to develop key themes. Transcripts were read horizontally, which includes grouping segments of text by theme (Flick , 2018). Thus, major themes would be condensed into sub-themes so that they would be convenient to analyse. The data would be engaged with critically, and links within the data would be established.

### 3.10 Research rigour

Rigour entails all the steps taken in the study to ensure thoroughness and consistency (Cypress, 2017). If rigour is not ensured, a study is flawed. A step undertaken to ensure rigour in this study was to share the study at a postgraduate supervision cohort session, so that it could be critiqued and evaluated by many readers, not just by my supervisor.

Furthermore, to ensure research rigour, data was generated in multiple ways. This study included member checking used during the data generation stage and data transcription processes respectively. Smith and McGannon (2018) asserted that one of the most used strategies to ensure rigour in qualitative research is member checking, which was popularised by Lincoln and Guba in 1985 within the qualitative research literature. Also, audio data generated in the interviews were transcribed verbatim to ensure accuracy of participants' responses before developing themes. Trustworthiness is discussed next.

#### 3.10.1 Trustworthiness

Trustworthiness is a measure of whether the findings of a research study can be relied on by readers. It speaks to the processes followed in gathering data or information (Daniel, 2018). Bertram and Christiansen (2014) suggested that trustworthiness in qualitative research can be ensured if appropriate research methodology is applied. As this study is a qualitative one, I considered the entire research design to ensure fitness of purpose. In the interviews, my participants were given a chance to restate what they said to be sure that they had meant what they said. The interview questions were open- ended in order not to impose opinions on the participants.

One of the key steps that was taken to ensure trustworthiness is known as 'member checking' (Birt et al., 2016). Birt et al., (2016) suggest that member checking is related to participant reflection and consists of taking data and interpretations back to the participants in the study so that they can confirm the credibility of the information and narrative account. A popular strategy is to convene a focus group of participants to review the findings, or have the participants view the raw data and comment on their accuracy. For this study, member checking was applied during data generation. The essence of member checking is to ensure that participants can express their views accurately on the phenomenon being explored, and to avoid misinterpretation by the researcher. Interview transcripts were also subjected to member checking. For interviews, member checking is important because of the possibility of mishearing what was said and to ensure that their views are accurately captured. To ensure member checking, the recorded audio was transcribed, and the participants were allowed to read the transcription of their interviews and video records to confirm the authenticity and accuracy.

Sutton and Austin (2015) maintained there are no statistical tools for measuring the validity and reliability of data analysis in qualitative research as there are in quantitative research. However, there are other ways of establishing confidence in the findings of qualitative research, which is termed "trustworthiness" of the research. There are four criteria of trustworthiness, namely: credibility, transferability, dependability and confirmability. According to Belotto (2018), credibility deals with how to align the findings of a study with reality. To ensure the credibility of the findings of this study I used multiple data generation methods, engaged in member checking of interview transcripts, and triangulated data obtained. (Cohen et al., 2018) add that a study incorporating two or more methods of data collection displays triangulation. To further enhance the credibility of this study I had regular meetings with my supervisor, especially during data analysis to seek consensus and clarify misconceptions. I also shared my analysis during master's cohort sessions to obtain critique and comments from a wider inter-university academic community.

Kivunja and Kuyini (2017) describe transferability as the extent to which the findings of one study can be applied to other situations (contexts). This study as a case study did not aim to generalise the findings. Cohen et al., (2018) argued that readers must determine for themselves the degree to which the results and conclusions of a qualitative study apply to their current context. Creswell (2014) asserts that transferability is achieved by providing a detailed, rich

description of the settings studied to provide the reader with sufficient information to be able to judge the applicability of the findings to other settings that they know. I provided rich descriptions of the context and research design to enhance transferability of this study.

Cohen et al., (2018) stated that dependability deals with the way in which a study is conducted and should be consistent across time, the researchers and analysis techniques. Dependability is achieved when the researcher details the research design and process so that the study can be replicated in another setting. The detailed research design and the triangulation of data further enhanced the dependability of this study.

Conformability is concerned with establishing that data and interpretations of the findings are not figments of the inquirer's imagination but are clearly derived from the data. El Hussein, Jakubec and Osuji (2016) highlighted the use of an audit trail to enhance the confirmability of a study. I presented my findings to my supervisor and to critical academic audiences to ensure rigour of interpretation of data. The triangulation of data, according to Johnson et al., (2017), contributes to the confirmability of a study.

### 3.10.2 Ensuring validity of the research

Validity in qualitative research refers to the overall authenticity of the research. Unlike rigour, validity speaks to the entire research report rather than merely the process of gathering information in the research. FitzPatrick (2019) proposed that one of the measures of ensuring validity is to include thick or rich descriptions.

Thick description, as described by FitzPatrick (2019), is a procedure used to describe the setting, the participants and the themes in qualitative research. Furthermore, stated that thick descriptions are deep, dense, detailed accounts which help x-ray the credibility of the research. FitzPatrick (2019) further added that thick description speaks to the confidence with which the readers feel as if they had experienced, or could experience, the events being described in a study thus, bringing the story alive to the reader. The process of writing using thick description is to provide as much detail as possible. In other words, thick description is the ability of the research to connect with every reader of the research report in the simplest and most comprehensible language. This procedure would influence my study at every step.

The criticism of the data collected and analysed to generate the findings was done by other researchers and academics. This was administered to ensure the accuracy, findings and conclusions that were made by the researcher.

### 3.11 Conclusion

This chapter has displayed the interpretivist paradigm the study will follow, and utilises the qualitative approach. The case study used is the explanatory case study along with the convenience and purposive sampling of grade 7 technology teachers was located in the Umlazi District. The sampling used was convenience and purposive samplings. Member checking to ensure the legibility of the participants was done. Data were collected through questionnaires, document analysis, and post observation interviews. The analysis of data was thematic analysis, accompanied by the validity and credibility advanced by member checking.

# CHAPTER FOUR: PRESENTATION OF FINDINGS AND DISCUSSIONS

## 4.1 Introduction of findings from data

As mentioned in chapter 2 TSPCK enables a teacher to pedagogically transform difficult content of specific topics into forms best understandable to learners. TSPCK refers to a teachers' ability to transform their content knowledge on a given topic into formats that are suitable for teaching Mavhunga, (2012). This understanding of TSPCK makes teachers important elements in the learning process.

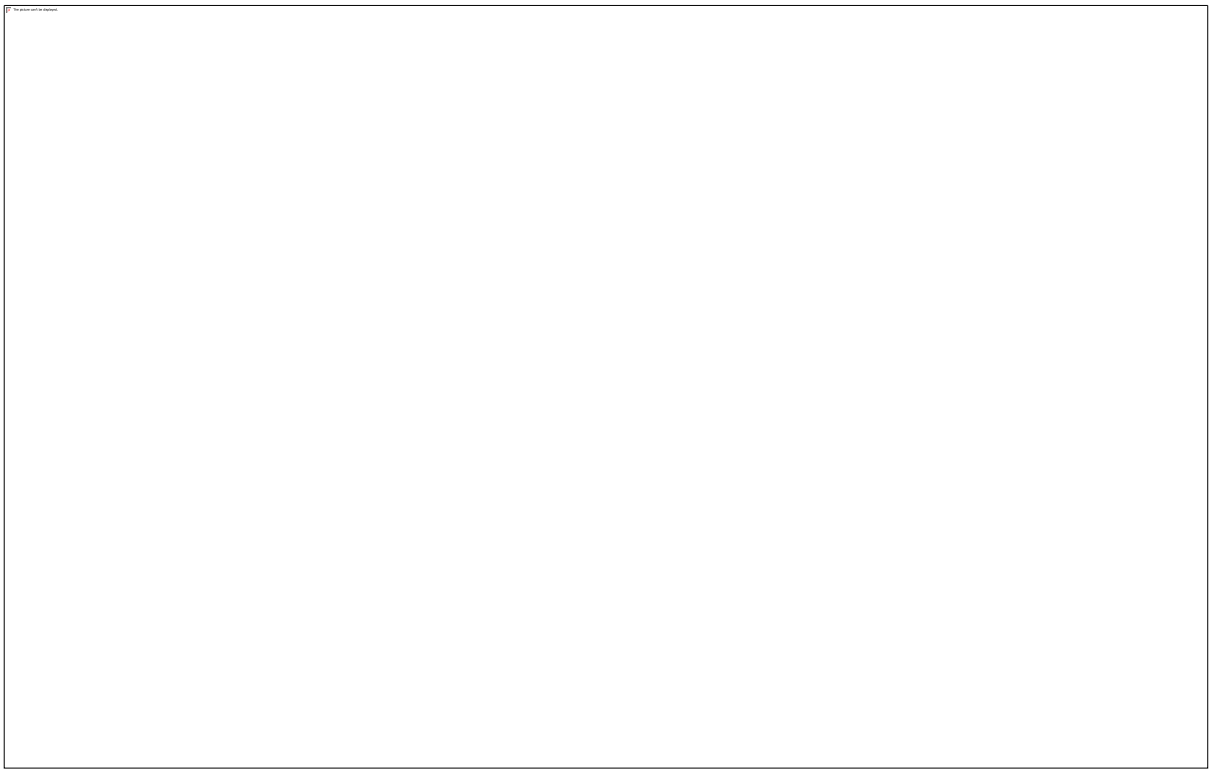
In this chapter, data were collected in response to the three research questions posed, namely:

i. What is grade 7 technology teachers' subject matter knowledge on graphic communications?
ii. What topic specific pedagogical knowledge do grade 7 technology teachers use when teaching graphic communication?
iii. Why do grade 7 teachers use their topic specific pedagogical knowledge for teaching graphic communication in the way that they do? The chapter is organized into sub-sections. For example, section 4.2 presents teachers' biographical data, while section 4.3 focusses on presenting data and findings in response to research question one. Section 4.4 pays attention to research question 2 and section 4.5 answers research question three. The chapter ends with a conclusion.

## 4.2 Teachers' biographical data

This part of the data focuses on the biographical information of the teachers. Table 4.1. reflects the biographical data of the participants. Teachers' biographical data is important as it may have a bearing on how they teach, their content knowledge, pedagogy, their training, professional development, and experience teaching technology and more specifically graphical communication.

**Table 4.1: Biographical Data of Teachers in the Umlazi District**



Amongst the six teachers, three are females, and the others are males. These teachers will be identified by using the letter T and the number in which they are assigned by the researcher (T1 – T6). In terms of their teaching qualification, it is worth noting that only one (T 3) out of the 6 teachers have a qualification in technology education. When one is trained to teach, technology specifically, there are aspects of technology content, pedagogy, and skills that are taught at university. Studies have shown that subject-specific training of teachers is directly linked to effective teaching resulting in higher student proficiency (Porsch & Whannell, 2019).

T1 possesses a Primary Teacher Diploma (PTD) only, which is a qualification spanning over three years. T2 is a music graduate. This teacher holds a degree in Music, thereafter, did a Post Graduate Certificate in Education (PGCE), with an Honors in Education (Learnership and Management). T3 has PTD and Honors degree in Education (technology education). T4, holds a B. Ed degree specializing in intermediate and senior phase. Additionally, the two teachers, T5 and T6 have Bachelor of Education (BEd) degrees, and honors degrees in education. T5 acquired an Honors degree in technology education, and T6 did an honors degree in curriculum studies.

It can be inferred that the teacher with a qualification in technology education, may have acquired the pedagogy and topic specific content knowledge required to engage in teaching GC. Teachers with no qualification in technology education are teaching out- of -their- field. This information can be gathered by looking closely at their years of teaching in general and years of experience in teaching technology and the topic of graphical communication. Teaching 'out-of-field' is a phenomenon where teachers are assigned to teach subjects for which they have inadequate training and qualifications (Hobbs, 2013). Teaching out-of-field occurs mainly because the teachers in the education system do not match the subjects taught in schools (Hobbs & Porsch, 2021). Therefore, those teachers are given any subject without taking their specialization subject/s into consideration. As the evidence displayed in table 4.1. teachers teaching out of field, teach other subjects in addition to technology. This means that these teachers will need different pedagogies, content knowledge and topic specific content knowledge when they teach each subject. Juggling with diverse pedagogies, content knowledge and topic specific content knowledge might impact how they engage with GC, as they will be applying different skills when teaching each of these subjects. It can be argued that teachers PCK is developed through practice.

Four teachers out of the six have been teaching for over 10 years, however all six have been teaching technology and the topic graphical communication for less than 10 years. All six teachers have not been capacitated, via in-service training or continuous teacher professional development to teach technology or the topic of GC. However, it is possible that the TSPCK of these teachers may also be initiated by different factors, such as professional learning communities, school support, and resources available.

### 4.3 Research Question 1: "What is Grade 7 Teachers' Subject Matter Knowledge on Graphic Communications?"

In this section, the data collected from the questionnaire and the semi-structured interview are presented and discussed in response to research question one. Three themes emerged regarding technology teachers' subject matter knowledge about GC namely:

- Graphic communication conveys an idea or thought via drawings or sketches
- A technological process that learners use to do a practical assessment task when designing to communicate ideas into paper or an article.
- Graphic communication is a language spoken by architects and contractors.

#### 4.3.1 Teachers' subject matter knowledge about GC

Table 4.2. bellow illuminates technology teachers' topic specific content knowledge

**Table 4.1: Teachers' SMK about GC**

| Understanding of GC | Number of teachers |
|---|---|
| Conveys ideas via drawing /sketches | 2 (T1 &T2) |
| GC as design | 2 (T4 & T3) |
| GC as Language used to communicate with engineers/contractors/ architects | 2 (T5 & T6) |

***GC conveys ideas via drawings and sketches***

Two teachers espouse the notion that GC conveys ideas via drawings and sketches as is reflected in the testimonies below:

T1*"Graphic communication conveys an idea or thought via a drawing or sketch to make things"* (Interviews)

*T2: "I introduce drawing as language of symbols and conventions, understood by any speaker of any language with the basic understanding of these symbols"* (Questionnaire)

Two out of six teachers think of GC as a language that involves communication of ideas through drawings, sketches and symbols used as instructions for manufacturing of real objects. The excerpts reveal that these technology teachers acknowledge that the nature of technology as a practical subject extensively involves design and communication of technical ideas and solutions through graphic means, and plays a significant role in the design and construction of the building, and manufacturing of products. Studies conducted by (Camburn et al., 2017) and (Bertoline, 2005), established that designers think about many features that cannot be communicated with verbal descriptions but rather dealt with using visual images and nonverbal processes that are translated into a drawing or picture depicting what is in the designer's mind.

***GC as design***

As reflected in table 4.2. two teachers espouse the notion of GC as design to be a part of their TSPCK. The testimonies below bear evidence of GC as design.

*T4: Graphic communications is design, drawing the idea so it can be communicated and shared, the specs can be adjusted to improve the design. It is only by think about GC as design can I unpack and tech the concept of GC.* (Questionnaire)

*T3: Design, Designing the product to improve its features /artistic qualities, designing allows for creativity to emerge in the final specs. It is the technological process.* (Semi-structured interview)

The above excerpts show these teachers understanding of graphic communication is confined to the design process. Teacher 3 perceives graphic communication as a technological process that learners employ when designing to communicate ideas onto paper or to make a product. While it is true that learners are involved in the process of designing and expressing their ideas

graphically when solving problems, graphic communication is not only limited to design and following the technological process. It is multifaceted, involving the skill of reading and interpreting advanced working drawings, presented with conventional signs and symbols that must be understood by engineers and technologists (Camburn et al., 2017; (Bertoline & Wiebe, 2005). Such a confined understanding of graphic communication limits the teacher's creativity and ability to organize content into distinct parts of knowledge, explore relevant instructional approaches, and present the content knowledge in a way that promotes active learning Almeida et al., (2019); Stronge (2018).

***GC as a language***

*T6: "graphic communication is the sharing of ideas using all forms of graphics it maybe sketches it may be using the conventions it may be using a symmetric drawings or single or double point vanishing points single or double vanishing points with the use of specific drawing instruments such as the grid square sheet the usage of all proper instruments such as the rulers specific pencils if the school is lucky enough they also use projectors to teach this aspect of graphic communications.*" (Questionnaire)

*T5: it is the only way to communicate ideas when manufacturing, building, designing, solving problem*. (Interview)

These teachers understand GC as a sole foundation of communication, using drawing skills that are taught in technology. They mentioned the different drawing skills and the possible instruments that learners use when applying the GC skills in their activities.

This means that they construe graphic communication as a language of communication between designers, architects, engineers and contractors. They have an idea of some stakeholders who use graphic communication in the field of manufacturing engineering and construction. Edholm (2013) and Bertoline and Wiebe (2005) elucidate that graphic communication is a clear precise language with definite rules, universally used by engineers and technologists to communicate technical ideas and problem solutions. The above excerpt demonstrates the teachers possess special understanding of the content knowledge to effectively transmit the knowledge to their learners( Kok , 2018).

The above findings reveal that theoretically teachers espouse the subject matter knowledge on graphics communication that is in keeping with key ideas expressed by scholars such as (Bertoline & Wiebe, 2005); (Edholm, 2013); and (Camburn et al., 2017).

### 4.3.2 Research question two: 4 What Topic Specific Pedagogical Knowledge (TSPK) do grade 7 technology teachers use when teaching graphic communication?

According to Mavhunga and Rollnick (2015), TSPK is the pedagogical knowledge that allows teachers to translate their understanding of subject matter knowledge of a topic to make it accessible to learners. In other words, in this study it will be the way in which teachers use their subject matter knowledge to teach GC. Data from the questionnaire and the semi-structured interviews were used to respond to research question two. Two themes emerged on the TSPK teachers use when teaching GC, namely hands- on approach and chalk and talk Each of these themes will be elaborated upon next.

***Hands on approach***

Two teachers embrace a constructivist approach to teaching and learning of GC as is visible in the excerpts below.

*T1: "I start by drawing. They draw what they used daily, e.g., cups or desks then a question is asked, what we use when we draw. They will then decide whether to draw it or write it they must give a clear vision of what to draw using elements of graphic communications."* (Questionnaire.)

*T3: I bear the lesson objectives in mind, then introduce the learner to the views of the objects, and dimensions. They are physically involved in a hands-on activity, where they view the object from different angles, then they draw. Free hand drawing and sketching is synonymous with GC.* Interview.

From the excerpts above it is evident that a link or alignment exists between learning objectives and the teachers' subject matter knowledge and the teaching methods used. These teachers realize the practical nature of technology and thus linked to knowledge of the grade 7 technology curriculum (knowledge of goals of technology, curricula material, links between the purpose of teaching GC and teaching practice); instructional strategies (understanding and use of teaching strategies for GC, knowledge of specific task-based instructions) and knowledge of learners' understanding of GC (misconceptions / preconceptions that will talk

back to instructional strategies deployed). Resonance/alignment amongst the abovementioned three components of PCK, together with the teacher's subject matter knowledge, is of pedagogical significance as it enables teachers to decide on effective instructional strategies for planning of lessons and assessments.

***Chalk and Talk approach***

Four teachers (T2/4/5/6) use the chalk and talk approach to teach GC as can be seen in the excerpts below.

> *T2: I am not a trained teacher of technology, I don't explain when I teach technology, I only draw, and I ask learners to follow, only coping drawings, this is the best that I can do.* (Questionnaire)
>
> *T4: I have to draw on the board and learners copy and practice drawing, this is not the only subject, I'm teaching two other subjects I'm not trained in technology… I do what I think is right, the training to implement the CAPS policy was very poor*. (Interview)

These teachers painstakingly draw diagrams on the board or make charts to teach GC to their learners. A rigid teacher dominated approach to teaching prevails leaving no room for learner engagement or creativity *(I'm not trained … best I can do)*. It is noted that these teachers are teaching out of phase *(subjects they are not qualified to teach)*. As such the action verbs used in the above excerpt *(draw, copy)* confirm these teachers' depth of subject matter knowledge (SMK) pertaining to GC (or bookish learning) without understanding what is required to scaffold learners' thinking needed for higher order thinking for example diagrams requiring projections, and mental manipulation of objects. Additionally, these verbs reveal how these teachers' understanding of GC influences their decisions about content-specific instruction *(draw, practice, copy, list)*. The above finding resonates with that of Ma (1999) who asserts that SMK influences a teacher's capacity for selecting ways to convey ideas to learners.

The above excerpts illustrate that these teachers' conceptual understanding of GC as reflected in table 4.1. (Their SMK) is not perpetuated into their teaching of GC (TSPK). Hence, they foreground and favour rote learning and simple recall during their teaching of GC in their classroom. It can be inferred that these teachers are not familiar with the requirements of the CAPS technology curriculum, regarding the teaching of GC. These teachers' practice begs the question: How cognitively stimulating is copying without deep understanding and exposure to the discourse of GC?

The disjuncture between theses teachers' SMK and their TSPK for GC is exposed via the above excerpts. The above finding concurs with Singh-Pillay and Ohemeng- Appiah's (2016) study which highlights the mismatch between teachers espoused conceptual understanding of the design process with their actual practice of teaching the design process in the grade 9 technology classroom. The findings support the argument that a teacher's SMK affects the quality of his/her teaching. The findings resonate with those of Singh-Pillay and Sotsaka's (2017, 2020) study which demonstrates that in EGD, teachers who understood multiple representations of EGD concepts were able to use those representations in their teaching practice to promote learner engagement. This means that teachers with deeper SMK were more likely than those with weaker knowledge to engage learners in meaningful learning through their classroom activities and teaching strategies.

### 4.3.3. Research Question 3: Why do grade 7 teachers use their Topic Specific Pedagogical Content Knowledge for teaching graphic communication in the way that they do?

***Technology is practical in nature***

Teachers 1 and 3, who use a hands-on approach for teaching GC linked their TSPK to their understanding of the nature of technology as can be seen in the excerpts below.

*T1: For me technology is about practical knowledge and innovations which benefit people…. therefore learners have to be actively involved in the learning process, doing practical activities… in GC they measure, draw, rotate object, check multiple views…."(*interview)

*T3: Technology is a subject that requires hands on activities- you cannot get learner to memorise and rote learn- they have to engage in design activities*…"(interview)

The above excerpts indicate that understanding the nature of technology is important for making wise decisions regarding teaching and learning with technology Yenilmez et al., (2021)

***Teaching out- of- field***

Teachers reported they were teaching out- of -field and were not qualified to teach technology. Technology was a filler subject to make up their workload.

T4: I am *not a qualified teacher of technology it is just a filler subject in my workload -I really cannot cope teaching it- I have no passion for it, I cannot learn the content. (*Interview)
*T6: it's a filler and a killer subject- I am forced to teach it to make up my workload, I don't know any content- I get lesson plans and just deliver them in class, I don't take teaching technology seriously s. (*Questionnaire)

From the excerpts is it clear that these, teachers are assigned to teach subjects for which they have inadequate training and qualifications. Teaching out -of- field arises because of systemic shortage of technology teacher in these schools. Teaching out-of-field presents a challenge for these teachers because of the need for them to learn new content, but they are resistant to learning new content Porsch, and Whannell (2019).

Furthermore, the status of technology as a school subject is illuminated (filler and killer subject). Technology as a school subject is not taken seriously or granted the same status as other subjects.

***Lack of professional development***

Teachers bemoaned the lack of professional development to teach GC and technology as is visible in the excerpts below:

T5 *How can you teach GC if you have not received any training to teach it. (*Interview)
T2: *Professional developed is sadly missing in ….it is impacting how we each* (interview)
*T4: teachers teach using strategies they think are correct.. without professional development it cannot be helped….we need to be trained and developed continuously*. (interview)

The lack of professional development is impacting how teachers TSPK of GC.

**Summary**

This chapter has covered the data collected from the questionnaire and interviews. There were three research questions, and the data were answered. In those research questions, themes emerged, and when combined, assisted the researcher to conclude the whole chapter. These are the research questions:

(i) What is grade 7 technology teachers' Topic Subject Matter Knowledge on graphic communications?

(ii) What Topic Specific Knowledge do grade 7 technology teachers use when teaching graphic communication?

(iii) Why do Grade 7 teachers use their Topic Specific Pedagogical Content Knowledge for teaching graphic communication in the way that they do?

In research question one, the data were analysed based on the questionnaire, and the interview. In that data, there were themes that emerged, based on the teacher's experiences with teaching GC. The themes that emerged were based on the teachers' understanding of GC, their own definition of what GC means based on their understanding, and their teaching experience of GC. The first theme emerged when teachers were defining GC. They defined GC as a way of conveying an idea through drawings or sketches. The second theme was that GC is a technological process that learners use to solve problems in assessments. Lastly, they mentioned that GC is a language that is used by architects and contractors.

Furthermore, the second research question themes were the approaches that teachers use when they teach GC. They use the hands-on approach and the chalk and talk approach.

Lastly, the third research question. The first theme emphasized that technology is a practical subject in nature, the second theme surfaced that the teachers were teaching out- of- field. The last theme was that teachers had a lack of professional development.

The findings of this chapter raised a question as to how can teachers be supported and constantly developed for them to keep abreast with the teaching of GC? In the next chapter, the researcher will discuss the importance of continued teacher development, in-service training for teachers to teach GC. The causes that are important for teachers to teach GC and more research to be done on teaching GC.

# CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

The purpose of this study was to explore grade 7 technology teachers' understanding of graphic communications, and teachers' topic specific pedagogical content knowledge when they teach graphic communication. This research used a case study approach. The data were collected in the Umlazi District, from grade 7 technology teachers at 10 selected schools. The data was collected through a questionnaire, observations, document analysis and semi -structured interviews. The data collection was subjected to content analysis.

In this chapter, I present a summary of findings and outline the recommendations based on the findings of the study.

## 5.2 Summary of findings

In this section the summary of findings is presented in table 5.1.

**Table 5. 1: Summary of findings**

| Research question | Key findings |
|---|---|
| What is grade 7 technology teachers' Subject Matter Knowledge on graphic communications? | • Graphic communication conveys an idea or thought via drawings or sketches<br>• A technological process that learners use to do a practical assessment task when designing to communicate ideas into paper or an article.<br>• Graphic communication is a language spoken by architects and contractors. |
| What Topic Specific Pedagogical Knowledge do grade 7 technology teachers use when teaching graphic communication? | • Hands on approach<br>• Chalk and Talk approach |
| Why do grade 7 teachers use their Topic Specific Pedagogical Knowledge for teaching graphic communication in the way that they do? | • Technology is practical in nature<br>• Teaching out -of -the- field<br>• Lack of professional development |

Three key findings emerged in response to research question one which illuminate grade 7 technology teacher' SMK on graphic communication. based on the teacher's experiences with teaching GC. The themes that emerged were based on the teachers' understanding of GC, their

own definition of what GC means based on their understanding, and their teaching experience of GC. Grade 7 technology teacher used the hands on and chalk and talk pedagogical approaches when teaching GC. The reason for grade 7 technology teachers using the hands-on approach was technology is practical in nature. Grade 7 technology teacher resorted to the chalk and talk approach to teach GC as they were teaching out of the field and due to the lack of professional development.

## 5.3 Recommendations

The following recommendations are suggested based on the findings of this study.

### 5.3.1 Teacher continuous professional development

According to Nazaretsky et al., (2022), continuous teacher professional development is aimed at keeping practicing teachers updated with their pedagogical skills, knowledge, abilities, and competencies over the course of their careers. There are changes in classroom practices of teachers, changes in their attitudes and beliefs, and changes in the learning outcomes of learners. Five out of the 6 teachers in this study were teaching out- of- field, their subject matter knowledge of GC and the topic specific pedagogical knowledge used to teach GC did not espouse the methods envisaged in the CAPS technology curriculum. The implications are that these teachers need teacher development for them to stay on par with the teaching practices of GC.

### 5.3.2 Recommendation for further research

A larger study ought to be conducted, to gain insights into teachers SMK, TSPK related to GC.

## 5.4 Conclusion

The findings of this research emphasized the challenges teachers have when they teach GC. This involved their teaching practices of the GC content and to address these challenges, there are programs recommended in place. These programs will not assist technology teachers in grade 7 only, however, but the whole technology curriculum in basic education will also benefit, if these recommendations are put into action. The teachers' understanding of GC, their SKM and TSPCK will be enhanced.

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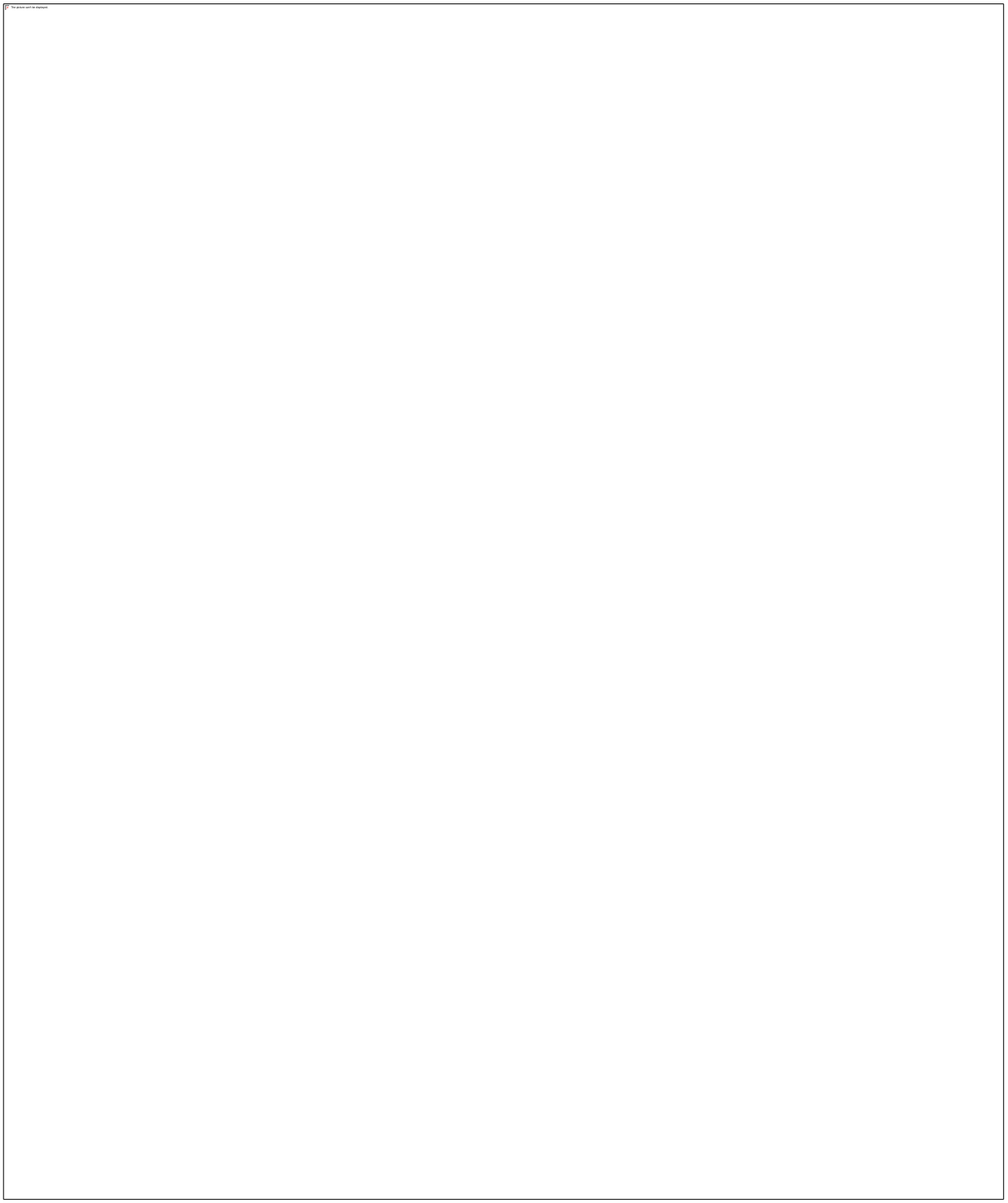
# APPENDICES

## Appendix A: Ethical Clearance Certificate

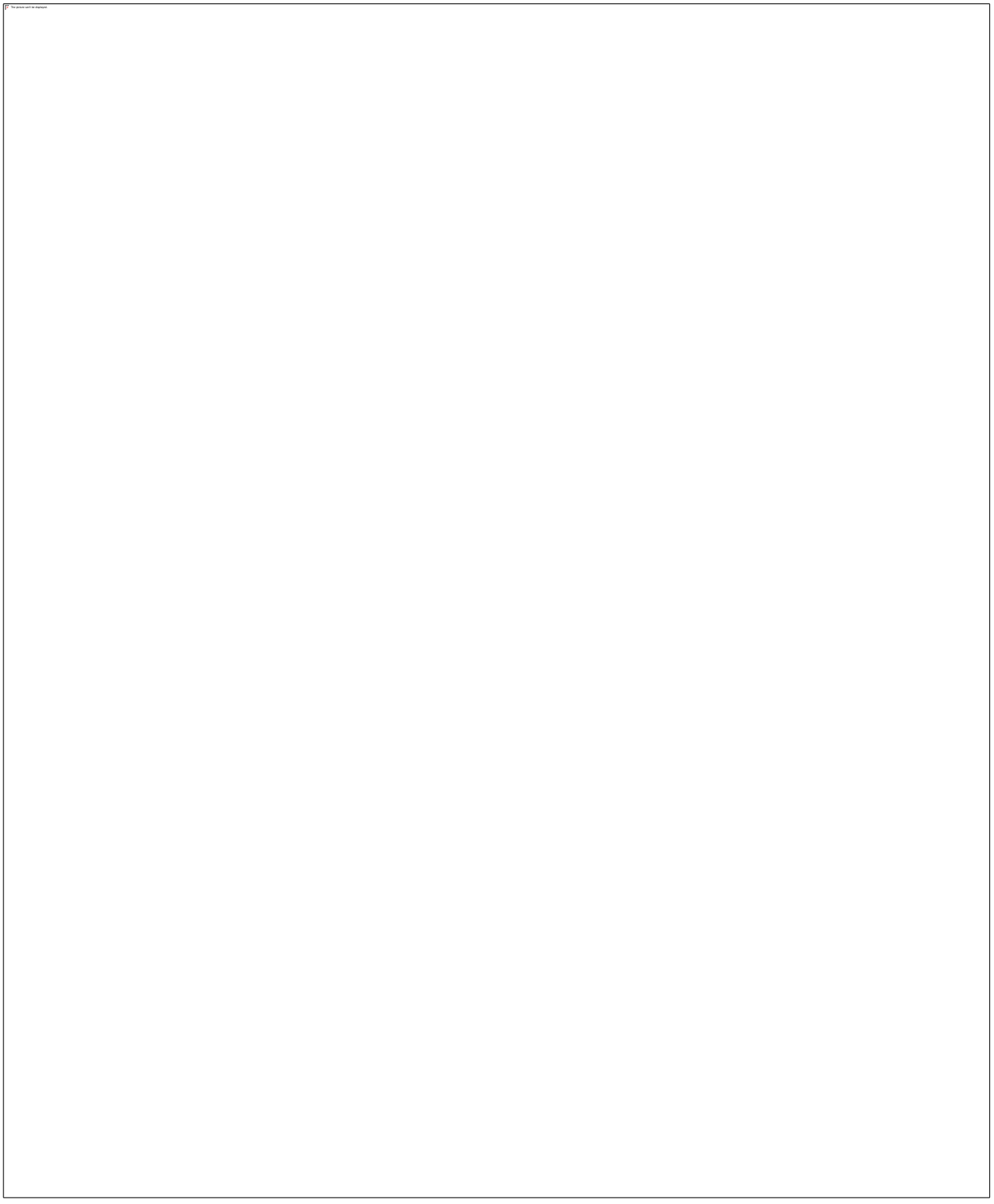
## Appendix B: Editing Certificate



## Appendix C: Turnitin Report

## Appendix D: DoE consent letter

## Appendix E: Gatekeeper letters

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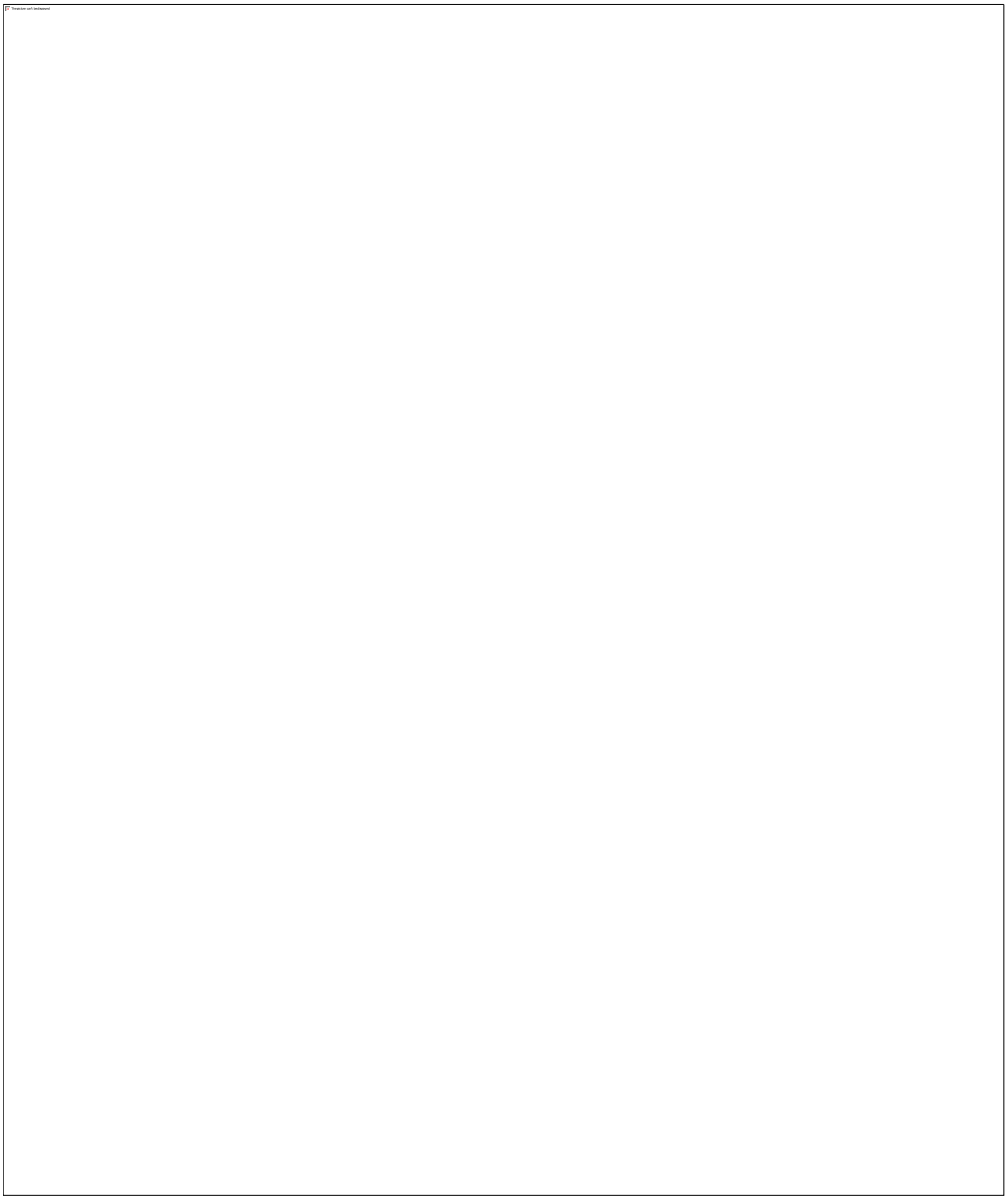
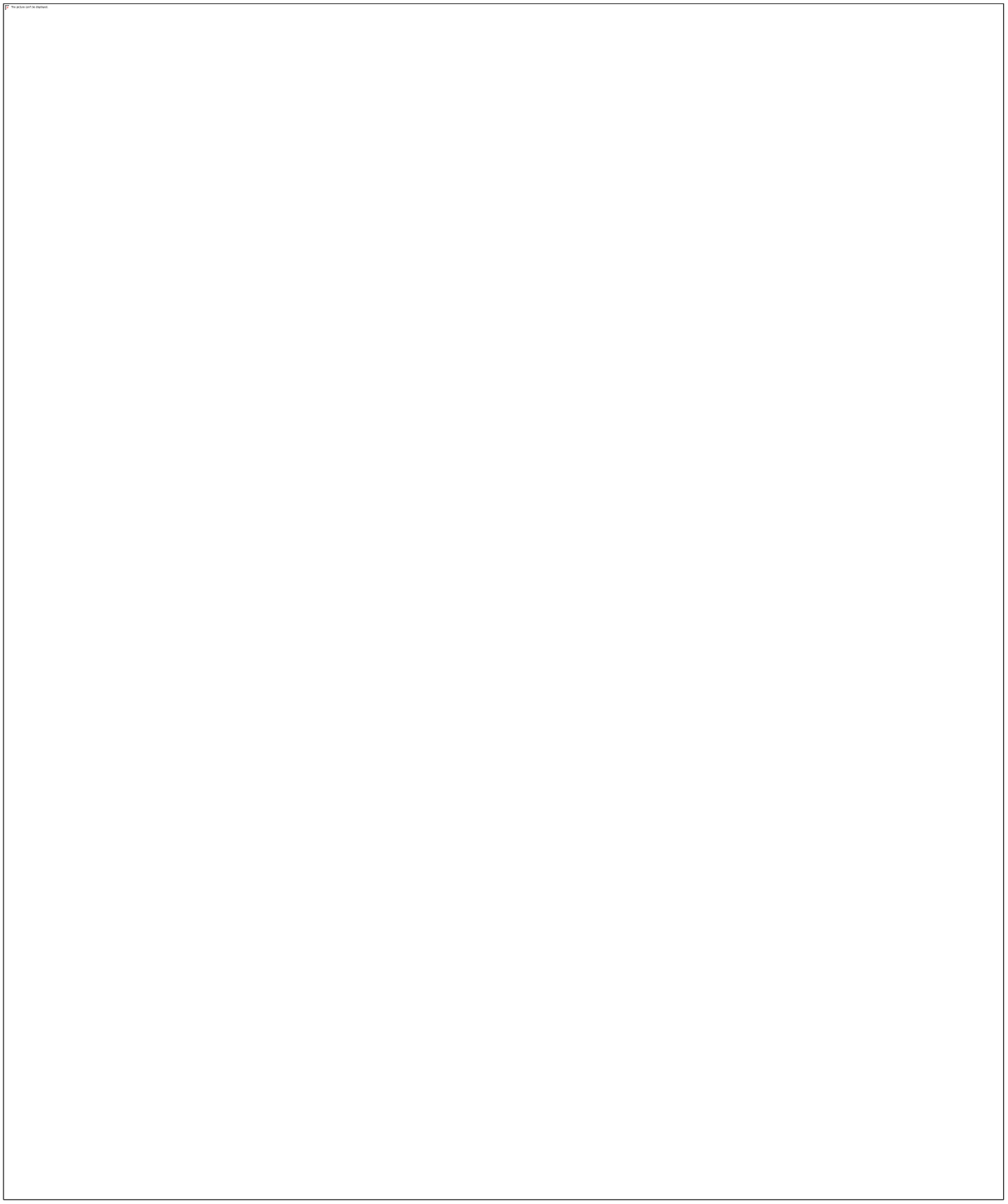
**Appendix F: Letter to request permission from DBE (KZN province)**

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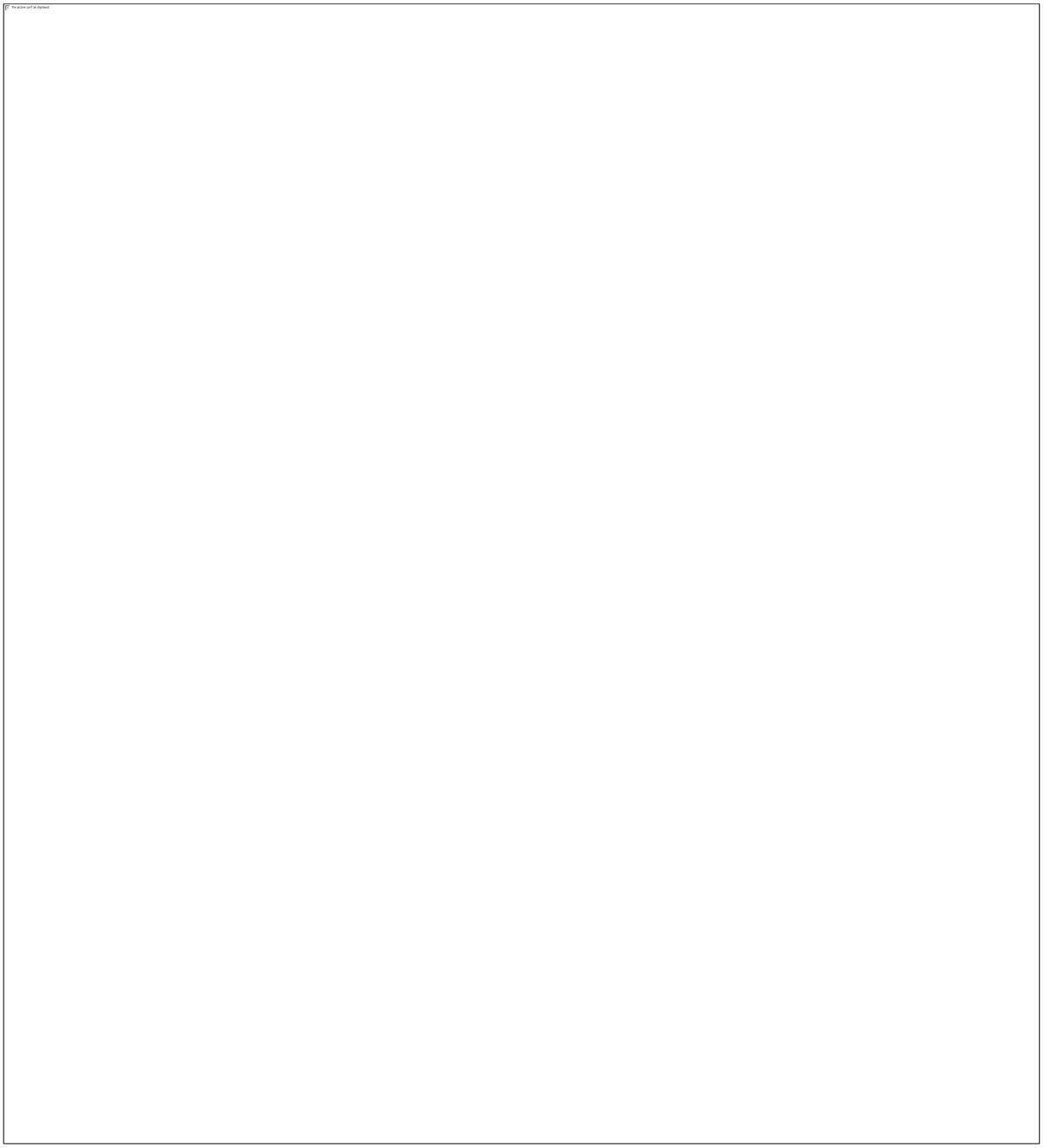
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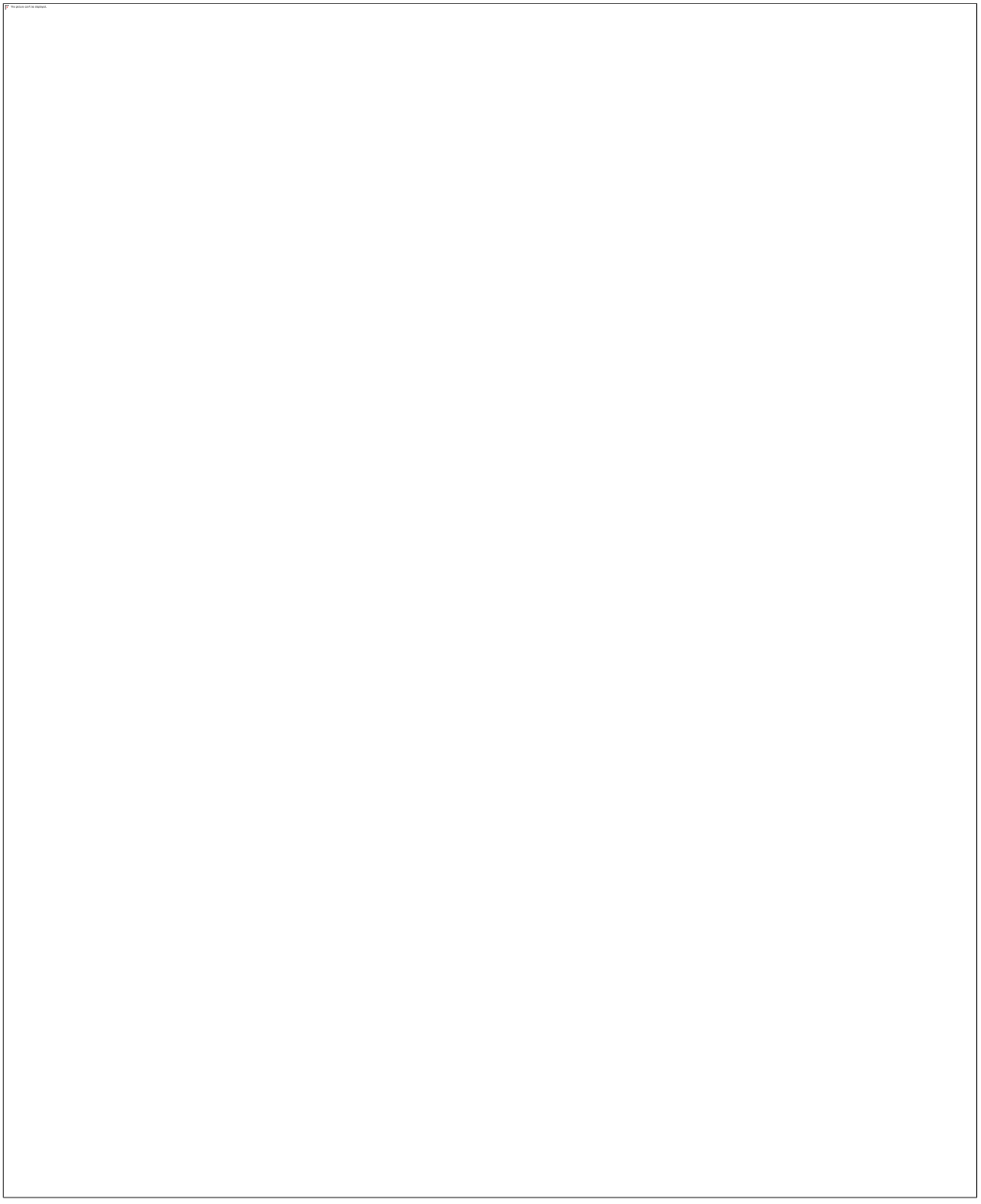
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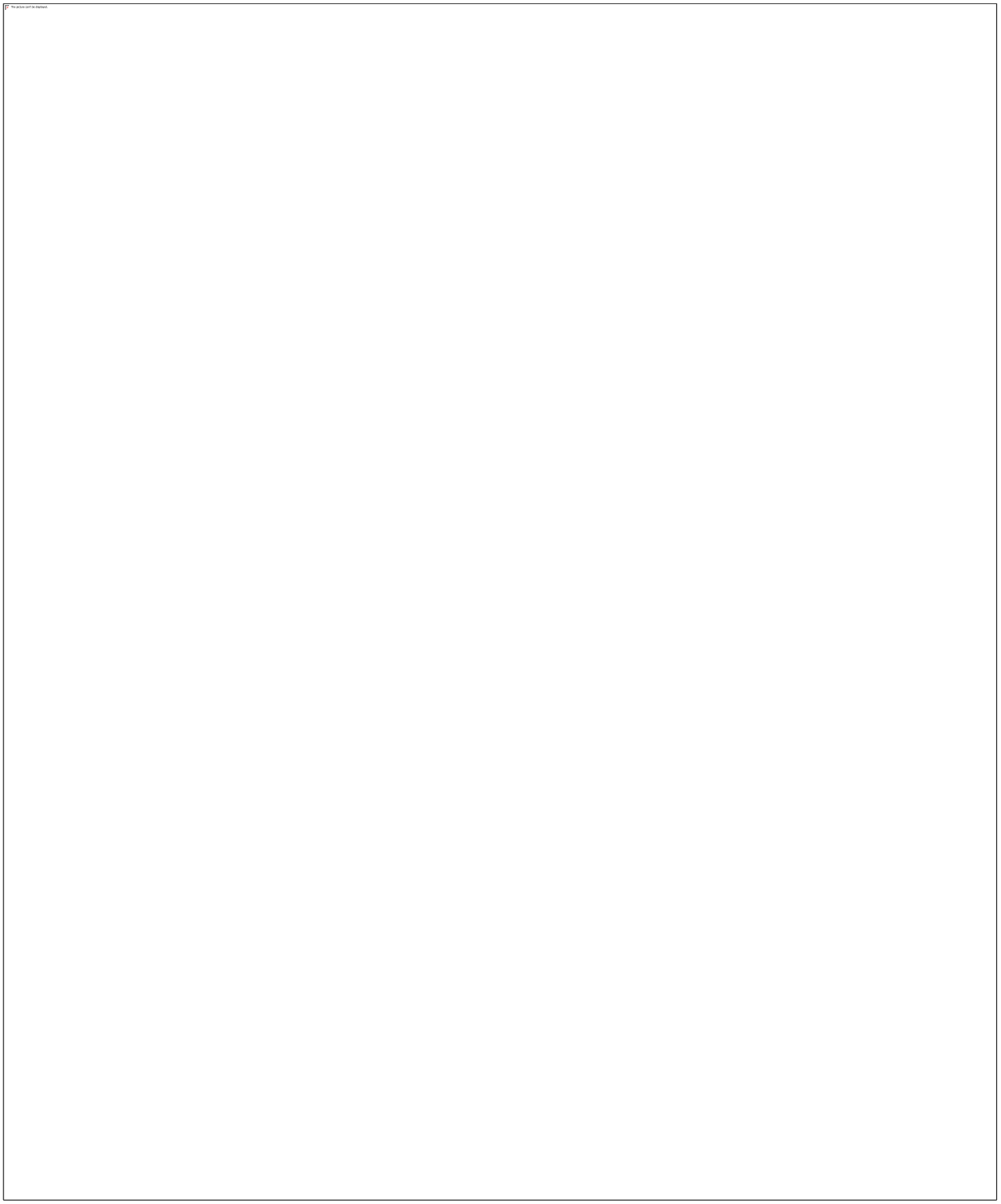
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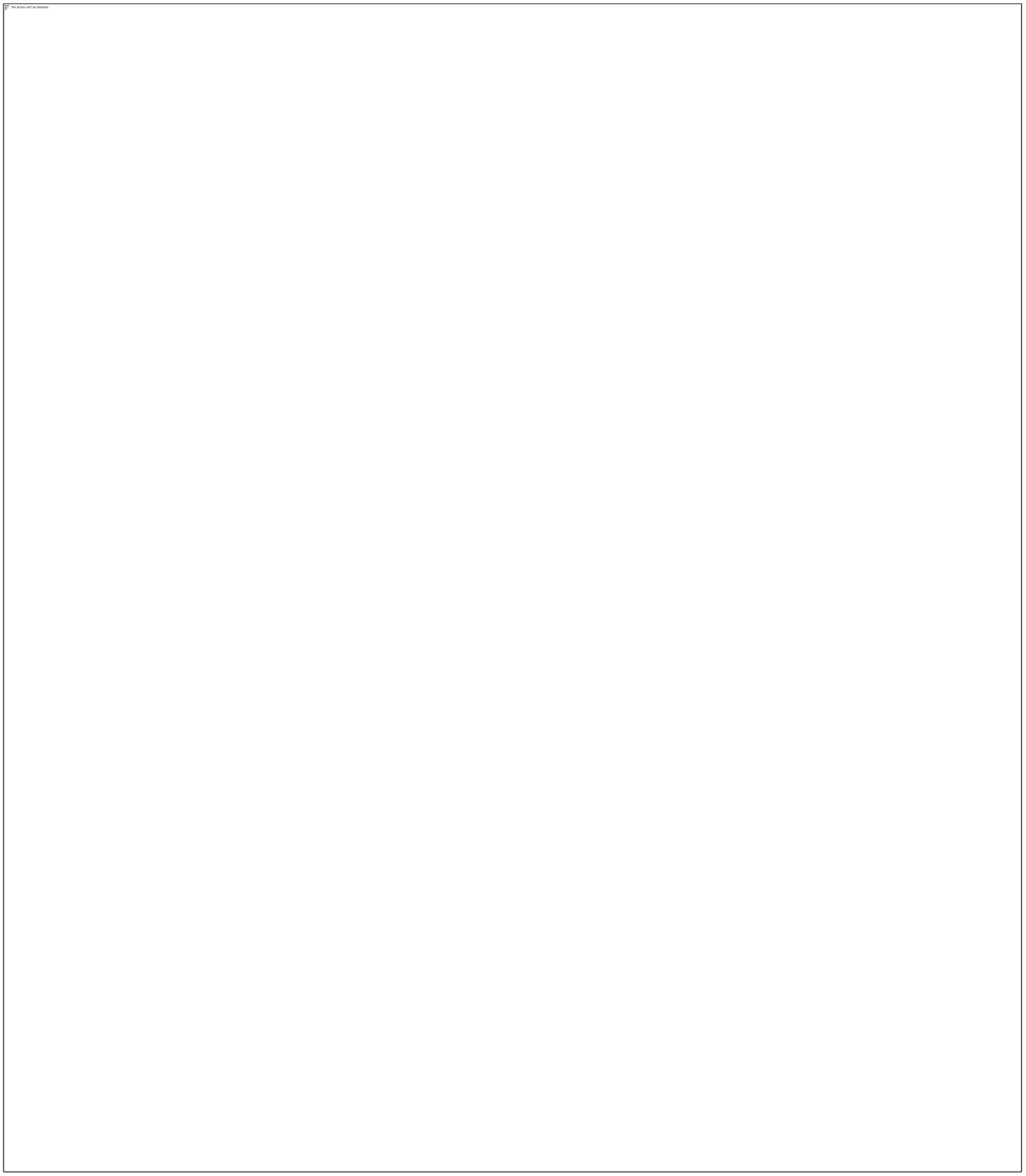
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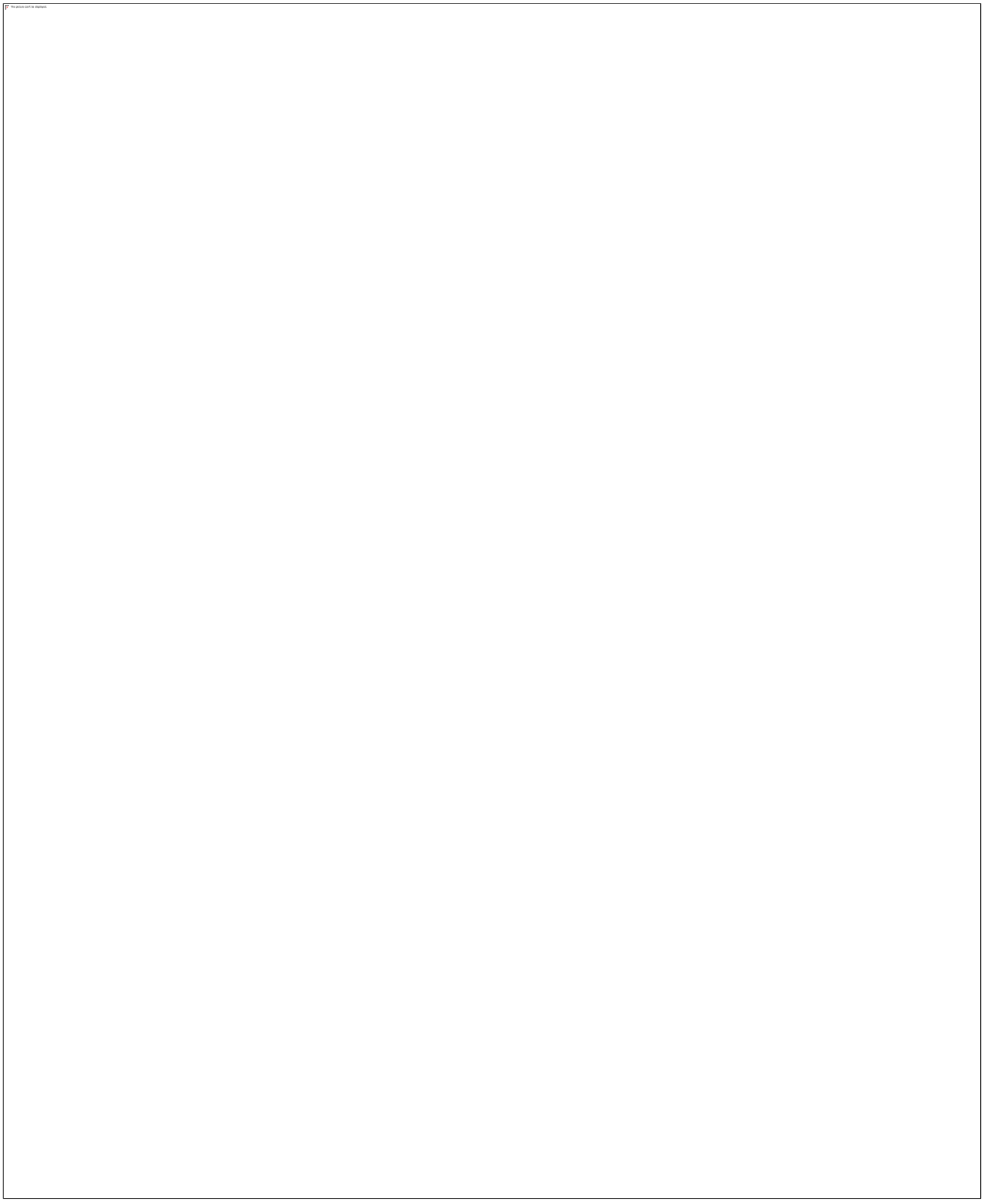

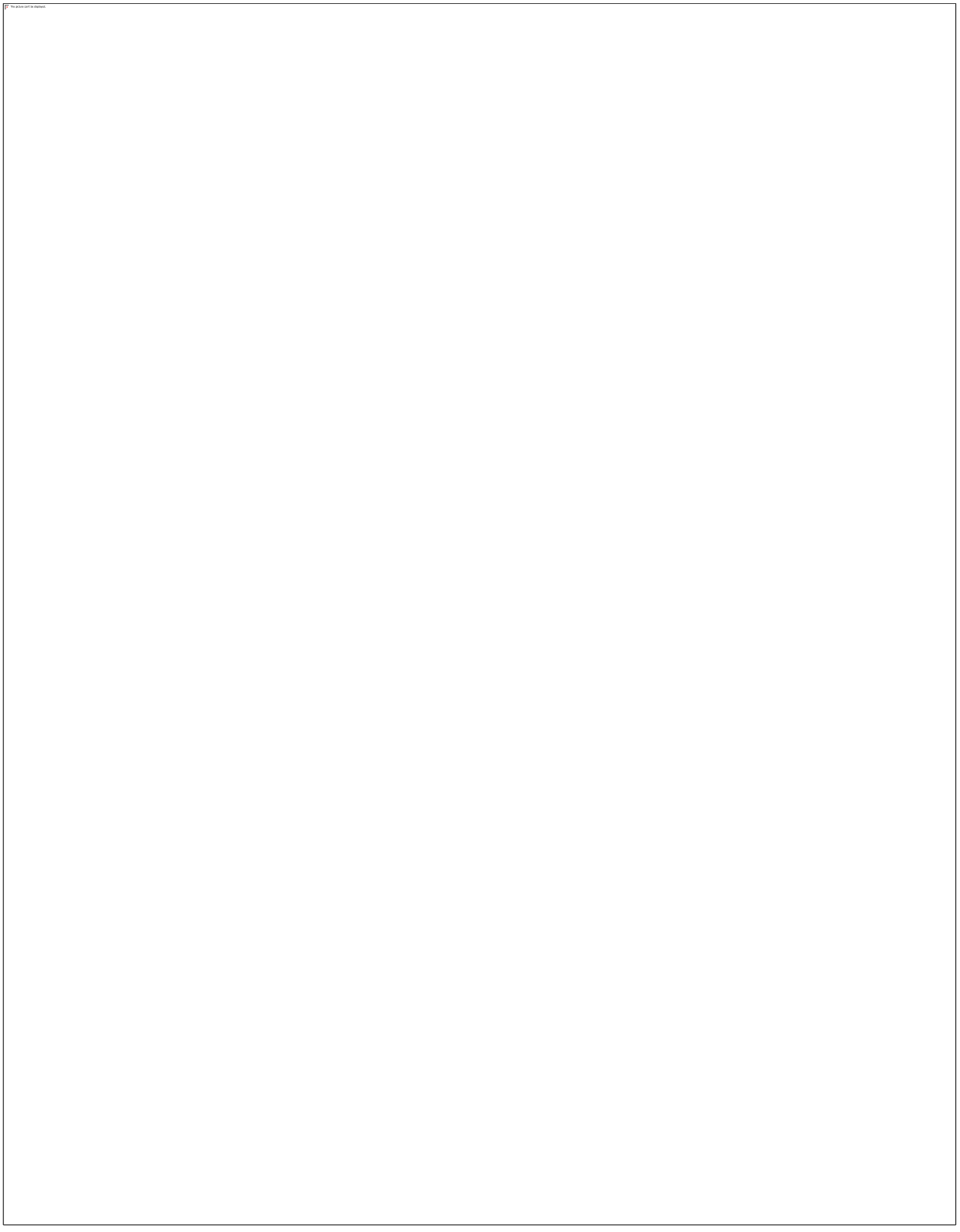
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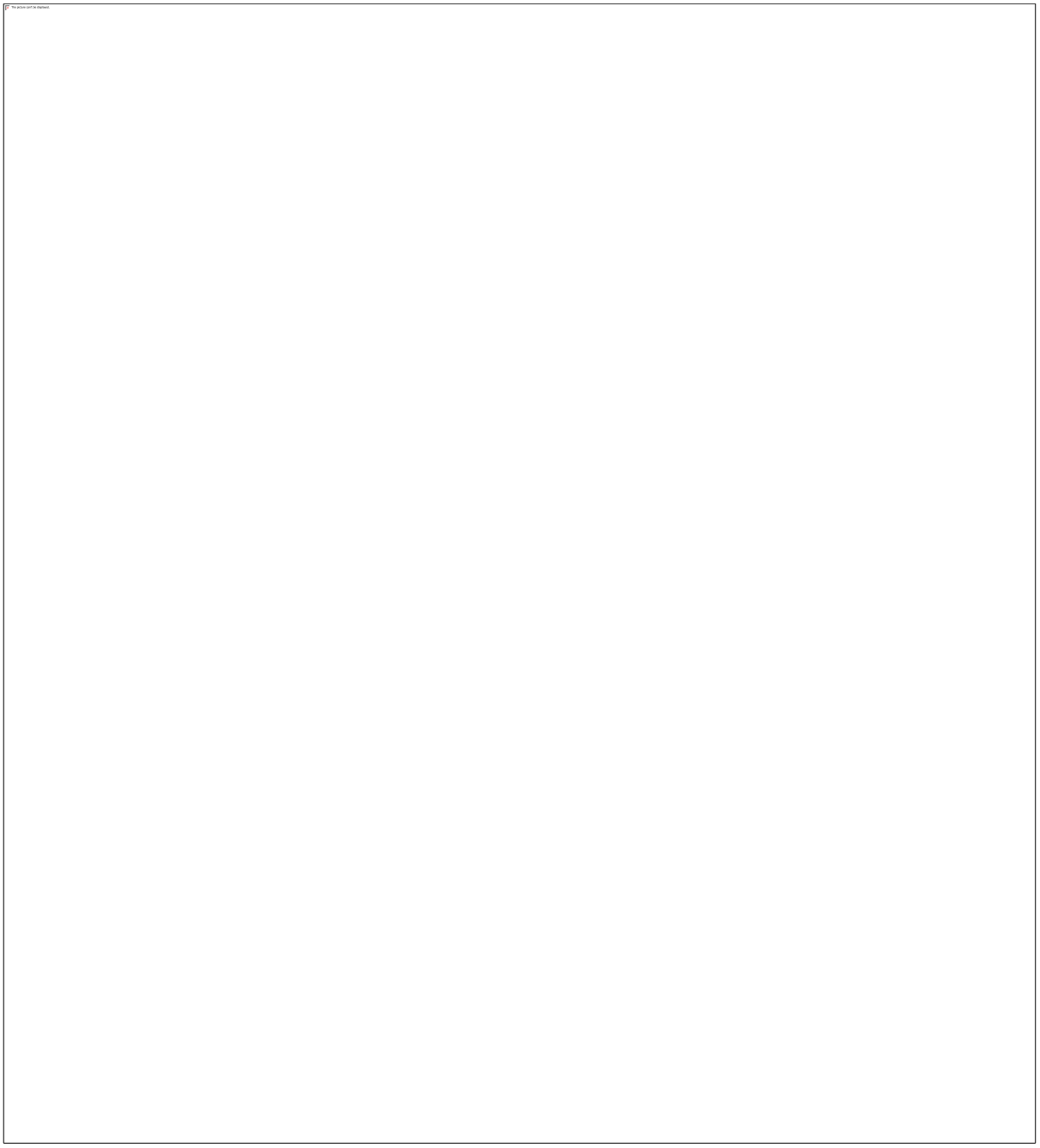
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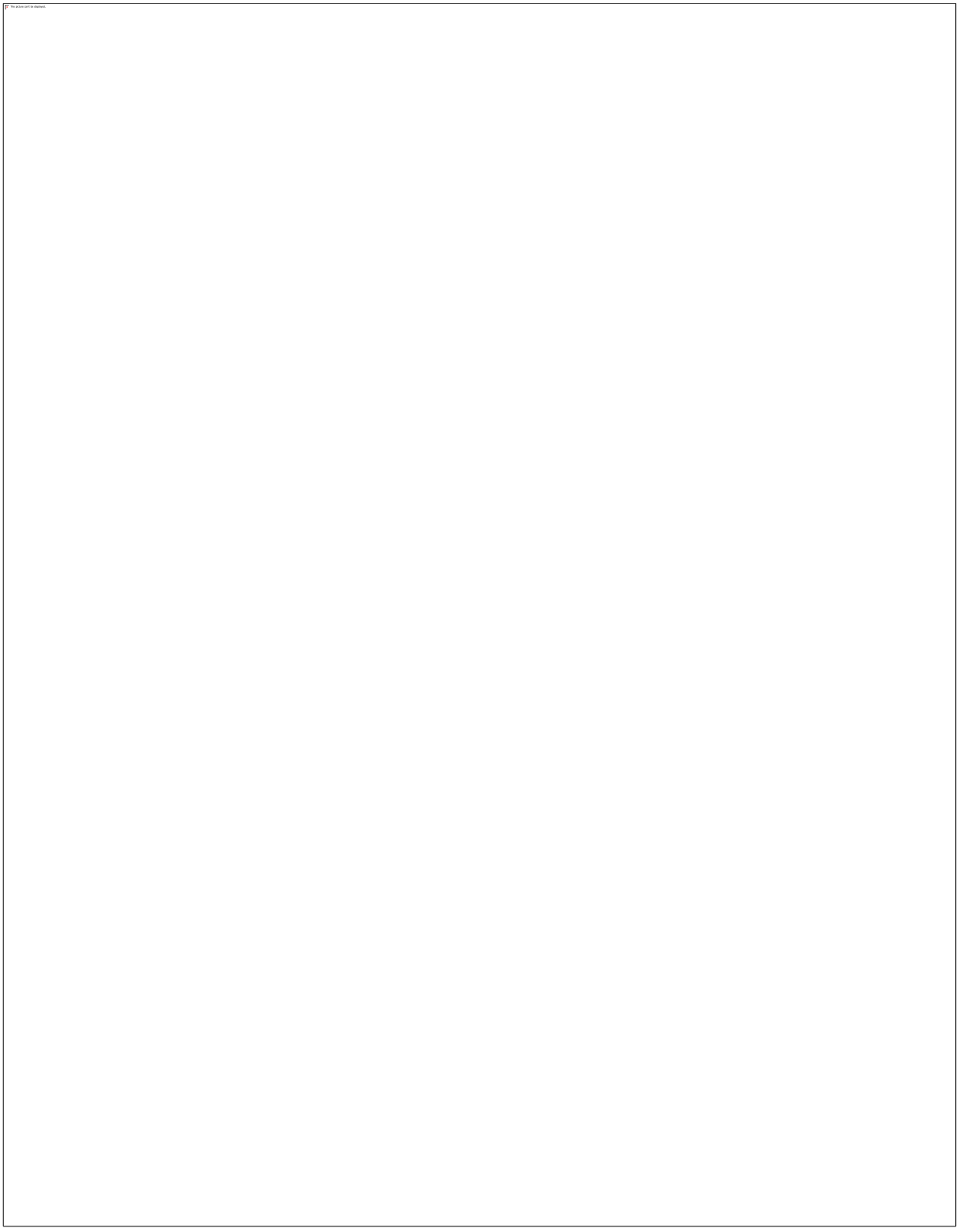
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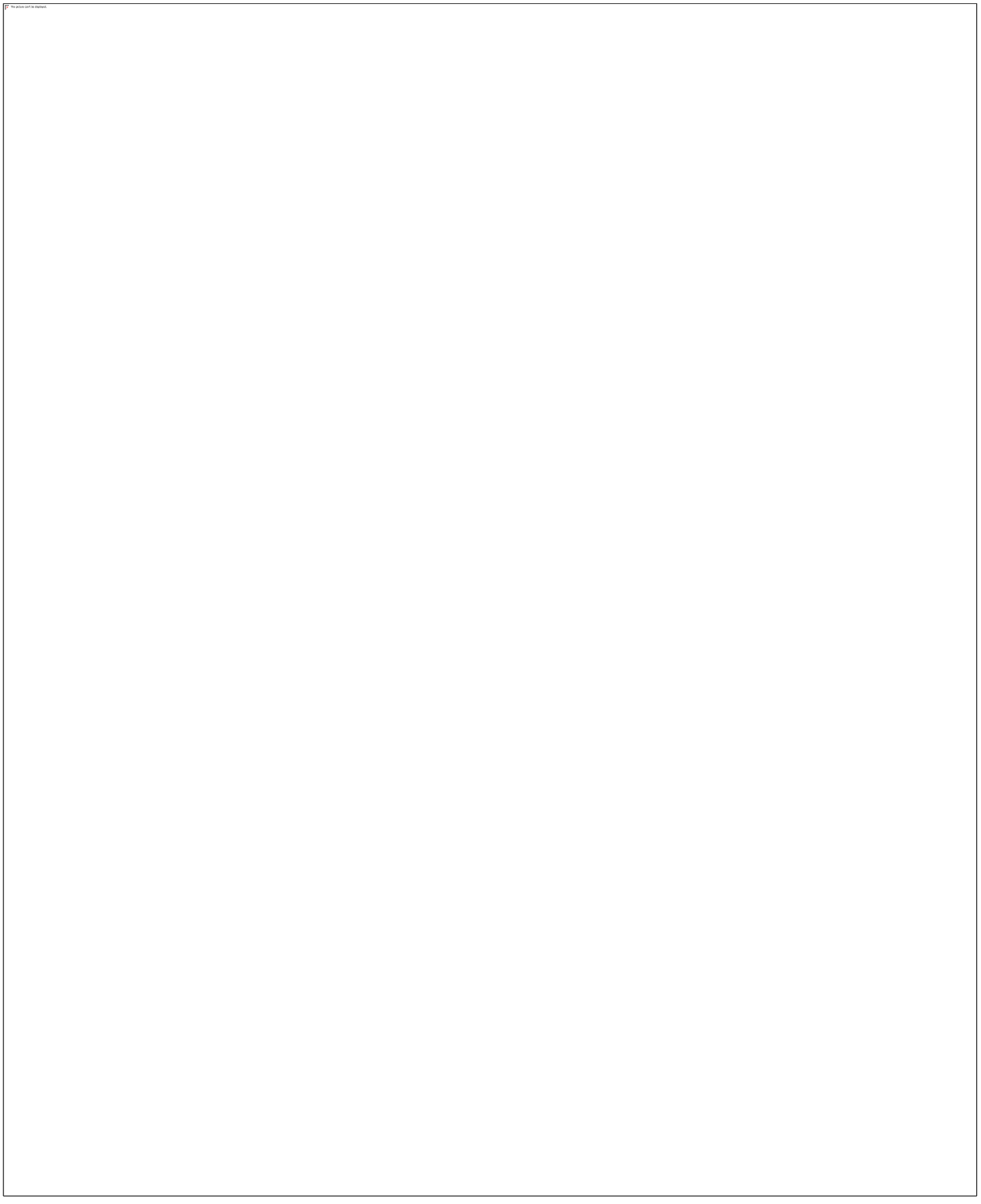
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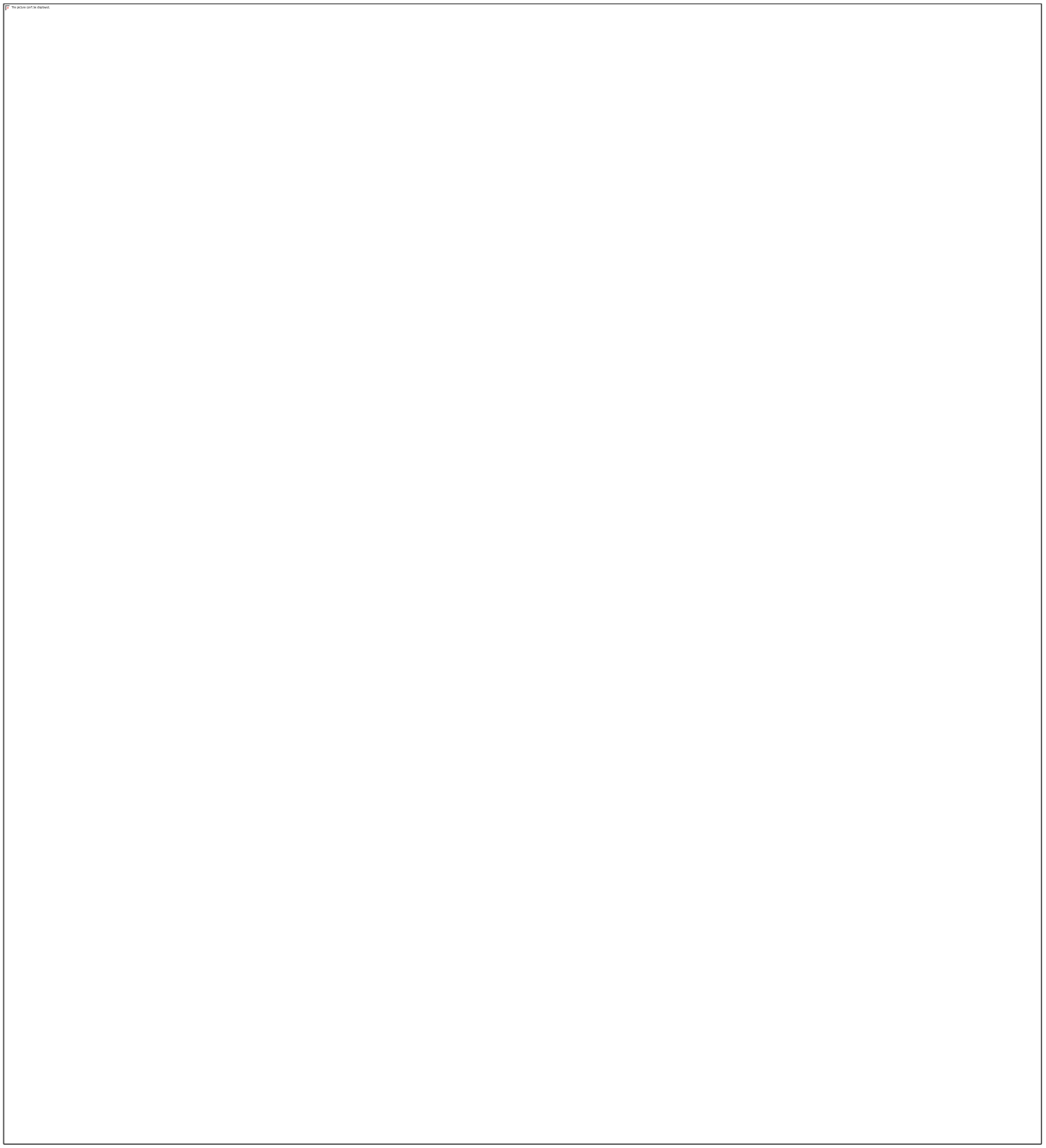
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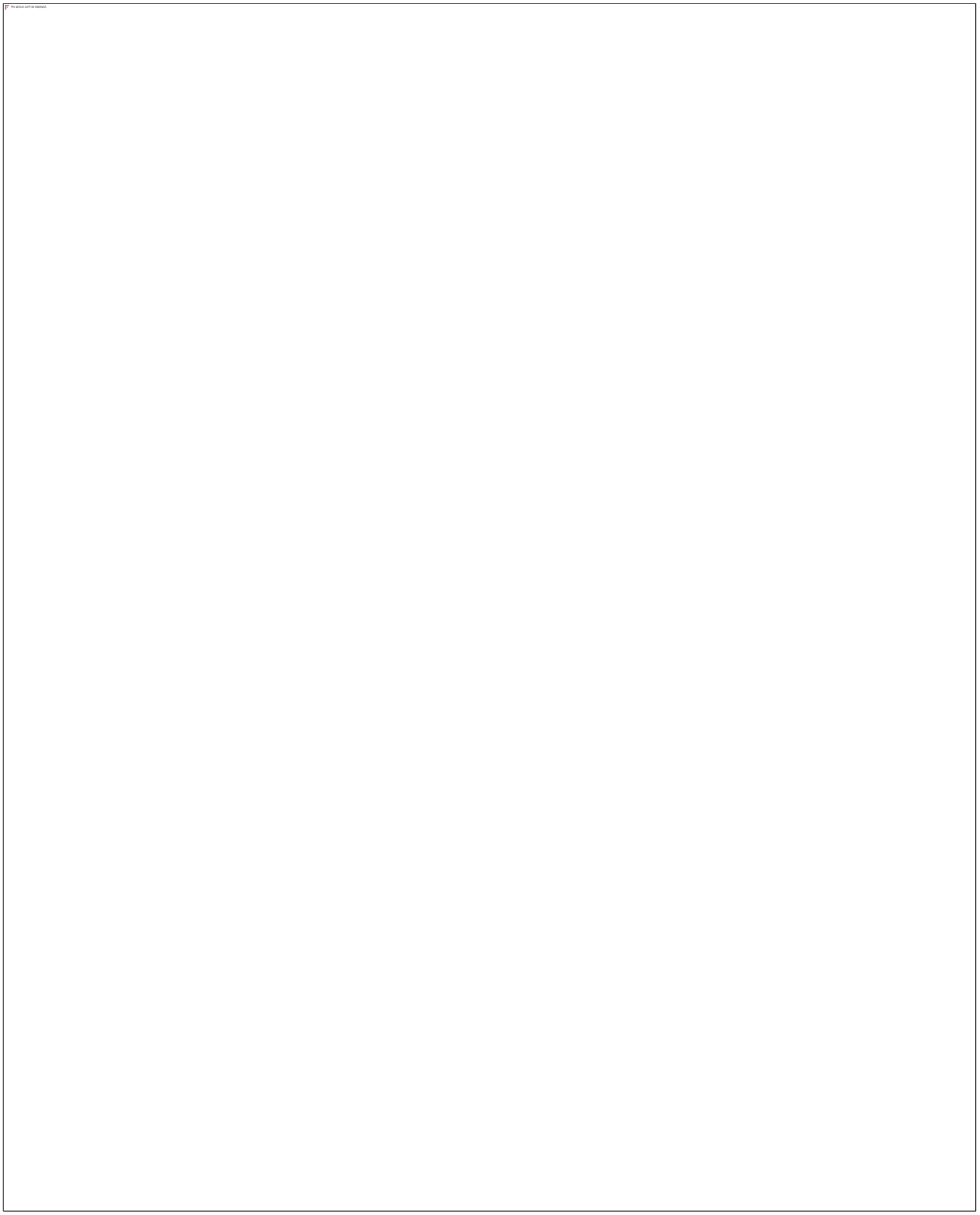
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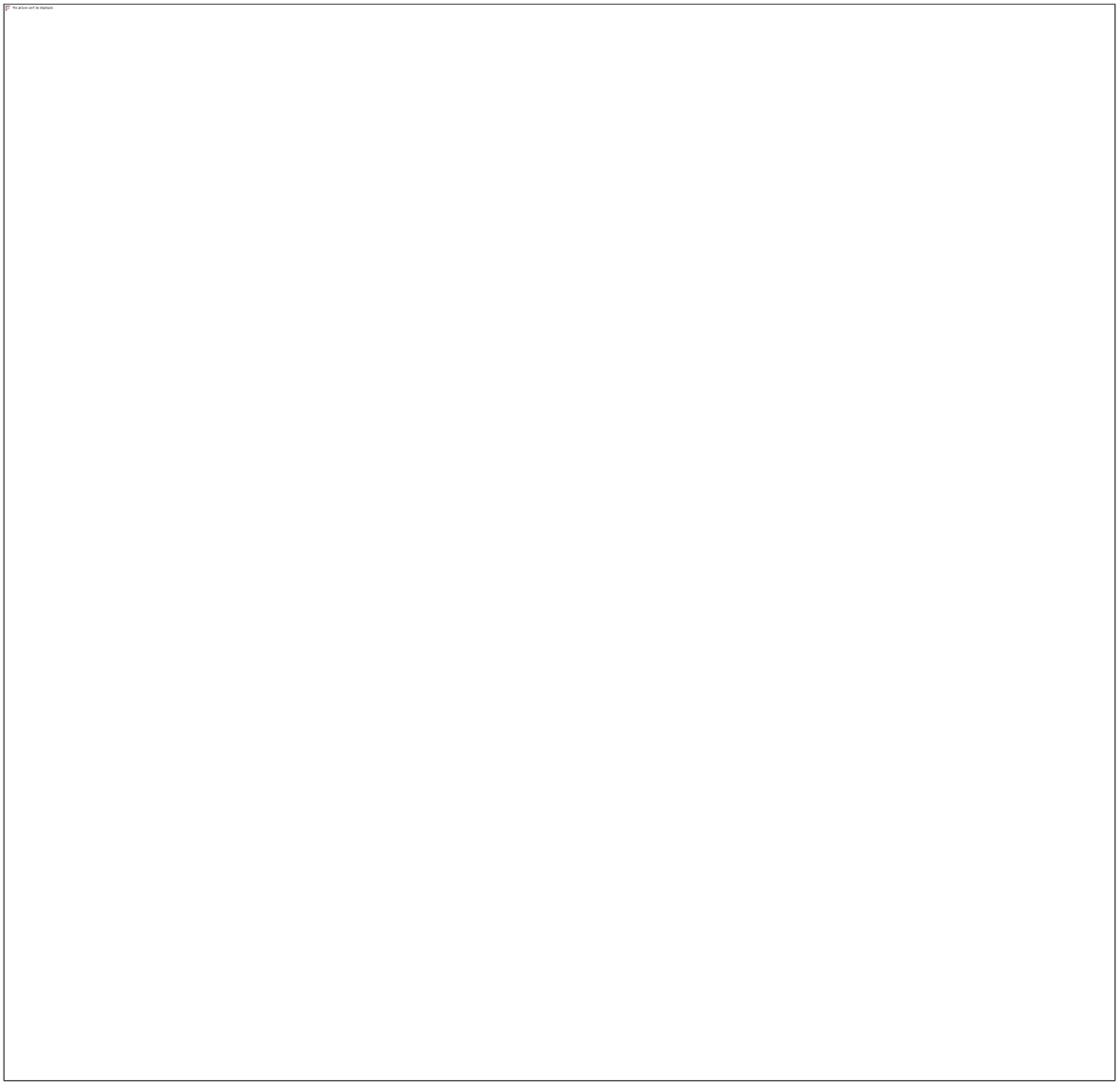
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## Appendix G: Interview Questions

1. What is your view of GC?
2. Is GC important in teaching technology, please explain
3. Why do you have this view of the GC?
4. What methods do you use to teach the GC?
5. How do you plan and prepare when you teach GC?
6. How do you present the idea of the GC to your learners?
7. Do you emphasize any particular aspect of GC- please elaborate?
8. What methods do you use to teach GC, is this the only method you use to teach the GC?
9. Why do you use the method/s you mentioned?
10. What type/ kinds of activities do you give to learners during your GC lesson?

**Appendix H: Observation schedule**

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

**Appendix I: Questionnaire for participants**

Please complete the information needed below

| | |
|---|---|
| Gender | |
| Number of years teaching in general | |
| Number of years teaching Technology | |
| Qualification/s Qualification in Teaching Technology in grade 7. | |
| Have you attended any training in Technology, GC for teaching and assessing GC? | |
| Please elaborate about the training and its duration How many periods of Technology do you teach a week? | |
| How many periods of Technology make up your workload? | |
| Do you teach other learning areas? - Please list them. Please indicate the number of periods these other learning areas contribute to your workload. | |
| On which level are you employed e.g., L1, L2 | |
| Nature of appointment: Permanent/ temporary | |

1. What do you understanding about GC in grade 7 ? please explain

_____

_____

2. How do you use your knowledge of GC when teaching GC? Please elaborate

_____

_____

3. Do you understand all the components of GC?

_____

_____

_____

___

_____

___

4. How would you describe your practice of teaching GC?

_____

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_____

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_____

_____

_____

5. What type/types of assessment do you use to engage learners in practicing GC? Please elaborate

_____

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6. Do you have relevant resources to engage in classwork as required by the CAPS document for GC? Please explain.

_____

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_____

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_____

___

7. Do you feel adequately trained to implement the demands made on you in respect of the teaching and assessing in this section of work? Please elaborate.

_____

___

_____

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8. What are your views on the content knowledge and skills that the grade 7 learners are expected to have/ to know pertaining to GC? Please explain.

_____

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9. What strategies /method you use to improvise for resources that are lacking at your school for the teaching and assessing of GC? Please explain.

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10. Do you consult with students for resources? Please explains

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11. What support structures are available to you for teaching and assessing of GC? Kindly explain.

_____

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_____

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_____

12. What methods of teaching do you use when teaching GC?

_____

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_____

13. Are the results of your students reflecting that they have learned the aspects of GC when assessing them?

_____

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_____

14. Why do teachers use their TSPCK of GC when they teach GC the way that they do?

_____

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_____

_____

_____

15. Is the way that teachers use to teach GC beneficial for the students?

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16. Graphic Communications (GC) has sub-topics, list all the sub-topics under GC.

_____

_____

_____

_____

_____

_____

17.Name and draw examples of **conventions** on the table below:

| Convention | Example | Use | application |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

19.Explain the following terms, using your own words

a) Sketching

_____

_____

_____

b) Working drawing

_____

_____

_____

c) 3D oblique drawing

_____

_____

_____

d) 3D artistic drawing

_____

_____

_____

1. Give three examples of: Colour , Texture and shading

| | | | | |
|---|---|---|---|---|
| **Colour** | | | | |
| **Texture** | | | | |
| **Shading** | | | | |

**Appendix J: Interview responses**

1. **What do you understand about GC in grade 7?**

**Teacher One**

*Generating ideas one way of communication. Some lenders can't explain in words it is easier for them to draw it is basically communication.*

**Teacher 2**

*graphic communications is communicating through drawings it could be rough drawings or sketches or technical drawings.*

**Teacher 3**

*Graphic communication is the way at communication all communicating through drawings and pictures.*

Teacher 4

graphic communications is designs.

teacher 5

drawing your ideas.

Teacher 6

graphic communication is the sharing of ideas using all forms of graphics it maybe sketches it may be using the conventions it may be using a symmetric drawings or single or double point vanishing points single or double vanishing points with the use of specific drawing instruments such as the grid square sheet the the usage all proper instruments such as the rulers specific pencils if the school is lucky enough they also use projectors to teach this aspect of graphic communications.

1. **How do you use your knowledge of graphic communications when teaching GC?**

**Teacher one**

I start by drawing. They draw what they used daily each caps desks then a question is asked what we use when we draw. They will then decide whether to draw it or write it they must give a clear vision of what to draw using elements of graphic communications.

**Teacher 2**

I use it to teach my learners and I also give them a choice to draw I included in mini pets for formal assessments.

Teacher 3

graphic communication to me it's a way of sharing ideas communicate a message through drawings or pictures.

teacher 4

graphic communication is the art you use to design your product which will enhance the interest of the people or consumers

teacher 5

it was my mathematics ideas to differentiate between 3D and 2D shapes

2. **do you understand all components of GC?**

Teacher one

yes but some are hard to apply to the students. They must use shading texture and label the object views will be added shapes and all the unintroduced the content including graphs.

Teacher 2

yes I understand most of them more especially those that are required increase 7.

Teacher 3

not really I get stuck on the artistic drawing but the other components I mustered them so well.

I teacher 4

yes I do.

teacher 5

no

3. **how would you describe your practice of teaching GC?**

Teacher one

practical.

Teacher 2

I use both teacher centered and Linux centered approach.

teacher 3

it's his lender censored a group leaners into small groups for activities.

teacher 3

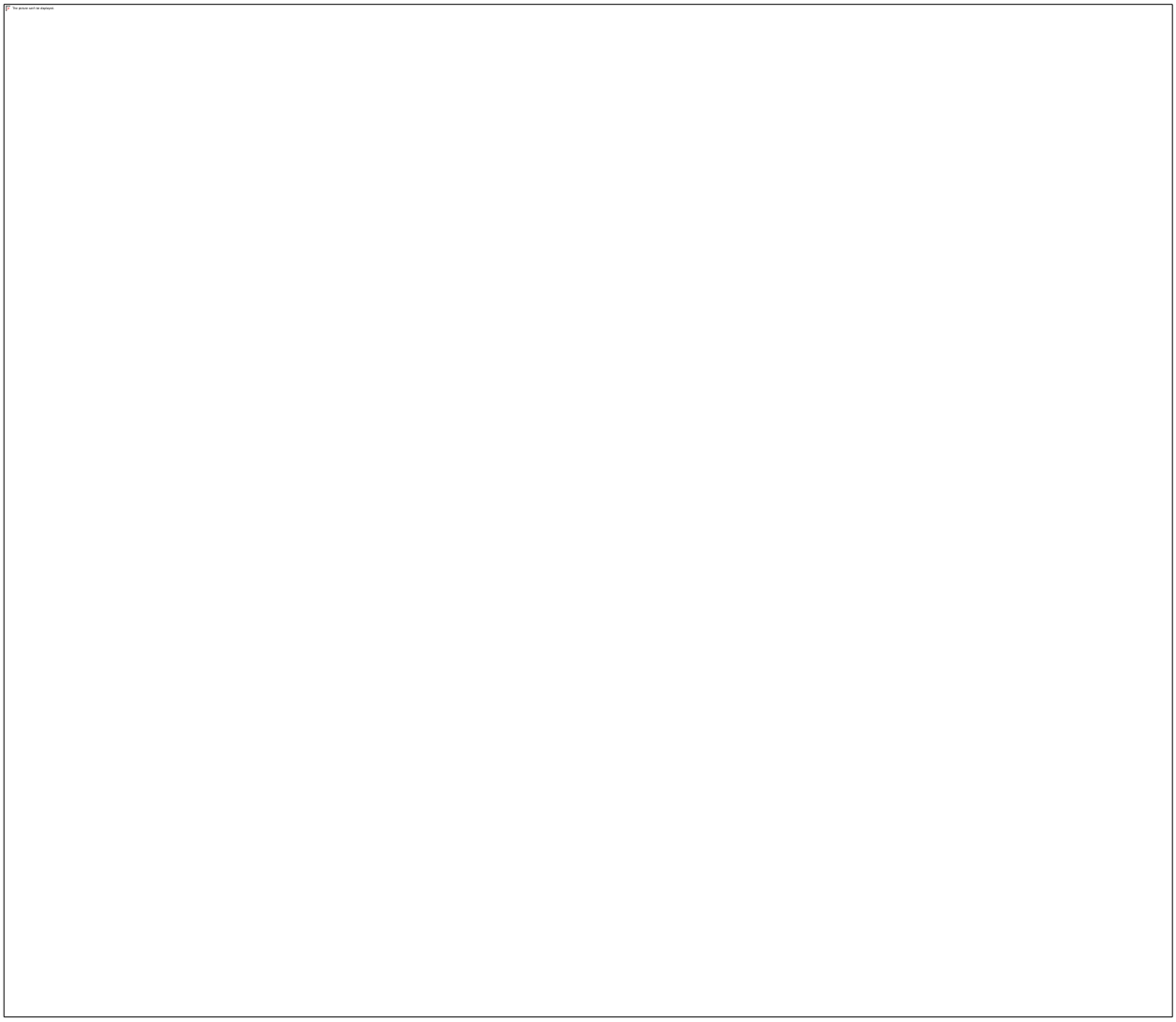
demonstration first then give list what to do to to practice what they learned.

Teacher 4

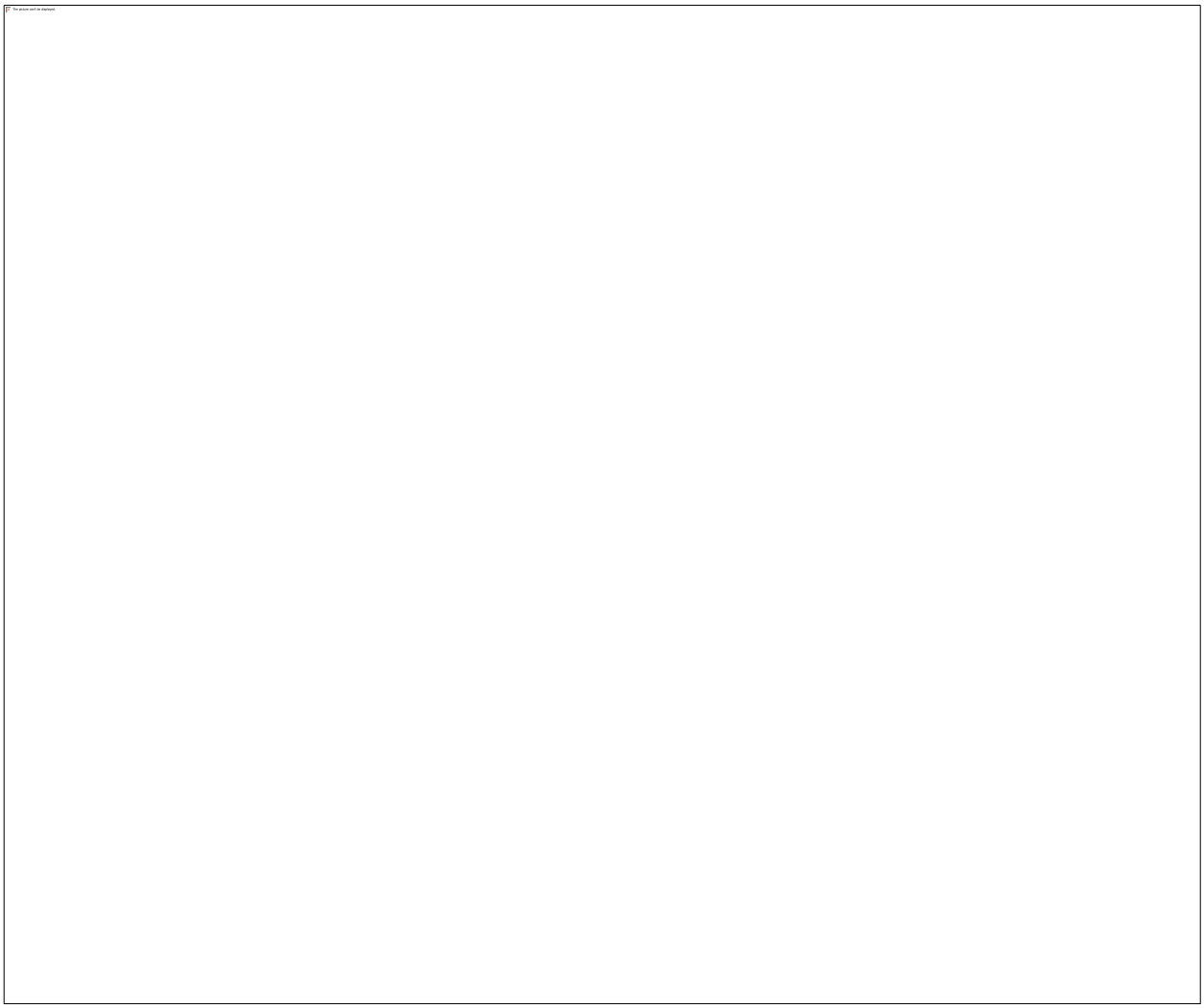
learner centered

## Appendix K: Questionnaires : Teacher Biographical Data (T1-T6)

## Teacher :1



**Teacher :2**



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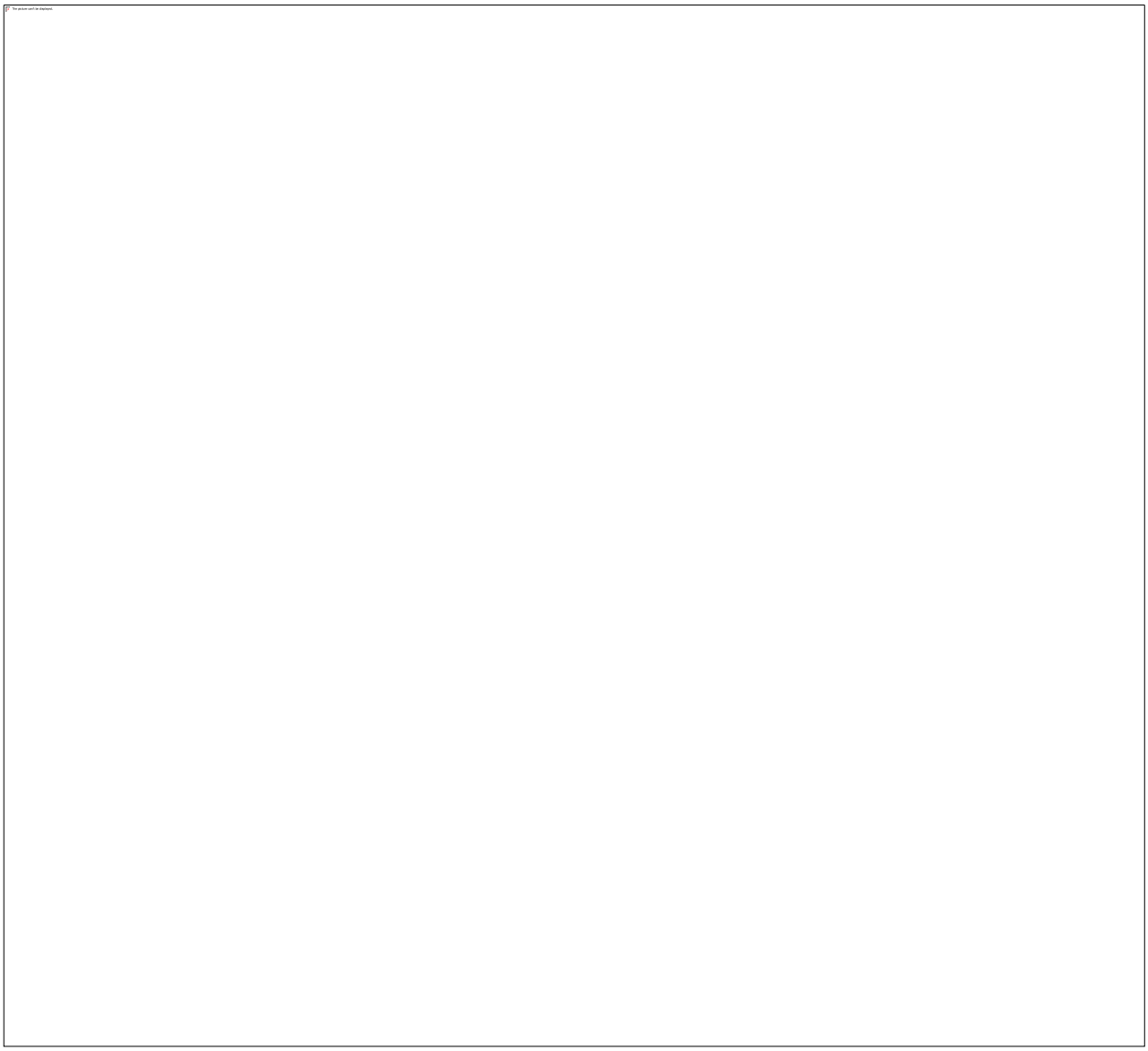

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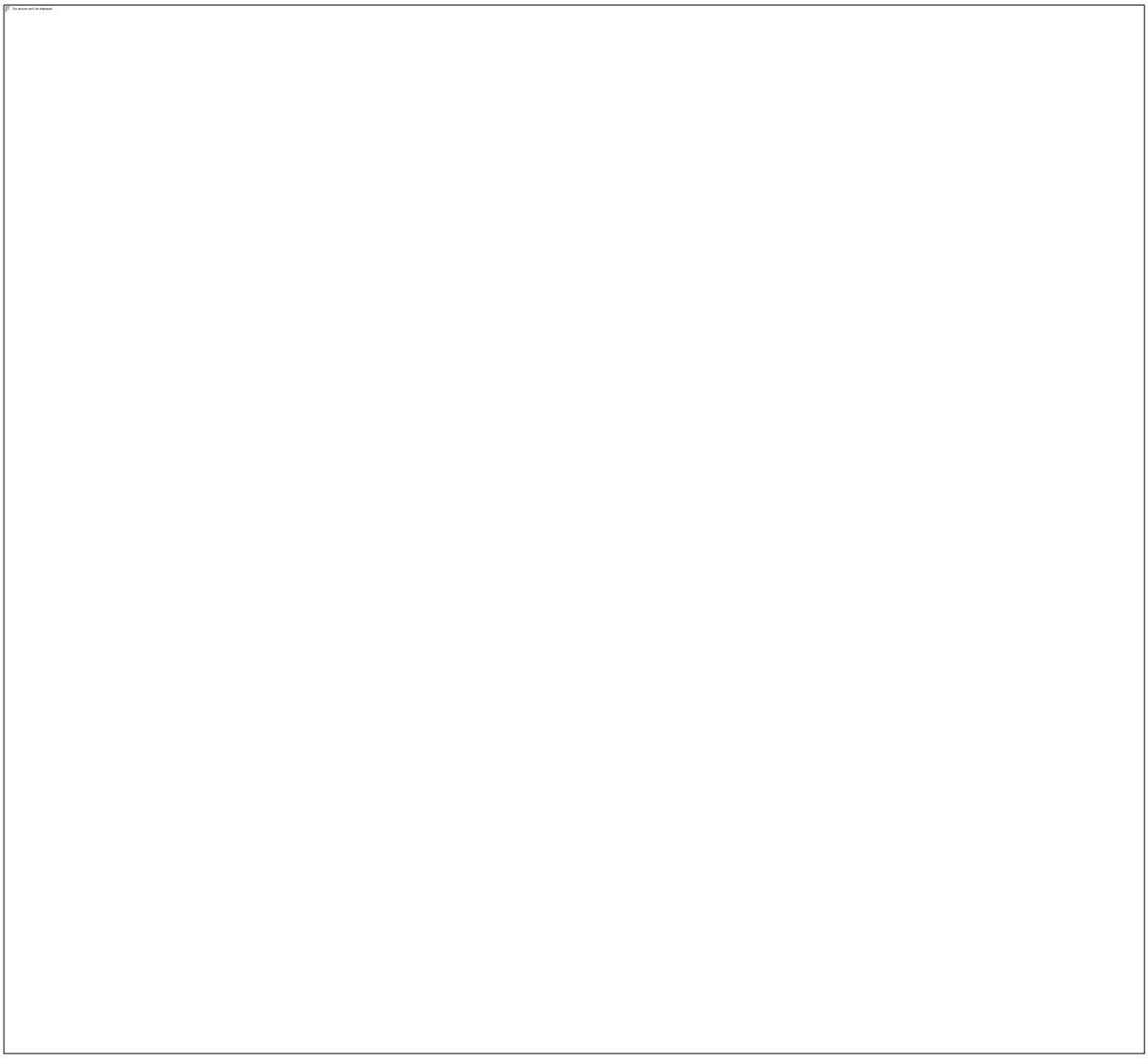

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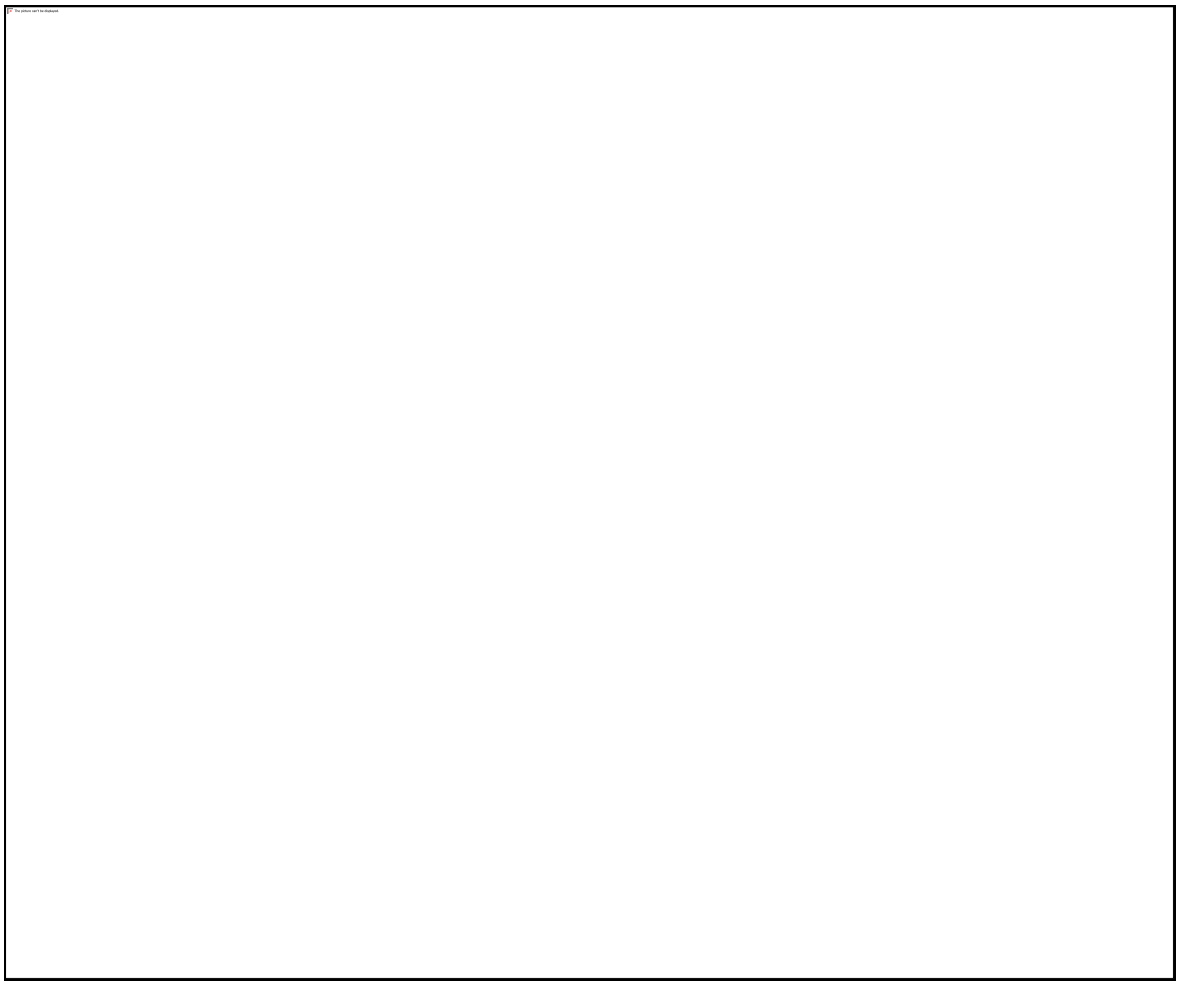

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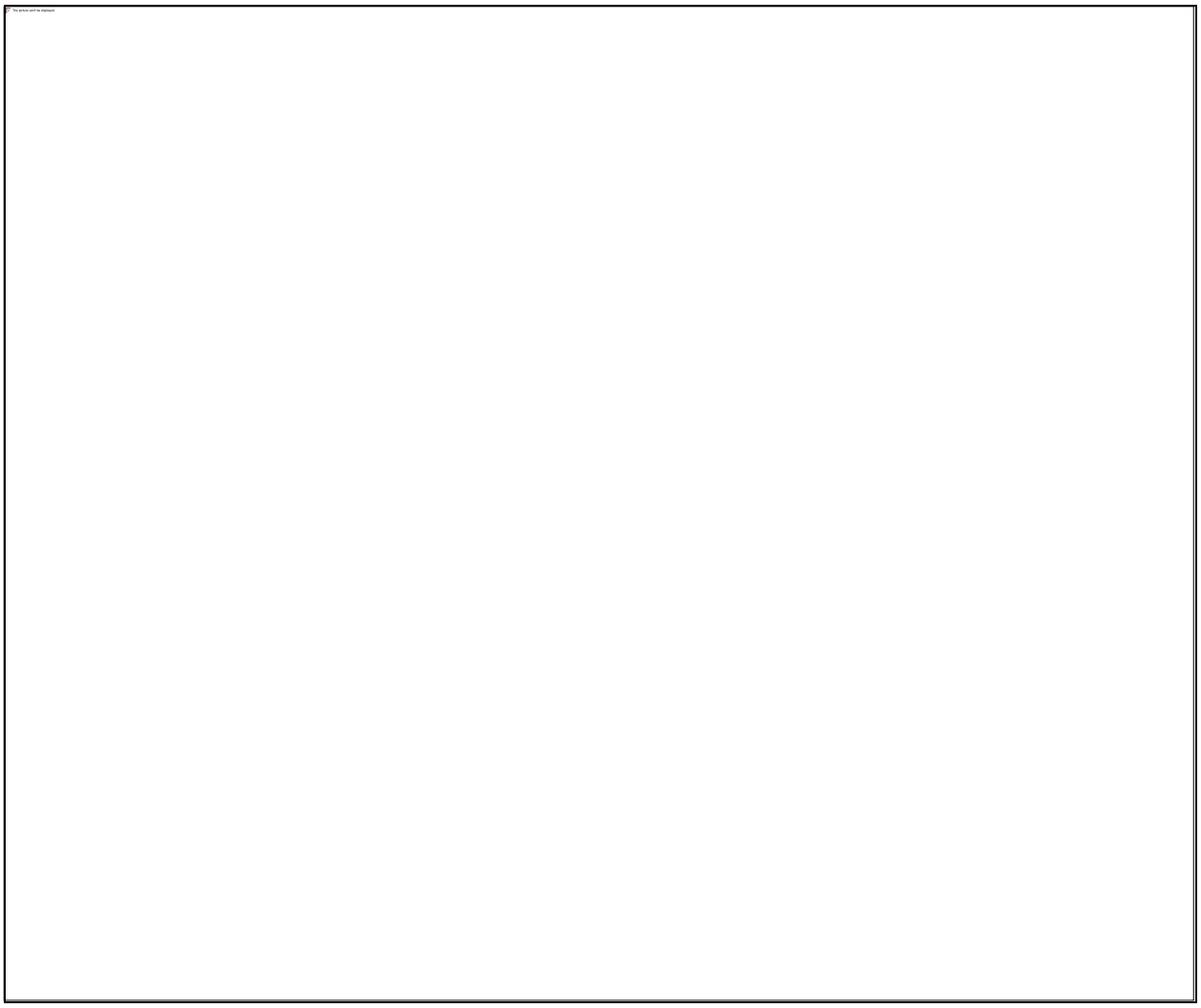


**Appendix G: Teacher Assessment**

**Page 1**

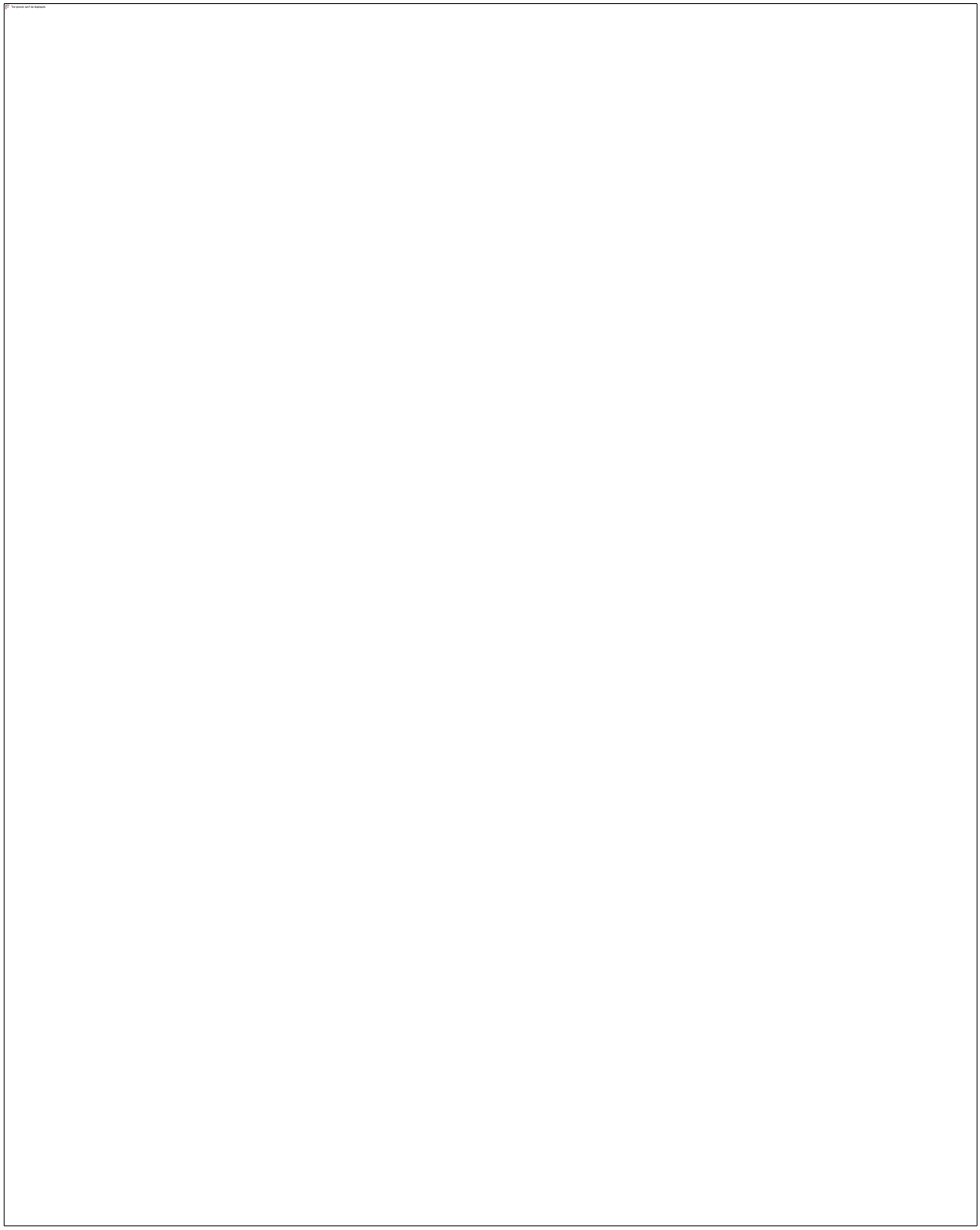
**Teacher 6**

## Teacher 3

## Teacher 5

**Page 2**

**Teacher 6**



**T1**

**T5**