# Grade 11 Civil Technology Teachers' Practice of Promoting Active Learning During the Teaching of Graphic Communication

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# DECLARATION

I, the undersigned, **Sithembile Hove**, hereby declare that this thesis entitled "An exploration of Grade 11 Civil Technology teachers' practice of promoting active learning during teaching of graphic communication: A case study of the uMgungundlovu district" is my own original work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

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# ABSTRACT

Graphic communication is a language of communication that is used for visual representation and expression of ideas and concepts. 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, 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, 2019).

Graphic communication is a fundamental part of Civil Technology (CT) embedded in the CT curriculum. Through graphic communication skills, learners are taught how to read, interpret, design, and draw civil drawings using freehand or instrument drawing techniques guided by the South African National Standards (SANS) code of practice for building drawings – SANS 0143. The graphic communication skills in CT include among others, the ability to draw orthographic projections of floor plans, elevations and sectional elevations of single and double storey buildings, interpretation of site plans, detailed drawing of building features such as foundations, staircases, doors and door frame installations, cavity walls, plan and front elevation courses of brick walls in English and stretcher bond, arches, roof trusses, and so forth (Education, 2014). The National Senior Certificate (NSC) examiners and moderators' reports for CT from 2016 to 2019 reflect learners' remarkable ineptitude with regard to graphic communication skills. The diagnostic reports highlight learners' poor performance on examination questions that test for graphic communication skills. The following common mistakes and misconceptions have been established from the CT NSC Examination diagnostic reports for 2018 and 2019: learners struggle to read and interpret graphic text correctly; misinterpretation of dimensions; failure to apply scale correctly on drawings; and incorrect representation of SANS symbols on drawings (Education, 2018; 2019). On a yearly basis, at professional development meetings organised by the department of education and facilitated by subject advisors, teachers are made aware of the areas that learners perform poorly in, yet learners continue to perform poorly in graphic communication.

This study explores grade 11 Civil Technology teachers' practice of promoting active learning during teaching of graphic communication lessons, using a case study of uMgungundlovu district, KwaZulu-Natal. The theoretical framework that guides this study is underpinned by the qualities of effective teachers (Stronge, 2018). A qualitative case study design approach to inquiry was used to generate data through a questionnaire, semi-structured individual interviews, focus group interviews and analysis of lesson plan portfolios and recorded graphic communication lessons. Purposive sampling was used to identify the respondents for this study. Data collected was subjected to content and thematic analysis.

The findings of the study reveal that there are three ways in which grade 11 CT teachers promote active learning when teaching graphic communication. These are: chalkboard illustration/demonstration; explanation of concepts and field excursions; and learners draw and make projects to link theory and the practical. Teachers actively engage learners in graphic communication lessons in four ways, namely: giving learners individual drawing activities to complete in class; group discussions and activities; use of digital projector to show videos and pictures; and making models, simulations and giving learners enrichment exercises outside the classroom.

Research findings further reveal that all CT teachers encounter challenges when promoting active learning in teaching of graphic communication. These include challenges encountered when teaching theory and practical lessons, and learners' misconceptions on site plans, floor plans and calculation of perimeter and area of site and proposed building. The challenges encountered emanate from contextual factors that constrain the teaching of graphic communication, namely: lack of drawing equipment; learners' lack of motivation with the subject and not submitting tasks; too much workload for teachers; lack of access to modern technology such as internet; insufficient time to cover the expected content; and under-resourced workshops to perform practical lessons. My findings illustrate that a combination of contextual factors and teachers' pedagogical knowledge, pedagogical content knowledge or subject matter knowledge and their classroom practices impede the promotion of active learning when teaching grade 11 graphic communication lessons. This problem manifests itself in poor quality NSC results at matric level when learners exit the school system. The findings of this study point towards suggestions and recommendations of professional development intervention programmes to support CT teachers in their endeavours to promote active learning when teaching graphic communication in uMgungundlovu district.

Key words: graphic communication, promoting active learning, practice, teachers.

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| | |
|---|---|
| 2D | 2 Dimensional |
| 3D | 3 Dimensional |
| C2005 | Curriculum 2005 |
| CAD | Computer Aided Drawing |
| CAPS | Curriculum Assessment Policy Statement |
| CK | Content Knowledge |
| CPTD | Continuous Professional Teacher Development |
| CT | Civil Technology |
| DBE | Department of Basic Education |
| EGD | Engineering Graphics and Design |
| FET | Further Education and Training |
| GET | General Education and Training |
| ICT | Information and Computer Technology |
| KZN | KwaZulu-Natal |
| NCS | National Curriculum Statement |
| NSC | National Senior Certificate |
| PCK | Pedagogical Content Knowledge |
| PK | Pedagogical Knowledge |
| SANS | South African National Standards |
| SCK | Subject Content Knowledge |
| UKZN | University of KwaZulu-Natal |

# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction and background

Engineering remains a key profession in the economic and infrastructure development of South Africa (Blyth, 2016). However, the ongoing dearth of engineering skills continues to overshadow the economic growth and development of the country as evidenced by the country's dependence on such skills (Blyth, 2016). In an initiative to address the national skills crisis in the engineering profession, the government of South Africa, through the department of basic education, introduced a technology curriculum at grades 10-12 level in order to provide learners with solid foundational skills that equip them for industry-related engineering professions, entrepreneurship or to prepare them for further training at tertiary institutions (Education, 2014). In contrast, the engineering field in contemporary society continues to suffer complexities of incompetent personnel, especially young graduates at entry level who seem to lack concise understanding of engineering practices (Trevelyan, 2019). Trevelyan's (2019) study reveals that there still exists a malalignment between engineering education and engineering practices in the world of work despite efforts by a host of education reforms to set an education curriculum that aligns well with the needs of industry. For the purpose of this study, I hone in on Civil Technology as one of the technical subjects offered within the South African secondary schools' curriculum.

Civil Technology (CT) is a practical subject in nature that focuses on concepts and principles in the built environment. It embraces practical skills and the application of scientific principles to solve problems related to the built environment, to enhance the quality of life of individuals and society ensuring sustainable use of the natural environment (Education, 2014). Embedded in it 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, 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, 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 prior to manufacture of artefacts, assembling and construction of building structures (Dobelis, 2019).

Pondering on practices of promoting active learning in the teaching and learning of graphic communication in CT and encouraging learners to become active participants rather than passive recipients in knowledge building (Christie, 2017), research shows that learners often lack sufficient instructional support to help them hammer out their design intuition and develop design thinking skills that empowers them to imagine and reason about engineering systems and enables them to solve emerging and challenging problems (Xie, 2018). Looking closely at graphic communication, learners are taught how to read, interpret, design, and draw civil drawings using the South African National Standards (SANS) code of practice for building drawings – SANS 0143. Across all areas of CT specialisations, namely, civil services, construction and woodworking, learners engage in freehand and instrument drawing of building features. The graphic communication skills in CT include among others, the ability to draw orthographic projections of floor plans, elevations and sectional elevations of single and double storey buildings, interpretation of site plans, detailed drawing of building features such as foundations, staircases, casements, doors and door frame installations, cavity walls, plan and front elevation courses of brick walls in English and stretcher bond, arches, roof trusses, built-in-cupboards and drawings to illustrate drainage and sanitary fitments on building structures (Education, 2014).

Graphic communication is a core skill in CT and related fields in the engineering space. It is indisputable that 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. Mtshali (2020) acknowledges that CT is one of the subjects that emphasises more on the ability to use drawings as part of communication skills; and in this fourth industrial revolution era, the ability to communicate graphically is a requisite skill that is likely to sustain one in careers in the engineering space (Mtshali and Ramaligela, 2020). Therefore, the competence and contribution of learners to local and global economic growth through graphic communication skills in contemporary engineering applications is largely dependent on whether the learners acquire the necessary fundamental knowledge and skills in the classroom. Dobelis et al. (2019) suggest that in the field of engineering and technology, the traditional mode of instruction such as lecturing, where the teacher is the primary source and deliverer of information, no longer suits the goals of active learning. Instead the teaching and learning of engineering graphics should be redesigned to stimulate learners to actively take more responsibility for their own learning. Against this background, it would be reasonable to say that with the use of visual representation of ideas through drawings, graphic communication becomes a linchpin in the manufacturing and engineering sector. Accordingly, learners should be taught the skill of constructing, reading and interpreting civil and engineering drawings to suit contemporary skills that are responsive to the needs of industry since graphic communication is an important visual language of communication between draughting technicians, engineers, manufacturers and other stakeholders in the design and manufacture of products and construction of structures. Thus teachers have a significant role to play in ensuring that active learning takes place during the teaching of graphic communication, to hone and optimize the acquisition of skills.

## 1.2 Rationale

I have been a senior CT and Engineering Graphics and Design (EGD) teacher for the past twelve years in the South African education system in a rural area with many quintiles 1 and 2 schools[1]. Informed by experience and reflecting on published literature on technology education, I have gained insights on the mismatch between curriculum implementation in CT with regard to teaching of graphic communication lessons and the aims for theory and practical lesson as set out in the Curriculum Assessment Policy Statement (CAPS) grade 10-12 Civil Technology policy document. Additionally, it is worth noting that teachers in rural areas often teach multiple subjects, schools lack physical resources, and teachers do not get support and professional development required for curriculum implementation (du Plessis, 2019). The above-mentioned contextual factors are a huge barrier towards successful delivery of the CT curriculum in uMgungundlovu district in particular and in South Africa in general. Teachers are, and have always been, the primary locus of schooling systems around the world (Spaull, 2013). Therefore, their effective training and successive professional development is pivotal and intimately related to the quality of output of any education system.

[1] Quantile 1 and 2 schools are a group of “no fee paying” schools in the South African school quantile ranking system. The schools cater for the poorest of learners, and this is determined by the community’s levels of income, literacy and unemployment.

According to the Department of Basic Education, the recommendations for human resources recruitment for a Civil Technology teacher specify that the person must be a trained subject specialist, preferably a Civil Technology artisan/technician with industry-related experience and workshop management skills with a tertiary qualification in technical teaching (Education, 2014). Consulted literature reveals that Technology teacher training has been and continues to be a challenge in South Africa. According to Gumbo (2013), only a few technology teachers have received formal training. One key factor in ensuring effective professional teacher development in the discipline of technology education, specifically in terms of pedagogical content knowledge, is to continuously provide technology teachers with on-site support. In this research, it is envisaged that continuous professional teacher development (CPTD), is an instantaneous intervention towards bridging the gap of curriculum implementation challenges faced by technology teachers in terms of promoting active learning during teaching of graphic communication lessons. The rate of social and educational transformation requires that teachers continuously upgrade and update their knowledge to keep abreast with any changes and remain professionally competent, otherwise their knowledge from pre-service training becomes inadequate or obsolete (Luneta, 2012). Likewise, continuous professional teacher development in technology education should be a progressive enterprise designed to enhance high learning outcomes and effectively achieve set educational goals. Teachers need progressive support as they find their feet in the profession, and make sense of curriculum reforms, initiatives, and implementation of the policies in the classroom (Nkambule, 2018).

The study will help to uncover meaning, develop understanding, and discover insights into teachers' practice of promoting active learning during teaching of graphic communication lessons. It will also illuminate challenges teachers encounter when promoting active learning in the teaching of graphic communication. Therefore, insights gained from the study will subsequently call for the attention of teachers to be reflective on their teaching, and to devise teaching and learning mechanisms that promote active learning and acquisition of skills.

## 1.3 Problem statement

The technology education curriculum in South Africa has undergone several reviews and transformations over the years from its introduction in 1991, up to the present era where the Curriculum and Assessment Policy Statement (CAPS) is in operation. Despite the comprehensive curriculum reviews over time by education specialists, successful implementation of the curriculum has not yet been fully realised due to some constraints that include, among others, the lack of qualified technology teachers, curriculum overload, lack of physical resources to promote active teaching and learning, and inadequate professional development for in-service teachers (Gumbo, 2013). Singh-Pillay and Sotsaka (2020) allude to the fact that the critical shortage of engineers in South Africa is linked directly to the schooling systems' inability to develop fundamental skills required in engineering courses, such as spatial visualization ability linked to graphic communication. At the Further Education and Training (FET) phase, Grades 10-12, the CAPS technology curriculum has replaced the National Curriculum Statement (NCS) policy document for technology since 2012. Currently four technology learning areas are offered in the FET phase, namely Civil Technology, Mechanical Technology, Electrical Technology and Engineering Graphics and design (Education, 2011). A further review in 2016 has seen the implementation of a new version of civil technology CAPS, fragmented into distinct specialisation focus areas where learners make the following choices: Civil Services (construed as plumbing), Civil Construction (focuses on concrete and brick structures) and Woodworking (structures made of timber in the built environment) (Education, 2014). With all the curriculum changes and restructuring subject names, content, and instructional methods under way Nel (2017) affirms that measures for curriculum implementation in the form of teacher professional development have always been inadequate. On that account the teachers' practices of promoting active learning remains implausible amid learners' poor performance in civil technology, and specifically, graphic communication.

On closer inspection of the National Senior Certificate (NSC) examiners and moderators report for CT from 2016 to 2019, a number of problems emerge, and for the purpose of this study particular attention is given to graphic communication. The diagnostic reports highlight learners' poor performance on examination questions that test for graphic communication skills. The following common mistakes and misconceptions have been established from the CT NSC Examination diagnostic reports for 2018 and 2019: learners struggle to read and interpret graphic text correctly, misinterpretation of dimensions; failure to apply scale correctly on drawings; and incorrect representation of SANS symbols on drawings (Education, 2018; 2019). On a yearly basis, at professional development meetings organised by the department of education and facilitated by subject advisors, teachers are made aware of the areas that learners perform poorly in, yet learners continue to perform poorly in graphic communication. Each year, the examiners and moderators' report is sent to all relevant schools, so that both the principal and CT teacher have access to it and can use the suggestions to improve teaching and learning. What amazes me is that the identified areas of weakness and misconception still persist year on year among CT learners. It would seem that CT teachers take no heed of the examiners and moderators' report when planning and aligning their teaching of graphic communication, and remain oblivious to the learners' difficulties mentioned therein, or are unable to address them. This raises pertinent questions in terms of CT teachers' practice of promoting active learning during the teaching of graphic communication theory and practical lessons. These concerns form the platform for this study.

## 1.4 Purpose of the study

The purpose of the study is to explore grade 11 Civil Technology teachers' practice of promoting active learning during teaching of graphic communication theory and practical lessons using a case study of the uMgungundlovu district.

## 1.5 Objectives of the study

The objectives of the study are to:

- To explore how grade 11 Civil Technology teachers promote active learning when teaching graphic communication.
- To ascertain if grade 11 Civil Technology teachers encounter any challenges when promoting active learning during the teaching of graphic communication.
- To discover possible reasons for challenges encountered by grade 11 Civil Technology teachers when promoting active learning during the teaching of graphic communication.

The above objectives translate into the following research questions, namely:

1. How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication?
2. Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication? If so, what challenges do they encounter and why?

## 1.6 Significance of the study

The study is envisaged to provide continuous professional teacher development (CPTD) as an instantaneous intervention to support in-service teachers in order to improve classroom practices and quality of teaching graphic communication. It will also be useful for subject advisors, curriculum developers and other educational specialists to consider conducting professional development workshops to improve teachers' Pedagogical Content Knowledge (PCK), both on theory aspects and the practical domain of graphic communication. In principle, the findings of this study will help civil technology teachers to engage in reflective practices with respect to promoting active learning when teaching graphic communication. Consequently, that will help CT teachers to be proactive in their planning for graphic communication lessons, think about the teaching strategies that would be best applicable for learners' understanding of graphic communication concepts, and integrate various teaching methods in a way that will optimise and elicit the desired knowledge and sets of skills in learners.

## 1.7 Limitations of the 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, 2018). Additionally, Yin (2018) contends that a case study is an appropriate method of inquiry that allows for in-depth information and rich thick description of a phenomenon within its real-world context, especially if context and the phenomenon are not clearly distinguishable. Thus in this research, a case study has been established as a credible, valid research design that facilitates in-depth exploration and analysis of complex issues (Harrison, 2017). The method allows for in-depth and detailed study of CT teachers' real practice of promoting active learning when teaching graphic communication anchored on their real-life experiences and gives rich thick descriptions and insights into their thoughts, attitudes, perceptions, behaviours, and practices.

## 1.8 Overview of the study

The study is organised into 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, problem statement, research questions, objectives, and significance of the study.

**Chapter 2:**

The chapter focuses on review of local and international literature related to the major aims of the study. The literature explores the aims of practical work in technology and civil technology, the purpose, aims and structure of practical work in technical courses in other countries, teaching and learning strategies and practices that promote active learning, and challenges teachers encounter when teaching graphic communication lessons locally and globally. It presents a theoretical framework by Stronge's (2018) Qualities of effective teachers, used to advance the argument and analysis of the research findings.

**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 in order 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.

## 1.9 Conclusion

This chapter outlines the significance of graphic communication across various disciplines in the field of engineering, and provides background information on the introduction of CT in the South African curriculum and the teaching of graphic communication in the context of CT as a practical subject. The chapter highlights the complexities of incompetent personnel, faced by contemporary society, in the field of engineering. Specifically, it hones in on poor graphic communication skills demonstrated by learners' remarkable ineptitude in solving graphic communication related problems in CT at school level. Evidence from national examination reports shows that learners still struggle with reading and interpreting graphic text, design and graphic representation of civil drawings and features using the South African National Standards (SANS) code of practice for building drawings. Hence there are unanswered questions relating to teachers' practice of promoting active learning when teaching graphic communication lessons. The chapter also presented a statement of the problem, research questions, objectives of the study, significance of the study, and overview of the study. Research findings from this case study are envisaged to provide continuous professional teacher development and support in order to improve classroom practices of promoting active learning and the quality of teaching graphic communication in CT.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The literature review explores local and international literature related to the major aim of this study, which is an exploration of grade 11 Civil Technology teachers' practice of promoting active learning during the teaching of graphic communication theory and practical lessons. At the outset, it is important to highlight that both technology education and civil technology are emerging fields of research within the South African context, hence I draw on studies conducted in other countries; for example, Germany, Australia, Finland, Sweden and Nigeria. The literature review is arranged into 4 broad themes, namely, the aim of practical work in technology and civil technology, the purpose, aim and structure of practical work in technical courses in other countries, challenges teachers encounter when teaching graphic communication lessons locally and globally, and lastly, literature on active learning during teaching.

## 2.2 The aim of practical work in technology and civil technology

The epistemological framework of technology education defines the nature, scope and ways of acquiring knowledge. The South African technology Curriculum Assessment Policy Statement (CAPS) for the Further Education and Training (FET) phase outlines the unique features and scope of the technology subject as one that is based on problem solving through conceptual knowledge and practical skills (Education, 2014). The technology CAPS curriculum for grades 10-12 emphasizes developing a technologically literate population for the modern-day world, with a clear understanding that technology is part of people's regular course of activities in a daily routine and cannot be treated in isolation, be it at work, school, social forums etc. (Education, 2011). One of the major aims of the introduction of technology education in South Africa was the need to promote technological literacy among citizens, and this is achieved through comprehensive learning that engages both theoretical and practical aspects of the subject. The essence of merging theory and practical work is to give learners the opportunity for exploratory learning and foster practical skills to develop solutions to existing problems through creativity, innovation, and critical thinking as they engage with tools, machinery and materials. The CAPS for technology senior phase grades 7-9 form the platform for the CT curriculum for grades 10-12 in terms of practical work and skills development. The technology curriculum grades 7-9 aims at providing learners with opportunities to develop and apply specific design skills to solve technological problems and understand concepts and knowledge used in technology education (Education, 2011). The curriculum content focuses on four strands of technology, namely: structures, processing of materials, mechanical systems and control, and electrical systems and control. The approach to teaching and delivery of the content and all learning aims is designed in such a way that learners are introduced to the theoretical knowledge and principles, and this is subsequently followed by practical work in which the knowledge is applied. When teaching structures, for instance, in grade 8, the theoretical knowledge and concepts cover aspects like purpose of structures, types and examples of structures (frame, solid and shell structures, bridges, steel beams, concrete lintels, steel columns, arches etc), components or members of structures, forces acting on structures, for example tension, compression, shear, torsion, methods of providing strength and rigidity to structures like cross-bracing and triangulation, and causes of structural failure (Education, 2011, p. 22). To integrate the knowledge learnt with practical skills for each topic or strand, learners engage in a mini practical assessment task that exposes them to the design process skills that include investigation, designing, making, evaluation and communication using appropriate materials and tools. This allows for integration of theoretical knowledge (conceptual knowledge) and procedural knowledge (practical work) as they solve real life problems (Education, 2014). The projected focus and aims of the curriculum content are to introduce learners to the basics needed in Civil Technology, Mechanical Technology, Electrical Technology and Engineering graphics and design at grades 10-12 level (Education, 2011). The Technology curriculum content of each grade shows progression from simple to complex, thus creating a platform for the CT curriculum at grades 10-12 level.

The CT curriculum for Further Education and Training (FET) phase, grades 10-12, is designed to prepare learners for skills in three specialisation areas, namely civil construction, woodworking and civil services, that are related to the built environment (Education, 2014). Learners doing civil technology at grade 10 are introduced to the fundamentals of civil and structural engineering, architecture, quantity surveying and artisan courses like bricklaying, cabinet making, carpentry, roof designers etc. They get insights into scientific and technological principles of problem solving in the light of what happens in the world of industry and work. Graphic communication is a section embedded in the CT curriculum in all three specialisation areas. This section focuses on the use of graphics as means of communication, where drawings and interpretation of drawings related to the built environment are an essential means of communication. Graphic communication entails spatial visualisation skills (mental manipulation of 2D-orthographic and 3D-isometric drawings) and the ability to read and interpret graphic text, and this forms part of the fundamental and requisite skills in the field of engineering and manufacturing technology (Kok & Bayaga, 2019). As outlined in the CAPS Civil Technology policy document, grades 10-12, one of the specific aims of CT is to develop in learners graphic communication skills in respect of drawing and interpretation of drawings. It involves, among others, basic freehand drawing of sketches of any features related to the building industry, application of different types of lines, dimensioning, labelling or annotation of drawings, application of South African National Standard (SANS) code of building drawing practice (SANS 0143), orthographic and isometric drawing of building construction features like floor plans, sectional elevations, elevations, illustration of brick bonding and alternate brick courses, calculation of perimeter and area of site and proposed building etc (Education, 2014). Merging the theoretical techniques and principles of drawing with practical work, drawings can then be translated into simulations and modelling to make representation of objects and construction features more real and reinforce the learning process.

Research on graphic communication skills in Civil Technology, Mechanical Technology, Electrical Technology and the related subjects like EGD has established that learners struggle significantly with 2D and 3D conventional drawing as well as reading and interpretation of graphical text (Singh-Pillay & Sotsaka, 2020). Kösa and Karakuş' (2018) study established that graphic communication skills are part of the core curriculum of all industrial technology and engineering fields and require spatial visualisation skills. Spatial visualisation, according to Kösa and Karakuş (2018), refers to the ability to mentally manipulate visual images by being able to generate, retain, retrieve and transform visual objects through the mind's eye. Spatial skills are crucial for engineering design work such as designing and representation of building construction structures, assembling mechanical components, and designing electrical networks and ventilation ducts, etc. (Kösa & Karakuş, 2018). This implies therefore that the same spatial visualisation skills are critical in understanding graphic communication principles within the context of Civil Technology, Mechanical Technology, and Electrical Technology (Makgato & Khoza, 2016) at grades 10-12 level. In graphic communication, learners are expected to read, understand and be able to interpret the visual language of images, signs and symbols, and also design and represent objects graphically through the use of conventional drawing methods.

van As (2019) also points out that the construction of new knowledge and problem solving in technology education requires both conceptual and procedural knowledge. Procedural knowledge involves learners engaging in practical activities that entail different dimensions of complex thinking (van As, 2019). They engage in freehand or instrument drawing as they illustrate and express their design ideas graphically prior to making artefacts, exhibiting creative thinking, analytical thinking, logical reasoning and being able to make value judgements regarding suitability and choice of their design ideas (van As, 2019). Singh-Pillay and Sotsaka (2016) emphasize the fact that drawings are a means of communication for engineering and manufacturing fields, and they must be made clearly, accurately and be complete to prevent expensive and gross mistakes for manufacturers, producers and consumers. Therefore spatial visualisation skills are essential for understanding the dynamics of graphic communication in civil technology and related manufacturing and engineering technology fields (Makgato & Khoza, 2016).

Kösa and Karakuş (2018), on the other hand, acknowledge that the use of orthographic and isometric projection techniques and basic engineering graphic communication guidelines to draw views of an object such as a building structure or mechanical component is such a complex task. It requires visualisation of the object as a whole as well as viewing components as separate parts and being able to determine how they connect with each other (Kösa & Karakuş 2018). Similarly, Kok and Bayaga (2019) acknowledge that students often struggle with graphic communication, specifically, understanding and converting multi-faceted objects from orthographic (2D) into isometric (3D) projection. Kok and Bayaga (2019), propound that conventional teaching and learning practice of exclusively using the textbook and manual drawings is insufficient to promote learners' visualisation skills. Instead, effective teaching of graphic communication should be coupled with physical concrete models and modern technological use of 3D computer-aided design (CAD) modelling software to enhance learners' visualisation skills (Kok & Bayaga, 2019). Additionally, National Senior Certificate (NSC) examiners and moderators' report for grade 12 CT November 2018 and 2019 national examinations, consecutively, highlight learners' flaws with respect to their responses in answering graphic communication questions. Important to note from the reports is learners' misinterpretation of dimensions and SANS drawing symbols on floor plans and elevations, failure to relate features like landing on staircases correctly, differentiation between hipped and gable roof and incorrect drawing of scale diagrams to given measurements (Education, 2019). Simply put, this implies therefore that teaching and learning of graphic communication cannot be simplified to theory only; it requires a great deal of innovation and creativity in the teacher's approach to teaching and instructional strategies to promote active learning. Singh-Pillay and Sotsaka (2016) contend that teachers' pedagogical content knowledge (PCK) and their specialised content knowledge (SCK) or specific subject-related knowledge directly influences how they enact the curriculum and influence learners' understanding and level of knowledge acquisition. In respect of assembly drawing (one of the fundamental principles of graphic communication involving 2D and 3D drawing), Singh-Pillay and Sotsaka (2016) established that teachers' specialised content knowledge of assembly drawing is not confined to themselves, but it pervades and manifests in their teaching approach and practices and consequently impacts on learners' visual reasoning skills, mental manipulation of diagrams in 2D and 3D space, and skills to interpret simple and complex drawings. Thus, successful implementation of curriculum goals in respect of graphic communication discussed above requires competence of teachers in the field of engineering and manufacturing technology. Civil Technology teachers should be well-grounded in the practical aspect of the subject in order to transfer practical skills to learners (Maeko & Makgato, 2017). It is against this background that this study seeks to explore CT teachers' practices in promoting active learning when teaching graphic communication theory and practical lessons.

## 2.3 The purpose, aim, structure of practical work in technical courses in other countries (Finland, Australia, Germany, Sweden, Nigeria).

Technology education is offered in many different countries continentally and globally. The discussion below focuses on outlining the purpose, aims and structure of practical work in technical courses offered in Finland, Australia, Germany, Sweden and Nigeria. The literature reviewed shows that the general aim of introducing craft and technology in Finland was the need to equip students with practical skills for problem solving through their engagement with traditional craft activities (Autio, 2015). The focus of craft and technology is to develop students' personalities through enhancing their self-esteem, fostering decision making skills, and encouraging independent thinking and creativity through problem-based learning. Autio (2015) outlines that the technology curriculum in Finland is product-based and students learn via traditional craft activities. The curriculum incorporates outdoor education where students are exposed to green wood and sustainable design in problem solving (Autio, 2015). Essentially, the role of the teacher is to systematically guide students as they engage more with problem solving activities.

In Australia, the rationale for inclusion of technology in the curriculum is grounded on the principles of modernisation, responding to economic and social needs of people from the perspective of technology since they face technology every day (Rasinen, 2003). The aim is to provide students with problem solving skills, information-processing and computing skills, innovation, creativity, critical thinking as well as exercising sound judgement in moral, ethical and social justice aspects in technology-based problem solving. Technology courses are structured in such a way that they are delivered as discrete or specialised subjects at secondary level and integrated with other subjects at primary level. At secondary level, technology education is embedded in the following subjects or areas of study: Agriculture, Computing/Information Technology, Media, Home Economics and Industrial Arts, Manual Arts, Design and Technology (Rasinen, 2003).

In Germany, the broader aims of technology education are centred on: firstly, providing functional knowledge about technical devices and processes; secondly, teaching technology specific methodologies like creativity, co-operation and communication; and thirdly, to develop evaluation and assessment capabilities in learners (Banks, 2013). The subject is offered at secondary level, and there are generally three type of secondary schools: the general secondary school, apprenticeship preparation (*Hauptschule*); the general comprehensive school (*Realschule*); and high school, university preparation (*Gymnasium*) (Banks, 2013). Technology is only compulsory at the general secondary school, apprenticeship preparation, however in other secondary schools, learners can take it as an elective subject. The curriculum offers the following areas of focus: machine and production technology, transportation and traffic, electrical engineering, construction and the built environment, supply and waste management and information and communication. The aims and structure of teaching and learning technology is to expose both teachers and learners to skills that include instructions of how to do something, design exercises, manufacturing exercises, planning and production processes, conducting technology experiments, technological analysis, technological exploration outside the school, and technological assessment and evaluation (Banks, 2013).

The technology education curriculum in Sweden aims to develop technical competence in students (pupils). In the history of technology education in Sweden, the curriculum has gone through reformation since 1994, when it was made a core subject for compulsory schooling (Banks, 2013). Prior, the curriculum had a traditional technical education history that was vocationally oriented and also gendered, with craft technology for boys and home economics type of subject for girls (Banks, 2013). According to (Rasinen) 2003, the revised technology curriculum is fostered on providing pupils with technical expertise to address societal and physical environmental issues that affect people. The emphasis is on understanding the history of technical culture, acquiring knowledge to solve daily problems arising, and understanding the links between components, tools or machines and systems. Technology/Technics is studied at both primary and secondary levels, and the approach focuses more on practical work where students engage in carrying out tests or experiments, observing results, planning, constructing, and evaluation of their work (Rasinen, 2003). Additionally, Banks (2013, p. 39) outlines the objectives of technology education in Sweden at different grade levels as follows:

### 2.3.1 Objectives to be achieved by grade 5 (primary level aged 11); pupils must be able to:

- Describe, in some areas of technology they are familiar with, important aspects of the development and importance of technology for nature, society and the individual
- Use common devices and technical aids and describe their function
- With assistance, plan and build simple constructions

### 2.3.2 Objective to be achieved by grade 9 (secondary level aged 16); pupils must be able to:

- Describe important factors in technological development, both in the past and present, and give some of the possible driving forces behind this
- Analyse the advantages and disadvantages of the impact of technology on nature, society and the living conditions of individuals
- Build a technical construction using their own sketches, drawings or similar support and describe how the construction is built up and operates
- Identify, investigate and, in their own words explain some technical systems by describing the functions of the components forming it and their relationships

Nigeria perceives technology education as a vital tool for empowering citizens with practical skills towards the socio-economic development of the country. Lawal (2014) elucidates on the national aims of introducing technology education in the country as revolving on capacitating individuals with technical and vocational skills to meet the demands of the labour market and boost the economy of the country in all industry and manufacturing sectors. Oguejiofor (2014) echoes the same sentiments as Lawal (2014) on national goals of technology education in Nigeria. They state that the curriculum aims to train and impart technical knowledge and vocational skills to individuals for self-reliance and employment in various occupations that will contribute towards the sustainable development of the country (Oguejiofor, 2014).

## 2.4 Challenges teachers encounter when teaching graphic communication theory and practical lessons locally and globally

Technology and civil technology teachers endeavour to create a teaching and learning atmosphere that stimulates and fosters principles of active and critical learning as guided by the CAPS Civil Technology curriculum (Education, 2014). Nonetheless, challenges in implementation of the set principles are inevitable, whether contextual or cognitive in nature, but owing broadly to the teachers' conception, misconception or reception of education curriculum reforms as put forward by literature. Teachers, as key figures in educational operations, act as the interface between curriculum policies planned and the successful implementation thereof. Teachers are the key agents of curricular change, and without their willingness to participate, there can be no change (Park, 2013). Similarly, Makunja (2016) echoes the same sentiments; that teachers are filters through which the mandated curriculum passes, their correct conception, merged with their experiential knowledge and practices, can enhance successful execution of curriculum goals.

In an attempt to understand the perceptions and role of teachers in the enactment of curriculum innovations locally and globally, a few empirical studies conducted within the South African, Tanzanian and Korean contexts illuminate the recurrent challenges faced by teachers as they translate the curriculum reforms into practice. To begin with, in South Africa, it is important to note that a series of education curriculum policies have evolved over time, tried and tested in different cycles, and they are still undergoing restructuring and refinement, but with limited evidence of achievement of goals. With reference to Bantwini's (2010) study conducted in the Eastern Cape province of South Africa on teachers' perception of new curriculum reforms, it has been established that failure of curriculum policies in South Africa is mainly attributed to some implementation loopholes wherein teachers' knowledge and practices visibly play an integral role. Teachers have their own way of conceptualising the curriculum reforms, and the meanings they derive and attach guide them to map out their strategies to act upon the new policies, as pointed out by Fullan (1982), cited in Bantwini (2010, p. 84). Unfortunately, their implementation practices may be thwarted by lack of support in launching these reforms. Bantwini noted that the dearth of orientation workshops to unpack the vision and objectives of the reforms and a systematic outline of how the ideas will be implemented in the classroom gives rise to some challenges that teachers encounter in the classroom. Similarly, Singh-Pillay and Alant (2015) share the notion that the processes of curriculum formulation, mediation and implementation in South Africa are construed as discrete entities that operate independently of each other (Singh-Pillay & Alant, 2015). Curriculum formulation is the responsibility of the national task team, while implementation is exclusively the obligation of teachers to enact. Thus, the challenges continue to ravage any efforts of curriculum innovation and the realization of educational goals, while the underlying causes seem to be far from being unearthed.

In the context of civil technology and specifically the teaching of graphic communication, the literature widely suggests that challenges in the classroom are remarkably tenacious as teachers present their theory and practical lessons in South Africa and across the globe. Isaac's study on CT teachers' environmental knowledge in promoting active learning reveals that CT teachers struggle to prepare and deliver practical lessons effectively (Isaac, 2019). Based on the researcher's observations and interrogation with participants, research findings point to the teachers' incompetence in setting up and operating tools and machinery, lack of integration of theory with practical tasks, inability to maintain and service machinery, and lack of adequate machinery in the workshop, to mention a few. Notwithstanding the recommendations outlined in the CAPS Civil Technology curriculum Grade 10-12 – that CT teachers should be able to manage the workshop resourcing, budget for materials and consumables, safety, maintenance and service of tools and equipment, plan for practical and theory lessons, and teach the subject content with confidence and flair – some teachers seem to turn a blind eye, compromising the call to promote active learning (Education, 2014). The major hurdle underlying technical teachers' incompetence with practical lesson delivery is their lack of industrial experience and hands-on exposure with manipulation of tools and machinery during teacher training (Paryono, 2015). This tends to be incompatible with the values, ideals and expectations of a CT teacher – that they should be able to implement innovative teaching approaches and keep abreast with the latest technological developments (Education, 2014). Similarly, Maeko and Makgato's (2017) study found that student teachers at some selected universities in South Africa exit the CT courses without essential practical hands-on skills and proceed to the classroom with limited content knowledge of the subject, more precisely, the practical domain. The incapacitated teacher grapples with teaching practical aspects, thus fails to impart the requisite skills to learners, and this becomes a vicious cycle. Logically, it follows that learners also exit the schooling system with only the theoretical understanding of the subject matter and are barely able to operate any tool or equipment and exhibit any subject-related practical skill. Accordingly, this defeats the vision and aims of the curriculum – that learners should acquire high knowledge and skills through active and critical learning (Education, 2014). The paucity of teachers' content knowledge and knowledge of the related practical skills of the subject disparages their self-confidence when it comes to demonstration of the skills and negatively impacts on their quality of teaching and guidance of learners. It unfortunately creates a gap between teachers' knowledge and the expectations of the curriculum in terms of quality of skills learners should acquire. As recommended by Singh-Pillay and Sotsaka (2016), teachers need to be au fait with their PCK to be able to engage effectively with learners when conducting theory and practical lessons.

Notably, another striking challenge that teachers face is overload in classrooms, characterised by a high teacher-learner ratio that ranges from 1:50 to 1:80, making it strenuous for teachers to give attention to learners' individual needs (Bantwini, 2010). Likewise, some CT teachers express their discontent about large classes and inadequate equipment for conducting practical activities in the workshops, to an extent that they teach practical lessons in groups to save time (Isaac, 2019). This practice deprives learners of the individual attention required to be thoroughly groomed and guided towards acquiring essential practical skills, and does not advance active learning in any way. Isaac's research findings show that for teachers with overcrowded CT classes, only a few learners who get the opportunity to operate machinery and tools benefit from practical sessions; the rest remain inadequately skilled or unskilled altogether. Given such a scenario under which teachers operate in the schools, Bantwini argues that it poses a huge challenge to ensure that effective learning takes place and due attention is given to each individual learner amid a high teacher-learner ratio in the classroom. Despite the new curriculum's call to adopt new teaching approaches that are learner-centred and promote creative and critical thinking, teachers still cannot heed it.

Integration of theory and practice for CT lessons in some schools is not effectively enacted. Maeko and Makgato (2014) found that teachers hardly incorporated theoretical knowledge into practice. Irrespective of the fact that the department of education prescribed a total of four hours contact time per week, with two hours allocated for theory and two hours for practical sessions to facilitate translation of theory into practice for almost every topic, this is often overlooked (Education, 2014). Instead, teachers focus on teaching the theoretical component of the subject throughout the year, and learners only get exposure to the workshop and manipulation of tools and machinery towards the end of the year, around September, to hastily work on their practical assessment task (PAT) to meet submission deadlines. This alone is an indication of a mismatch between the curriculum aims for theory and practical lessons as set out in the CAPS grade 10-12 Civil Technology policy document, and the implementation practice of teachers.

Worth noting in this discussion is a close examination of learners' performance through different forms of assessment that can also be used to evaluate teachers' practices in promoting active learning during the teaching of graphic communication lessons in CT. Special attention is given to the diagnostic analysis of graphic communication errors and misconceptions made by learners in answering grade 12 final national examination questions; these are discussed forthwith. The Civil Technology examination at FET phase is comprised of one 3-hour paper with a total of six questions, both generic (general or common to all civil technology subjects) and specific to each specialisation area, namely construction, woodworking and civil services. From the diagnostic question analysis of Civil Technology-Construction paper 1, November 2018-2019 NSC Examinations, the critical comments relating to graphic communication are stated thus:

1. Poor drawing and interpretation skills were evident. There was poor distinction between line diagrams, sketches and scale drawings. Many scale drawings were not done using drawing equipment.
2. From the responses in the scripts, it is evident that the candidates lacked practical exposure and experience.
3. It is imperative that labels be indicated on all drawings. A significant number of candidates were not credited due to a failure to indicate labels.
4. It is recommended that learners study drawings by doing the drawing freehand until they know all the parts and the sequence to follow before they start with scale drawings.

Tables **2.1** and **2.2** show a summary of diagnostic analysis of learner performance with regards to common errors and misconceptions on graphic communication questions in paper 1, 2018 and 2019 November NSC examinations.

**Table 2.1: NSC Diagnostic Report**

| Civil Technology-Construction November 2018 NSC Examination (Diagnostic Analysis) | | |
|---|---|---|
| **Question** | **Topic** | **Common errors and misconceptions** |
| 2 | Graphics as method of communication (Generic) | a) Many candidates experienced challenges with the reading and interpretation of building plans and were not able to identify and interpret drawing symbols.<br>b) In Q2.12 (1 mark), a fair number of candidates could not differentiate between a gable and a hipped roof.<br>c) In Q2.29 (3 marks) and Q2.30 (7 marks), most candidates were not able to calculate the area of a room and the perimeter of a building because they could not interpret the dimensions from the given drawing or convert millimetres to metres. |
| 3 | Roofs, Staircases and Joining (specific) | a) It was observed that many drawings were not drawn to good proportion and members of the roof were incorrectly drawn in Q3.7. |
| 4 | Excavations, Formwork, Tools and Equipment and Materials (specific) | a) Most candidates could not draw the correct details of the shuttering for firm soil and formwork for a beam in Q4.3 and Q4.5 and could not label the members correctly. |
| 5 | Plaster and Screed, Brickwork and Graphics as means of communication (specific) | a) Many candidates drew a sectional view instead of external elevations of the cavity wall in Q5.2.<br>b) Some candidates were not able to draw the open eave in Q5.4. |
| 6 | Reinforcement in Concrete, Foundations, Concrete floor and Quantities (specific) | a) In Q6.2, many candidates were not able to correctly draw the reinforced concrete column from the given specifications and were not familiar with the correct names of the different members of the reinforcing. |

**Source: DBE, 2018**

**Table 2.2:NSC Diagnostic Report Part 3**

| **Civil Technology-Construction November 2019 NSC Examination (Diagnostic Analysis)** | | |
|---|---|---|
| **Question** | **Topic** | **Common errors and misconceptions** |
| | | |
| 2 | Graphics as method of communication | a) Many candidates experienced challenges to read and interpret the floor plan and elevation and were not able to identify and interpret drawing symbols.<br>b) Poor performance by candidates was noted in Q2.2 (1 mark), where the identification of a hipped roof posed a challenge to them.<br>c) In Q2.5 (1 mark) most candidates identified the component as a door opening instead of a door.<br>d) In Q2.8 (1 mark) the majority of candidates were not able to identify the symbol of a wash trough.<br>e) Some candidates could not identify the drawing symbol in Q2.13 (1 mark).<br>f) In Q2.16 (1 mark) the responses of candidates indicated that they were not familiar with the properties and uses of materials used for the production of sanitary fitments.<br>g) In Q2.28 (1 mark) the majority of candidates had difficulty in justifying why the floor plan was relevant to the elevation. This question required insight into the differences between a ground floor plan and that of the first floor.<br>h) In Q2.29 (1 mark) most candidates were unable to explain the consequences of not installing a sill below a window.<br>i) In Q2.31 (6 marks) many candidates could not correctly deduce the dimensions of the wall thickness and room sizes from the correct elevation. They also could not write them down |

| | | |
|---|---|---|
| | | next to one another and add the dimensions to obtain the total length of the wall correctly. |
| 3 | Roofs, Staircases and Joining | a) In Q3.5 (15 marks) most candidates attempted to draw the roof truss but the positioning of the wall plate, tie beam and ridge beam still posed a challenge to them. Candidates struggled to draw to scale the components of a roof truss. Candidates did not adhere to the prescribed scale. |
| 4 | Excavations, Formwork, Tools and Equipment and Materials | a) In Q4.7 (18 marks) most candidates were not able to draw the formwork for a beam with an attached floor slab. |
| 5 | Plaster and Screed, Brickwork and Graphics as means of communication | a) In Q5.5.1 (4 marks) and Q5.5.2 (1 mark) many candidates had difficulty in identifying the different strata of a paved area and were not able to state why a paved area may collapse.<br>b) Most learners were not able to draw a course of the cavity wall correctly in Q5.6 (7 marks).<br>c) In Q5.7 (14 marks) only a few candidates drew the horizontal section through a window frame showing how it is attached to a wall. Many candidates could not differentiate between a horizontal and a vertical section and hence drew the wrong section. |
| 6 | Reinforcement in Concrete, Foundations, Concrete floor and Quantities | a) In Q6.6 (11 marks) many candidates were not able to draw the reinforced concrete beam from the given specifications correctly and were not familiar with the correct names of the different members of the reinforcing.<br>b) Many candidates could not calculate the correct length of wall plates and the number of roof trusses in Q6.7 (10 marks). |

**Source: DBE, 2019**

NSC CT examiners and moderators' diagnostic reports highlight learners' flaws with respect to their responses in answering graphic communication questions. The reports point out weaknesses that are reflective of learners' misconceptions on interpretation of graphic symbols according to SANS drawing practices, poor construction of 2D drawings to illustrate courses of a cavity wall, failure to implement scale and dimensions correctly on drawing of floor plans, elevations and sectional elevations, and that these errors are highly attributed to teachers' approach or style of teaching the aspects of graphic communication (Education, 2019). Interestingly, the issues highlighted in the report show that most of the graphic communication sections tested in the question paper are linked to the practical work of designing and drawing building plans and making simulations and models to illustrate various building construction facets. For that reason, it is highly recommended that as teachers teach the graphic communication principles, they need to engage learners with construction tools and materials and make them perform practical tasks and simulations; for example, paving, dry packing of bricks to illustrate different types of brick bonding and alternate plan courses, drawing and construction of cavity walls to show all sectional details, modelling staircases etc. The ideas communicated graphically through freehand sketches and working drawings must be translated into practical solutions through simulations and modelling as a way of integrating theory and practice. Worksheets comprising schedules of all drawing symbols according to SANS 0143 code of drawing practice should be developed for learners to constantly refer to and apply the correct symbols when drawing plans and elevations of buildings. In this way they will also develop the skills to explain and relate practical knowledge with theory.

Looking at this more globally, Tanzania's education system is also not spared from curriculum implementation challenges. In his study on challenges facing teachers in implementing competence-based curriculum in Tanzania, Makunja (2016) affirms that the challenges teachers encounter are due to lack of initial and ongoing in-service training to orient them on the teaching approaches and practices anticipated for the new curriculum. Teachers demonstrated a great deal of incompetence on their lesson preparation as some of them could hardly identify and specify competencies or expert skills that learners were expected to exhibit at the end of each lesson (Makunja, 2016). Similarly, the case of Korea attributes the curriculum failure to poor implementation strategies where teachers' indifference about the new curriculum innovations contributed to their lack of commitment and impetus to implement the reforms (Park, 2013). Park and Sung (2013) draw special attention to the insufficient professional development programmes, lack of peer support for solving problems and resolving challenges of curricular reform implementation among teachers, as well as contextual and socio-cultural constraints. They argue that lack of incorporation of all stakeholders (including teachers who are the implementors) in curriculum reform processes wholly contributes to teachers' pedagogical practices and determines the results thereof. Based upon these findings, it is imperative to acknowledge and appreciate the importance of teacher involvement in the development and conception of any curriculum policy, and to provide continuous professional support to teachers. Consequently, it ensures effective enactment of the aims and objectives of CT theory and practical lessons and produces adept learners as they exit the secondary education system.

## 2.5 Active learning during teaching

As outlined in the CAPS document for Civil Technology curriculum grades 10-12, achievement of curriculum goals is based on the principles of active and critical learning rather than rote and uncritical learning of given truths (Education, 2014). Research conducted by Lima, Anderson and Saalman (2017) on active learning in engineering education elucidates active learning as learning that holistically engages, challenges and provokes learners to make meaning, demonstrate inquisitiveness, show creativity, be analytical, interact with each other and exercise personal reflection through their learning process. Learners construct knowledge based on the meaningful activities they perform, and that learning is enhanced in active learning environments (Lima et al., 2017). In addition to Lima et al. (2017)'s view of active learning, Rands and Gansemer-Topf (2017) emphasise that in active learning, learners are involved in more than just listening to the instructions from a teacher. Active learning incorporates teaching and learning practices that encourage greater understanding and transfer of knowledge through learners sharing their thoughts and values and engaging in higher order thinking such as analysis and synthesis of facts (Rands, 2017).

Similarly, a study by Connor, Karmokar and Whittington (2015) asserts that active learning creates an environment that inculcates excitement and curiosity in learners and makes them take control of their learning experience. Therefore, instructional strategies that encourage learners to be actively engaged in their learning can produce high levels of understanding, retention and transfer of knowledge (Connor, 2015). Research shows that there are a wide range of approaches that promote active learning, not limited to classroom design (Rands, 2017), that include: instructional strategies that involve learners participating in activities such as doing and observation, collaborating with peers as they work on tasks and reflecting on their learning (McConnell, 2017); delivery or teaching methods that allow learners to explore through practical hand-on project-based learning, problem-based learning, simulations etc. (Jesionkowska, 2020); and redesigning learning spaces to include use of digital technologies like CAD systems, video tutorials and augmented reality applications to facilitate the learning process (Dobelis, 2019).

Drawing from insights from different scholars discussed above about active learning, in the section below, I elaborate on active learning in the context of graphic communication in civil technology. Since graphic communication is mainly characterised by the generation, documentation and communication of ideas through different drawing techniques such as freehand sketches, detailed or working drawings, isometric projection, perspective drawing and orthographic projection (Leake, 2013), teachers' approach to teaching and instructional framework must foster active learning. Olmedo-Torre, Martínez and Peña (2021) suggest that it is imperative to intensify innovations in the methods of instruction and educational practices that stimulate greater participation of learners in different learning processes inside and outside the classroom. Precisely in graphic communication, Olmedo-Torre et al. (2021) advocate for design thinking, visual thinking and project-based learning as learning activities that provide optimal learner engagement in the learning process. Design thinking, as opined by Olmedo-Torre et al. (2021), constitutes the basis for creative problem solving. Under the assumption that problems have multiple solutions, the purpose of design thinking is to equip learners with the cognitive and creative skills to address solutions to real life problems with empathy, and ideate and evaluate different solutions before making a final decision based on combination of knowledge and understanding of context (Olmedo-Torre et al., 2021). The design process exposes learners to a unique set of skills in respect of presenting complete and detailed sets of working drawings required for assembling, manufacture or construction of structures as well as creating freehand preliminary sketches for the generation of design ideas (Leake, 2013). It facilitates learner-teacher interaction and encourages teamwork among learners as they complete tasks and contemplate on what they are learning (McConnell, 2017), thus promoting active learning.

Spatial visualisation skill is one of the fundamental skills required in the manufacturing and engineering field, including the ability to read and interpret graphical text (Singh-Pillay & Sotsaka, 2020). Visual thinking involves the formation of mental models, creation of images in space, and the use of drawings, graphics and animations for representing and communicating design ideas on paper (Olmedo-Torre et al., 2021). It also includes the ability to visualise mental rotations, and to conceptualise how objects relate to each other in 2-D and 3-D space (Singh-Pillay & Sotsaka, 2020). In their study, Singh-Pillay and Sotsaka (2020) established that learners' incompetence and poor performance in graphic communication, particularly in EGD, is constrained by teachers' traditional teaching methods and approaches that do not scaffold learners' visualisation skills, among other factors. Singh-Pillay and Sotsaka (2020) contend that teachers explore very little in their instructional methods for graphic communication lessons, and the current teaching and learning of EGD is via static drawing – so much so that active learning is rudimentary. The findings from Singh-Pillay and Sotsaka's (2020) study reveal that the spatial visualisation ability of an individual can be improved by incorporating effective instructional methods that include concrete manipulatives such as the use of Legos/building blocks, digital manipulatives, and computer programs. Despite the call on education systems to incorporate active learning strategies that focus on learner-centred approaches when teaching engineering and technology subjects, research findings reveal that the dominant pedagogy for engineering education still remains the traditional 'chalk and talk' method (Connor, 2015). Additionally, Govil (2020) points out that the successful attainment of engineering education objectives is unattainable without the development of new teaching and learning techniques such as active and collaborative learning. NSC examination diagnostic reports on learners' performance on grade 12 CT examinations (Education, 2019) coupled with research findings on teachers' proficiency in specialised content knowledge of the subject they teach (Singh-Pillay and Sotsaka, 2016) and traditional teaching methods and approaches used to teach graphic communication (Singh-Pillay & Sotsaka, 2020) show that learners are incompetent in graphic communication skills. Acquisition of graphic communication skills required in civil technology and related manufacturing and engineering disciplines that suit the current modern industry's technical expertise as well as the supply of competent personnel in engineering professions does not keep pace with the demands of the fourth industrial revolution (Jesionkowska et al., 2020). Simply put, it means that the achievement of curriculum goals through the principles of active learning as alluded to by the CAPS Civil Technology curriculum grade 10-12 is out of touch with the reality on the ground. Jesionkowska et al. (2020) advocate for the adoption of pedagogical strategies that encourage learners to fully take ownership of their learning so as to improve levels of understanding the content learnt, retention and transfer of knowledge, and skills acquired.

Furthermore, Olmedo-Torre et al. (2021), Govil (2020), and Connor et al. (2015) propose and emphasise the use of projected-based learning as one of the strategies that promote active learning. Connor et al. (2015) argue that project-based learning potentially embraces principles of learning by doing, actively engages learners in discovering new ideas and methods of problem solving, captures learners' interest and drives their learning experience. Connor et al. (2015) express the view that active learning should be aimed at creating an environment that provokes learners' excitement, curiosity, and control of their learning experience through the instructional methods used and activities they perform.

## 2.6 Theoretical framework:

### 2.6.1 Qualities of effective teachers

The theoretical framework that guides this study is underpinned by the qualities of effective teachers. Students' achievement profoundly pivots on the teacher's effectiveness in delivering the subject content and leaving imprints of knowledge on their students. Stronge (2018) discusses different characteristics that contribute to effective teaching and learning in any education system. Teacher effectiveness revolves around six fundamental principles as expounded by Stronge (2018) and summarised in the concept relationship diagram in Figure 2.1.

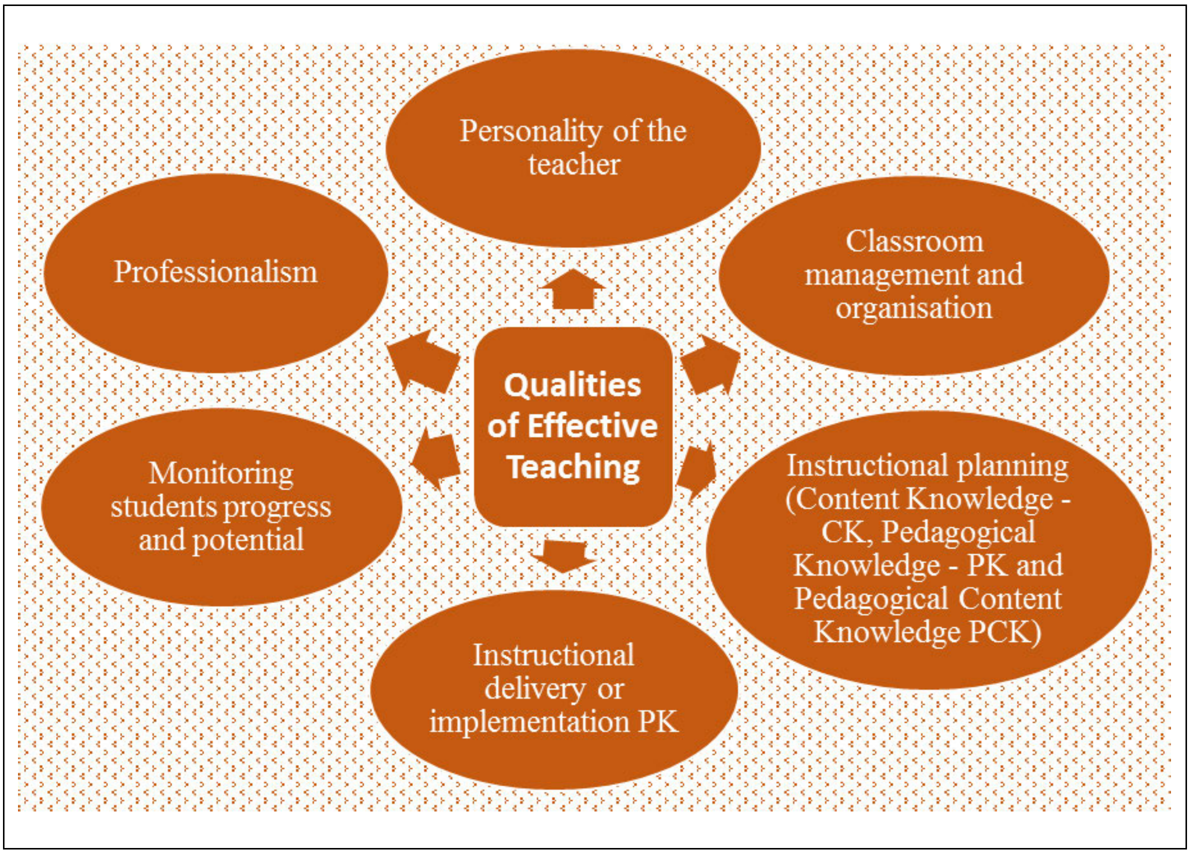


**Figure 2.1 Attributes of Effective Teaching**

Source: Author's own drawing

The principles include personality of the teacher, classroom management and organisation, instructional planning, instructional delivery or implementation, monitoring students' progress and potential, and lastly, professionalism. Stronge (2018) posits that a teacher's personality is an inherent facet; some traits of personality can neither be nurtured nor changed, however they have a huge influence on students' learning experience in the classroom. Positive personality attributes are portrayed through the teacher's communication, conduct, commitment to work and ownership of students' success (Stronge, 2018).

The teacher's skills and techniques to create and maintain a conducive learning environment in terms of utilisation of space, discipline, supervision and students' attention demonstrates good classroom management skills and promotes effective teaching and learning. Stronge (2018, p. 54) further elucidates the importance of planning and preparing for instruction as a practice that promotes effective teaching. Instructional planning, as defined by Stronge (2018), involves a systematic arrangement and structuring of learning activities and setting out the material resources and procedures for conducting the lesson. Literature also reveals that teachers' professional knowledge is a prerequisite for students' achievement. According to Stronge (2018, p. 15), professional knowledge refers to the teacher's understanding of the curriculum subject content and identifying strategies that can enhance students' learning experience. There are three types of professional knowledge that teachers must possess, and these include: content knowledge (CK), the knowledge of the subject matter; pedagogical knowledge (PK), the general knowledge about teaching; and pedagogical content knowledge (PCK), the specific knowledge about how to teach a particular discipline. PCK involves the art of understanding topics and their interrelationships, breaking them down into manageable chunks and strategizing how best to deliver content in a meaningful way that produces the best learning experience to a student.

Reflecting on Liakopoulou's (2011) study on the professional competence of teachers, the emphasis on pedagogy of teaching is also placed on lesson planning, time planning of activities to be accomplished by both teacher and learners, defining goals to be achieved, transformation of teaching material into teachable knowledge, and assessment of learners' performance. Audu (2014, p. 39) contends that good and effective teaching methods should equip learners with skills that help them make their own discoveries and contribute to the learning activities and process. Over and above the concept of PCK, Williams (2012) included the aspect of knowledge of the curriculum, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational aims, purposes and values as crucial attributes to teacher effectiveness in guiding the learning process of students. In support of Williams's assertion, Liakopoulou (2011) postulates the idea of contextual knowledge of circumstances surrounding the teacher's working environment as influential and having far-reaching implications on the effectiveness of the teacher in the classroom. Knowledge of learners and their family backgrounds, socio-economic factors surrounding the entire local community, infrastructure, organisation and management of the school as an entire system and other factors should inform the teacher on the suitable teaching strategies and techniques that best suit the context and optimise the teaching and learning experience (Liakopoulou, 2011).

Indistinguishable from Stronge's perception of effective teaching, Confait (2015) concurs with the notion that effective teaching practice is a constellation of factors that range from teachers' conception of effective teaching, their interaction with and interpretation of their teaching context, how they engage learners throughout the learning process, promote collaboration, use specific learning skills pedagogies and encourage learners to reflect on the content of what they learn. Additionally, Liakopoulou (2011), suggests that the way a teacher carries out their work is compounded by their personality traits, attitude and beliefs and also the acquired pedagogical skills and knowledge. While Stronge (2018) views teachers' personality as an innate or inherent facet, Liakopoulou (2011), on the other hand, opines that personality traits related to teachers' professional role can be nurtured and developed through initial education and continuous training. She argues that teachers' attitudes and beliefs on teaching and learning influences their degree of commitment to their duties, the way they teach, their treatment and sense of responsibility towards their learners, high expectations for learners, desire to achieve excellence and their perceptions towards their professional growth.

Liakopoulou (2011) expounds on teacher effectiveness, looking at different categories of knowledge that constitute 'professional knowledge' of a teacher and extensively contribute to their expertise. For a teacher to be effective, they need to be familiar with the content of the subject they teach, the related facts and scientific principles, the dynamics of presenting knowledge of the subject to learners, the value of the subject to everyday life, and its relation to other social issues. If the teacher clearly understands their subject content, they will be in a better position to diagnose learners' misinterpretation of knowledge, errors or points of weakness and come up with innovative strategies for learners to acquire the knowledge and skills in an effective way (Liakopoulou, 2011). Knowledge of learners is one of the contributing factors to effective teaching. Their biological, social and psychological well-being as well as cognitive development have a direct bearing on their mental ability to acquire new knowledge. Liakopoulou (2011, p. 69) asserts that knowledge of learners is useful in informing the teacher about learners' behaviour, learning motivation, abilities and learning difficulties so that the teacher can implement teaching strategies that best suit the learners' needs whilst embracing their diversity. In a nutshell, it is evident from the literature reviewed that there are several factors contributing to the effective teaching and learning of any subject or area of study.

Thus from Stronge's (2018) work and the work of other scholars cited above, it is unquestioned that the aforementioned characteristics of effective teaching are crucial and equally applicable to the teaching of graphic communication within the field of manufacturing, engineering and technology. As such, the inquiry into teachers' knowledge and practices in promoting effective learning when teaching graphic communication theory and practical lessons in civil technology is of invaluable significance in the education system if both the general and specific aims of the curriculum are to be resoundingly achieved. Stronge's (2018) framework of qualities of effective teaching was used as a lens to explore and understand teachers' practices of promoting active learning. This theoretical framework brings to the fore the distinctive attributes of effective teaching, and these form an integral part of active learning strategies. Active learner engagement during teaching is demonstrated through Stronge's (2018) principles of effective teaching that draws special attention to teachers' instructional delivery methods, planning and preparation of lessons, assessment and evaluation of learners' progress, pedagogical content knowledge and specialised content knowledge of the subject, classroom management and organisation and an outline of learner activities in and outside the classroom, all aimed at addressing optimal learning. Lima et al. (2017) maintain that in order to allow learners to construct their own learning in a meaningful way, teachers need to plan strategies of teaching and prepare relevant activities that will nurture an inquisitive mindset, invention, interaction, analysis and synthesis of information when completing tasks, thus promoting active learning.

## 2.7 Conclusion

In this chapter, I reviewed literature on the aims of practical work in technology and civil technology with specific focus on the teaching of graphic communication in South Africa. I also surveyed literature on the purpose, aims and structure of practical work in technical courses in other countries (Finland, Australia, Germany, Sweden, Nigeria) to illuminate scholars' perceptions on the significance, experiences of teaching and learning civil technology and teaching practices that promote active learning in the teaching of graphic communication lessons, reflecting on the local and global contexts. The CAPS document and civil technology NSC grade 12 examiners' reports were explored to determine the content and graphic communication skills outlined and expected to be acquired by learners as specified in the curriculum, juxtaposed with the outcomes from the national assessment in order to evaluate the acquisition of skills. Challenges teachers encounter when teaching graphic communication lessons locally and globally were also explored. The theoretical framework that underpins this study is elucidated. In the next chapter, I discuss the methodology used to gather and analyse data, and the ethical issues that were observed in conducting the study.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

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 in order 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.

## 3.2 Paradigm

A paradigm can be described as a worldview used in researching phenomena. It defines how research is carried out based on a different set of beliefs about how the world is possibly viewed and understood and also based on views of what counts as accepted or correct scientific knowledge (Cohen, Manion, & Morrison, 2018). A paradigm clarifies, organises and directs the thought patterns and actions undertaken in a study. There are three commonly used paradigms in research, namely: postpositivist, interpretivist and the critical paradigm. According to Creswell (2017), paradigms differ on the basis of their ontology (the nature of reality), epistemology (nature of knowledge), axiology (values associated with areas of research and theorizing) or methodology (strategies of gathering, collecting and analysing data). The interpretive paradigm aims to understand the social world through interpretations of human behaviour, beliefs, attitudes and perceptions. 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). The interpretivist paradigm holds the assumption that a researcher constructs knowledge and makes meaning of any studied phenomenon through their cognitive processing of data gained from their engagement and interaction with research participants (Kivunja, 2017). The interpretivist paradigm and approach were used in the study, and it directed the structure and methodological choices of inquiry used to conduct the research. The interpretive paradigm was considered ideal for conducting this study since the primary aim of the researcher was to get an in-depth understanding of CT teachers' practice of promoting active learning during teaching of graphic communication lessons. In the endeavour to understand the teachers' experiences of promoting active learning when teaching graphic communication, it was critical to examine and explore their personal experiences in their different contexts. Specifically, the study sought to ascertain what challenges CT teachers encounter when promoting active learning during teaching of graphic communication lessons. The study aimed to discover why teachers encounter challenges and to explore their perceptions of such challenges through their lived experiences in the world of work.

## 3.3 Research approach

The research approach can be described as the method or procedure of studying a phenomenon, emanating from philosophical assumptions, worldviews and the theoretical lens in order to gain complex and detailed understanding of the phenomenon (Creswell, 2016). There are generally three methodological approaches to conducting research, namely the quantitative, qualitative and mixed methods approach to inquiry. Quantitative research essentially focuses on understanding or explaining phenomena through collecting and analysing numerical data (Muijs, 2010). Mixed methods research is an approach that combines both quantitative and qualitative research methods to develop rich insights into phenomena of interest that cannot be implicitly understood using only a quantitative or qualitative method of inquiry (Venkatesh, 2013). Qualitative research as opined by Creswell (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). It involves developing concepts and insights, and deriving understanding from patterns in data collected (Taylor, 2015).

At this juncture, it is important to clarify the research approach adopted in this study. This research is informed by the qualitative strategy of inquiry. Since the purpose of my study is to explore and gain in-depth understanding and insights on teachers' practice in promoting active learning when teaching graphic communication lessons, and to uncover prevalent trends in learners' performance and teachers' lived experiences, thoughts and opinions, a qualitative approach was opted for over other approaches. It was deemed more reliable and appropriate in understanding thought patterns and behaviours within their everyday teaching and learning settings.

## 3.4 Research design

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, 2018). On a similar note, Kumar (2019) perceives it as a procedural operational plan that a researcher undertakes and that serves as a roadmap detailing how the research process will unfold, including methods of collecting data, selection of study sample and specific sites, and analysing the data. The choice of case study as an ideal research design that can provide optimal solutions to the research questions 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, 2017).

A case study is one of the important styles of qualitative inquiry used by researchers. Yin (2018) describes a case study as an empirical method of investigating contemporary phenomena in depth, to gain a clear understanding of the phenomena within its real-world and contextual settings. It allows for extensive inquiry and systematic in-depth study of a particular case, for example, a person, group of people, institution, organisation etc., aimed at gaining a more comprehensive understanding of a phenomenon (Yin, 2018). A case study is the pertinent method of inquiry particularly if the research questions are 'how' or 'why' questions that attempt to understand a social phenomenon (Yin, 2018). It takes a holistic approach to research. It focuses on gaining knowledge and making sense of the reality through conducting an in-depth investigation of an entity in a real-life context (Njie, 2014). Njie (2014), argues that research involving in-depth and thick descriptions of data provides a comprehensive understanding of a phenomenon when systematically analysed. This research used a case study: a case of uMgungundlovu district grade 11 CT teachers. This case study was envisaged to provide an insight on the participants' thoughts, attitudes, and perceptions of their real practice of promoting active learning related to the teaching of CT graphic communication in their various contexts. The intention was to establish the reality of CT teachers' practice of promoting active learning when teaching the subject, probe into how they promote active learning, what challenges they encounter, and why they are faced with such challenges in their effort to promote active learning when teaching graphic communication.

## 3.5 Research Site

The study is located in uMgungundlovu district, KwaZulu-Natal province in South Africa, as is illustrated in the geographical map on Figure 3.1 below.

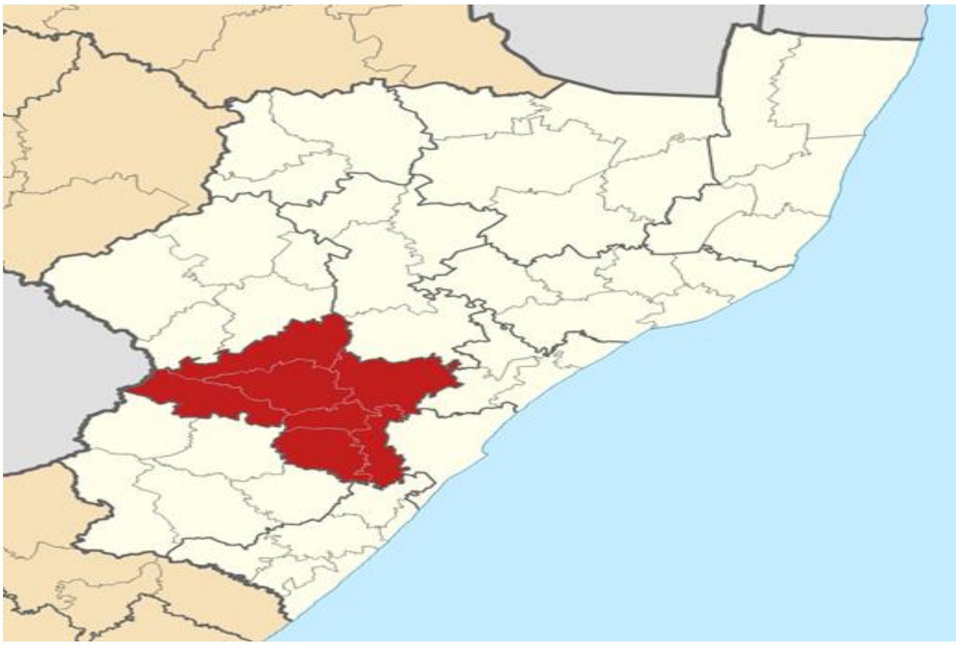

**Figure 3.1 KwaZulu-Natal Province highlighting uMgungundlovu district**

Source: https://en.wikipedia.org/wiki/Umgungundlovu_District_Municipality

UMgungundlovu district is one of the eleven district municipalities of KwaZulu-Natal. There are only eight secondary schools offering civil technology in the district of uMgungundlovu, and they have all been selected to form part of the study sample. The table below shows quantile ranking of schools offering Civil Technology in uMgungundlovu district.

**Table 3.1: Quantile ranking of schools offering Civil Technology in uMgungundlovu district**

| Quantile ranking | Description | Number of schools |
|---|---|---|
| 5 | Former Model C Schools | 2 |
| 4 | Township schools | 2 |
| 3 | Semi-rural schools | 3 |
| 2 | Deep rural Schools | 1 |

**Source: Author**

The schools are a combination of former model C schools, township schools, and rural schools. Of the eight schools, two belong to the former model C schools; they are located in Pietermaritzburg city and are ranked quantile 5. They are fee paying schools with good infrastructure, financial resources and equipment for teaching and learning. Two are located in the township areas under Msunduzi local municipality and these are moderately resourced schools. The other three are ranked quantile 3 and are located in the semi-rural areas on the periphery of Pietermaritzburg city. These can be categorised as under-resourced schools. The last one is ranked quantile 2, located 73km out of Pietermaritzburg city along Noordsberg road in the deep rural areas in uMshwathi local municipality. The school is distinctly under-resourced. Quantiles 2 and 3 are non-fee-paying schools as the communities are classified as less affluent and they depend entirely on government financial allocation for the running of the school. Teaching and learning materials and resources are remarkably limited in these schools. The schools have different quintile rankings as denoted by the Department of Basic Education, and these range from quantile 1 up to quantile 5 depending on the affluence of the communities, including infrastructure of the schools among other factors (Education, 2004). The higher the quantile ranking of the school, the better the infrastructure and resources for efficient functioning of the school. For example, in this case, quantile 5 schools are the most well-resourced of all the schools, and the list goes in a descending order to the most under-resourced school.

## 3.6 Sampling

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). Similarly, Oppong (2013) describes sampling as a process of selecting subjects to take part in a research investigation on the grounds that they provide information considered relevant to the research problem. Oppong (2013) expresses the view that in the context of qualitative research, it is impractical to select all members of a target population to provide information for a research inquiry. It is, rather, ideal to select research participants that bring optimal value to the research process and outcomes, and subsequently the credibility of the study. 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, 2016). It is used in qualitative research for the identification and selection of information-rich cases related to the area of study (Etikan, 2016). The criteria for selection of research participants took into consideration the learning area and grade. All purposively selected participants had to be teachers of grade 11 Civil Technology. There are 8 (eight) schools offering civil technology in the uMgungundlovu district; each school has one CT teacher, who teaches CT from grade 10 to 12. All 8 CT teachers were invited to participate in this study. The sample size for this study is thus eight (8) CT teachers.

## 3.7 Data collection methods

Data collection 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). This study was conducted at a time of unprecedented change and disruption due to COVID-19 (Lobe, Morgan and Hoffman, 2020) and I found myself under obligation to review my methods of data collection. Initially, I had planned to generate data via traditional face-to-face individual interviews, face-to-face focus group interviews and on-site classroom observation of civil technology lessons. However, because of the COVID-19 pandemic and the stipulated protocols to observe social distancing and avoid visits in schools, my data generation plan was amended. In the section that follows, I present a detailed discussion of the data collection activities and processes involved in this study, including approaches used, data collection instruments, recording the information, gaining access to the research sites, and phases of data collection.

### 3.7.1 Data collection instruments

In the section below I discuss the instruments that were used during data generation. A wide range of instruments were used to capture data to answer the research questions posed, namely, the questionnaires, individual interviews, focus group interviews and document analysis. The instruments listed were used because of their suitability in collecting qualitative data as determined by the research design.

#### 3.7.1.1 Questionnaires

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 asked about (Cohen et al., 2018). McGuirk (2016) argues 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 behaviour, attitudes, attributes, experiences, social interactions, opinions and awareness of events. Since my study seeks to understand the ways in which CT teachers promote active learning when teaching graphic communication, what challenges they encounter, and why they encounter those challenges in their effort to promote active learning in the light of their different environments and as part of a fluid reality, I have found the use of 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, 2016). A semi-structured questionnaire with both closed-ended and open-ended questions to gather data about teachers' personal information and information based on professional experiences was administered. The questionnaire was used to elicit information about the following aspects: teachers general teaching experience and experience for teaching CT, professional qualifications, experience of marking NSC grade 12 CT examinations, teachers engagement on professional development workshops for CT, strategies for teaching graphic communication and learners response to teaching strategies in terms of learning style, understanding of concepts, academic performance and classroom management (See Appendix C1 for questionnaire). The questionnaire was piloted with a group of CT teachers from another district to check for ambiguities. The pilot indicated that the questionnaire wording was unambiguous. The questionnaire was electronically distributed (sent as an email attachment) to participants, and they were given a time span of a week to respond to the questions and email their responses back to the researcher.

#### 3.7.1.2 Semi-structured interviews

An interview is a qualitative data collection technique that involves a one-on-one conversation between a researcher and interviewee, designed to obtain an in-depth understanding of participants' experiences, perceptions, opinions, feelings and knowledge about the phenomenon under investigation (Rosenthal, 2016). It involves the posing of open-ended questions and follow-up probes by the interviewer, with the intention to capture the in-depth experiences of respondents (Rosenthal, 2016). Stemming from an interest to thoroughly understand CT teachers' classroom practices of promoting active learning when teaching graphic communication lessons, the use of individual interviews in the process of data collection was deemed necessary and rather inevitable if in-depth insights into the subject under exploration were to be achieved. In support of Rosenthal's notion of interviews, Alshenqeeti (2014) propounds that interviews are powerful in eliciting narrative data that allows researchers to investigate people's views in greater depth. Thus, the method was incorporated as one of the data collections instruments in this study.

One of the advantages of interviews is that they provide room for clarification of ambiguous questions posed, and it is easier for respondents to talk to an interviewer than write long responses on questionnaires. The interviewer can pick up on non-verbal clues from the interviewee that could be useful in interpretation of responses to questions asked (Cohen et al., 2018). Several different styles of interviews are widely used in the field of research, and these can be categorised into three groups, namely, the structured, semi-structured and unstructured interviews (Braun, 2013). In the context of interviews, the style that suited my research was the semi-structured interview. This approach was expected to optimise the gaining of rich and precise responses from participants. I prepared an interview guide prior to the interview session. This comprises a set of questions that probe the participant to respond within the scope of the content or subject matter under discussion (Braun, 2013). However, the interview guide is not followed with rigidity. The dialogue is flexible and gives room for the interviewer to make follow up questions, and this creates a potential of gaining in-depth knowledge and understanding of the research problem (Brinkmann, 2014). Based on insights from the scholars discussed above, a semi-structured interview was designed and used for dialogue with participants as it was deemed appropriate because of its flexibility in providing information on exploring teachers' practice of promoting active learning when teaching graphic communication lessons. An interview schedule was prepared, taking teachers through questions that sought clarity on their perceptions regarding the following topics under focus: significance of graphic communication in civil technology, theoretical knowledge and practical skills that learners are expected to acquire from teaching and learning of graphic communication, classroom practices and teaching methods used to ensure learners understand drawing concepts like 2D and 3D, teaching resources used, and any use of simulations or models to illustrate building components drawn in class. Finally, teachers were asked to shed light on any contextual factors that could seemingly be considered as obstructions to effective teaching of graphic communication. The interviews were conducted via WhatsApp video call and recorded with informed consent from participants.

I used the approach of prompts and probing questions to engage with participants, manage the flow of the interview and determine the course of the conversation, keeping the environment of the proceedings in control as the respondents freely expressed their ideas and own interpretations on the phenomenon discussed. Prompts are useful in allowing interviewees to further expand and clarify particular issues and re-direct them to the focus of the discussion if they tend to divert, and probing questions allow the researcher to uncover deeper levels and hidden meanings of the topic under discussion (Evans, 2018). Thus, the choice of interviews was perceived as absolutely ideal in conducting this study, to optimise on gaining deeper insights and understanding of teachers' perceptions of teaching graphic communication, and to act as a supplement to participants' questionnaire responses.

### 3.7.1.3 Focus group interviews

Focus group interviews were used in conjunction with other data collection tools in this study in order to extend and enrich understanding and provide alternative insights of the topic under investigation, from a collaborative point of view of the group participants (Gill, 2018). A focus group interview is a planned discussion convened by a researcher who guides a small group of participants through a conversation aimed at gaining insights of participants on the topic under discussion (Kruger, 2015). Additionally, focus group interviews present a significant advantage in the sense that responses of participants are influenced by each other as they build up from prompt questions posed by the researcher, and this is likely to provide the researcher with a rich and detailed set of data about perceptions, thoughts, feelings and impressions regarding the research problem (Barrett, 2018) .

Furthermore, Barrett (2018) posits that a focus group is not just a group of people gathered together to talk about a topic, but they are a homogenous purposeful sample composed of information-rich participants that identify with a certain common characteristic. It is on the basis of the facts discussed above that the use of focus group interviews was considered essential and valuable for eliciting CT teachers' experiences, opinions and beliefs on their classroom practices of promoting active teaching and learning of graphic communication. Focus group interviews are expected to facilitate the generation of a wide range of views from the collective input from participants that could otherwise not be captured using individual interviews only (Guest, 2017). A focus group interview schedule was used to probe and elicit information from CT teachers, with specific focus on the following themes: teaching and assessing of site plans, elevations and floor plan analysis, calculation of perimeter and area of site plans and proposed building, learners' strength, weaknesses and misconceptions in graphic communication concepts relating to 2D and 3D drawings, interpretation of drawings and use of conventional symbols. The interviews were conducted via Zoom meeting and video recorded with the informed consent of participants. All participants were provided with a link to the Zoom virtual meeting conducted on a set date. The discussion began with a message of welcome and introducing the topic of discussion to the group (An exploration of grade 11 Civil Technology teachers' practice of promoting active learning during teaching of graphic communication). Probing questions were asked to elicit teachers' opinions on their practice of promoting active learning when teaching graphic communication sections like site plan, elevations and floor plan analysis, calculation of perimeter and area of site plan and proposed building. To delve further into the discussion and gain in-depth information on their experiences, views, attitudes and beliefs about teaching the graphic communication section, follow-up questions were asked. Teachers were also asked to elaborate on the kinds of tasks and activities given to learners to reinforce graphic communication skills, to cite learners' strengths, weaknesses and misconceptions in relation to 2D and 3D drawing and use of conventional drawing signs and symbols, challenges encountered when teaching graphic communication, and intervention or support teachers expect from subject advisors or colleagues towards improvement of their teaching practices and learner engagement (See Appendix C3 for focus group interview questions).

#### 3.7.1.4 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). 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. Stronge (2018) asserts that teachers have a powerful influence that is far-reaching in determining the learning outcomes, and considering their degree of influence on imparting graphic communication knowledge and skills, it therefore becomes indispensable to understand what they do to promote active learning in the classroom. There is much more to promoting active learning than just standing in front of the room dispensing information and giving tests to students (Darling-Hammond, 2016). Effective teachers engage their learners in active learning through diverse methods and tools to advance their learners' knowledge. This includes, among others, careful organisation of meaningful learning activities and tasks, materials, instructional strategies, administering assessments as a measure of their teaching as well as measure of learners' learning capabilities, monitoring and evaluation of learners' strengths and achievement, and helping to develop learners' confidence and motivation in the classroom (Darling-Hammond, 2016). Therefore, the inspection and analysis of graphic communication lesson plans offered a great deal of insight about teachers' professional practices related to lesson preparation for graphic communication, and establishing the depth and intensity of teacher's preparedness to deliver theoretical and practical concepts effectively to learners during lesson delivery.

## 3.8 Data generation plan

As alluded to earlier, data collection methods were amended to suit COVID-19 protocols. Although COVID-19 has posed challenges and major setbacks to procedures of conducting qualitative research, transitioning from the traditional face-to-face data collection methods to the use of modern computer-mediated technological communications has offered great flexibility in terms of time and location of data collection (Lobe et al., 2020). Unanimously, Archibald (2019) opines that use of digital technologies to support qualitative data collection presents significant advantages for researchers, and these include convenience, efficiency and cost-effectiveness compared to in-person interviews and focus group interviews, especially when dealing with participants over a large geographical spread. In my case, this implied reduced time and cost of travelling to each of the schools to conduct individual interviews, distributing hardcopies of questionnaires for participants to respond to, and organising a central and convenient venue to conduct focus group interviews.

The study used a wide range of instruments to explore civil technology teachers' practice of promoting active learning in presenting graphic communication lessons. Data collection involved the use of questionnaires, individual interviews and focus group interviews, and document analysis as reflected in Table 3.2.

**Table 3.2: Summary of data generation plan**

| Phase of data generation | Research question | Data source | Instrument used to generate data | Analysis of data |
|---|---|---|---|---|
| 1. | 1. How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication? | Grade 11 CT teacher. | Questionnaire (These were emailed to the teachers), Interviews and Recorded lessons on teaching graphic communication | Content |
| 2. | 2. Do grade 11 CT teachers encounter challenges when promoting active learning in teaching graphic communication? If so, what challenges do they encounter and why? | Lesson plans: Grade 11 CT teachers | Analysis of lesson observation and conducting Individual interviews (Interviews via WhatsApp video call were recorded, interview questions were also emailed to participants so they could respond to the questions electronically as well), Focus group interviews were conducted virtually using zoom meeting. | Content |

**Source: Author**

## 3.9 Gaining access to research

The success of any empirical research lies with the researcher's ability to establish good rapport with their informants throughout the process of the study (Bergman Blix, 2015). This provides a sound basis for successfully gathering rich information through interviews with participants.

Gaining access to fieldwork is critical and a prerequisite to conducting research, and that involves finding and securing participants prior to the 'real' research (Peticca-Harris, 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). Preceding the fieldwork procedures, ethical considerations pertaining to gaining access to sites and participants were set in place for this study. Formal authorisation from the UKZN research office via the ethics committee and Department of Basic Education through school principals was sought in writing. School principals of the eight identified schools offering civil technology in the uMgungundlovu district were initially contacted telephonically, with the researcher introducing herself and explaining the intentions and purpose of the study. Emails were thereupon sent as a formal request seeking informed consent, detailing among other issues the central purpose of the study, the right of participants to voluntarily participate and/or withdraw from the study at any time without victimisation, assurance about protecting the confidentiality of participants (Creswell, 2016), and procedures of data collection using online platforms during the teacher's own convenient time without disrupting the normal teaching and learning process. Permission was then granted from all the principals of the eight schools that form part of the sample size (see appendix B1 for informed consent letter to principals). Consent was also sought from the individual civil technology teachers concerned and permission was granted (see appendix B2 for informed consent letter to participants).

## 3.10 Data analysis

The data collected in this study is qualitative in nature and therefore qualitative data analysis was used to interpret the verbal and aural data acquired from interview sessions. According to Cohen et al. (2018), qualitative data analysis involves organising data into themes, identifying patterns and categories, and also deriving meanings as defined and explained by participants. Raw data in the form of the researcher's notes as well as audio and video recordings drawn from interviews were transcribed verbatim, and then put into a usable text format. This involved organising and sorting data into codes, categories and themes as well as analysing patterns, relationships and discerning consistencies between data sets (Lester, 2020). I used the constructs of my theoretical framework, Stronge's qualities of effective teaching, to code data into themes, such as teachers' professionalism, instructional planning, instructional delivery, classroom management and organisation, and monitoring students' progress and potential.

## 3.11 Research rigour

In qualitative research, credibility of the study is measured in terms of rigor, accuracy and trustworthiness of findings, and comparability of results. Research rigor is an element of precision that must demonstrate the strength of the research design and appropriateness of methods used to answer research questions in an undoubtedly thorough and accurate manner to guarantee credibility of the research findings (Cypress, 2017). Trustworthiness of any qualitative research is measured on the basis of the study to demonstrate multi-dimensional aspects of quality such as credibility, transferability, dependability and confirmability (Connelly, 2016). A researcher's ability to conduct a rigorous study, maintaining consistency and providing thorough detail throughout all the stages of the research, foregrounds trustworthiness and credibility of the study (Nowell, 2017). To demonstrate a high degree of competence and abide with the ethical practices of research ensuring rigour, trustworthiness and credibility of the study, I used diverse strategies that include triangulation, data validation and verification of participants' responses through member checking. Measures of research rigour addressed in the study are discussed below.

### 3.11.1 Triangulation

Triangulation is a qualitative research strategy used to enhance the validity of research findings by applying multiple theoretical and methodological approaches to develop a comprehensive understanding of phenomena (Flick, 2018). In support of using triangulation in qualitative research, Carter (2014) adds that merging information from different sources is an effective strategy of gaining in-depth understanding of a phenomenon being examined and is helpful in checking the consistency of data gathered. In this study, data triangulation was implemented through the use of a variety of data generation methods, including individual interviews, focus group interviews, questionnaires, and analysis of documents like lesson plans and department of education reports for NSC examination results.

### 3.11.2 Member checking

Transcripts were emailed to participants for member checking and reaffirmation to ensure the accuracy of data collected. Member checking is a qualitative technique of exploring the accuracy and credibility of data by means of returning interview transcripts to participants to allow them to validate and verify data and confirm if it resonates with their experiences (Birt, 2016). This validation exercise enables participants to reconstruct their narrative, provide additional data, bring to the fore the voice of the participant, allow the researcher to find out if there are any disconfirming voices, and potentially enhance the accuracy data (Birt, 2016). Additionally, Morse (2018) propounds that through verification, the researcher is able to ensure adequacy and appropriateness of data quality that will further enhance pattern or category formation into different themes when data is being coded for analysis. Subsequent to member checking, interview transcripts were also read several times before coding began. During coding, the constructs of my theoretical framework were used to code the data generated into categories. Related categories were linked together to form themes.

### 3.11.3 Credibility and data validation

Credibility is a quality measure that involves establishing that research findings are in accordance with participants' contribution and articulation of data collected (Kumar, 2019). According to Creswell (2017, p. 206), "validation" in qualitative research is an attempt to assess the "accuracy" of the findings, as best described by the researcher and the participants. In order to ensure credibility of my study, data validation and credibility was achieved through re-engaging with all participants in the focus group interviews to reaffirm their responses, asking for further elaboration, and verifying if they agreed with the information gathered as initially articulated during focus group interviews. Similar to member checking explained earlier, focus group member checking was also implemented whereby original interview transcripts were taken back to participants in order to allow them to validate and verify the accuracy of their responses, to check if there is harmony and consistency.

## 3.12 Limitations of the 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., 2011). Additionally, Yin (2018) contends that a case study is an appropriate method of inquiry that allows for in-depth information and rich thick description of a phenomenon within its real-world context, especially if context and phenomenon are not clearly distinguishable. Thus in this research, a case study has been established as a credible, valid research design that facilitates in-depth exploration and analysis of complex issues (Harrison, 2017). The method allows for in-depth and detailed study of CT teachers' real practice of promoting active learning when teaching graphic communication, anchored in their real-life experiences, and gives rich thick descriptions and insights on their thoughts, attitudes, perceptions, behaviours and practices.

## 3.13 Conclusion

This chapter discussed an overview of the methodological approach used in conducting the study. The study falls within the interpretive paradigm, and it is qualitative research that uses a case study design of inquiry. Also outlined are the procedures involved in the preparation and collection of data. Data collection instruments used include questionnaires, individual interviews, focus group interviews and document analysis. Research instruments like interview schedules, focus group interview schedule and questionnaire were prepared prior to the collection of data. Measures to ensure validity and trustworthiness of the study were also discussed.

# CHAPTER 4

# PRESENTATION AND DISCUSSION OF FINDINGS

## 4.1 Introduction

The previous chapter (three) provided the methodological approach, research design, and population and sample procedures used in the study. Additionally, a detailed description of data collection methods and instruments, data analyses methods to ensure reliability and credibility of the study, as well as validity and research vigour measures implemented in light of the instruments used and ethical procedures followed were discussed. This chapter presents empirical findings and their interpretation from the data analysis performed.

The chapter starts by outlining the biographical data of teachers who participated in the study, as a means to understand teachers' personal attributes based on their professional experiences, skills, qualifications, experience of marking NSC examinations, exposure to professional development workshops, and how these factors influence their practice of promoting active learning when teaching graphic communication and their effectiveness thereof. As mentioned in chapter three, data was collected using a questionnaire, individual interviews, lesson observation and focus group interviews. The main objective of the study was to explore how grade 11 CT teachers promote active learning when teaching graphic communication. The data presented seeks to answer the research questions posed, specifically: (i) How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication? (ii) Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication? If so, what challenges do they encounter and why? The information presented in this chapter is divided into two parts: A and B. In order to understand how grade 11 CT teachers promote active learning when teaching graphic communication, part A presents biographical data that were acquired through a questionnaire in order to create a configured profile of individual teachers' personal attributes and behavioural consistency, as this information is believed to be a strong indicator of their current and future performance in the classroom. Part B attempts to answer the second research question by establishing if teachers encounter challenges when teaching graphic communication in their different contexts and why?

## 4.2 Part A: Biographical data of teachers

In the section below, I present biographical data of CT teachers in uMgungundlovu district. The data provides insight into the teachers' biographical information in terms of their gender, professional qualifications, general teaching experience, experience of teaching CT as a subject, subjects taught prior to CT, curricular that they have experienced, experience of marking NSC examinations, and their attendance at CT professional development workshops organised by the department of education. Eight teachers participated in the study and pseudonyms were used to protect and ensure the confidentiality of the participants.

**Table 4.1: Summary of biographical information of Civil Technology teachers in uMgungundlovu district**

| Teacher | Gender | Professional qualifications and major subjects | General teaching experience (No. years ) | Civil Technology teaching experience (No. years) | Subjects taught prior to Civil Technology | Subjects currently taught | Curricular experienced | NSC Marking experience | Attendance of professional development workshops |
|---|---|---|---|---|---|---|---|---|---|
| A | Male | Diploma in Education - Dip Ed (Woodwork- Tradesman) | 18 Years | 4 Years | Woodwork | CT- Woodworking, Technology grade 8/9 | CAPS 2 | No | 1-day long orientation workshop 1-week long practical workshops |
| B | Male | Higher Diploma in Education - HDE (Technical Drawing and Mathematics) | 30 Years | 16 Years | Technical drawing, Mathematics | CT-Civil services, EGD, Technology grade 8/9 | NATED 550, C2005/NCS, CAPS 1, CAPS 2 | Yes – More than 7 years | Four separate 1-week long practical sessions covering the aspect of old and new syllabus.<br>Facilitator at 2-week long courses specializing in allied mechanics. |
| C | Male | Junior Secondary Education Diploma-JSED, Further Education Diploma-FED (Woodwork, | 39 years | 16 years | Woodwork, Metal work, Technical drawing | CT- Construction, EGD | NATED 550, C2005/NCS, CAPS, CAPS 2 | Yes – More than 7 years | 1-week long training session on Graphic communication. 2-weeks long training on |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Metal work, Technical drawing ) | | | | | | | calculation of quantities and other content. 2-weeks AutoCAD training. |
| D | Male | Secondary Teachers Diploma – STD (Technical), Advanced Certificate in Education – ACE (Bricklaying and Plastering, Mathematical Literacy) | 21 years | 16 years | Bricklaying, Mathematical Literacy | CT-Construction, Mathematical Literacy, Technology grade 8/9 | NATED 550, C2005/NCS, CAPS, CAPS 2 | No | 1-week long workshop doing Civil Technology practical and theory |
| E | Male | Secondary Teachers Diploma – STD (Quantity surveying), Bachelor of Technology B Tech (Education Management) | 29 years | 16 years | Woodwork | CT-Woodworking | NATED 550, C2005/NCS, CAPS | No | 1-week long content-based workshop |
| F | Male | Diploma in Education – Dip Ed (Woodwork Tradesman ) | 16 years | 1 year | Woodwork | CT-Woodworking, Technology grade 8/9 | CAPS 2 | No | 1 week-long practical workshop |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| G | Male | Bachelor of Education-BEd (Civil Technology and Mathematics) | 2 years | 2 years | None | CT-Construction, Mathematics, Technology grade 8/9 | CAPS 2 | No | 1 week-long practical workshop |
| H | Female | Bachelor of Education – BEd (Civil Technology) | 4 years | 4 years | None | CT-Construction, Technology grade 8/9 | CAPS 2 | No | 2 weeks-long practical Workshop. |

**Source: Author**

This is how the table should be read; it is elaborated by means of the example below:

**Biographical data: Teacher B**

Teacher B is a male teacher who holds a professional qualification, Higher Diploma in Education (HDE) majoring in Mathematics and Technical Drawing. He had 30 years general teaching experience and 16 years CT teaching experience during the time of data collection. He has taught Technical drawing and Mathematics prior to the inception of CT in the technology curriculum in South Africa. Currently, he is teaching CT-Civil Services Grade 10 to 12, EGD Grades 10 to 12, and Technology Grades 8-9 at a former model C urban boarding school in the district. He has experienced the following curricula in his teaching career: the NATED 550 curriculum prior to 1994; the National Curriculum Statement (NCS) implemented in 2006; the Curriculum Assessment Policy Statement (CAPS 1) in 2011; and a revised version of the CAPS curriculum in 2014 - CAPS 2 that is currently running since its implementation in 2016. He has more than seven years' experience of marking Grade 12 CT NSC examinations. He has attended and facilitated professional development workshops organised by the department of education at provincial level, focusing on training other teachers on applied mechanics' content.

## 4.2.1. Presentation of findings

### 4.2.1.1. Gender distribution of teachers teaching CT in uMgungundlovu District

As presented in Table 4.1, there is a total of eight CT teachers in uMgungundlovu district; seven teachers are male and only one is female. Notably, the data in the Table is an indicator of an asymmetrical gender distribution of CT teachers in uMgungundlovu district, depicting a huge underrepresentation of females in the technical subjects. This is an indication that CT is still a largely male-dominated field. The preamble of the CAPS CT curriculum aims to address issues of gender equity, however, in reality, gender bias continues to exist as there are more male than female CT teachers (Education, 2011). The uneven distribution of female teachers in CT in the uMgungundlovu district can serve as a deterrent for the uptake of CT by female learners and them undertaking careers in the field of technology and engineering. The data in Table 4.1 pertaining to the gender distribution of CT teachers illuminates that society continues to regard technical subjects as a male domain. With regard to the above finding, it is worth noting Mlambo's (2021) observation that despite efforts to transform institutional spaces to reflect the diversity of members of all social categories and groups, gender inequality continues to devalue, exclude and alienate women from technical subjects even today.

#### 4.2.1.2. Professional qualifications and experience of teaching graphic communication

In respect of requirements to teach CT, the CAPS curriculum recommends that a CT teacher must be a trained subject specialist, preferably an artisan/technician/technical teacher in a CT related area; industry-related experience and workshop management skills are essential and a tertiary qualification in technical teaching is needed (Education, 2014). The data in Table 4.1 reveals that all eight teachers have acquired professional qualifications that align with the requirements to teach CT. Findings from the data show that teachers' qualifications vary, from a technical teacher qualification with a junior secondary diploma, a diploma in education, a higher diploma in education, to a bachelor of education degree in a CT related area, with some qualifying as tradesmen or artisans. Their profiles show that they have formal training as teachers of technical subjects, and this positions them at an advantage as CT teachers according to the recommendations of the CAPS curriculum. However, having these qualifications does not confirm their ability to teach graphic communication. From the data collated, four of the eight CT teachers have sixteen years' experience of teaching CT and graphic communication, respectively. Of these four teachers, two of them teach both CT and EGD. EGD is a subject that foregrounds graphic communication and thus complements the requirements of graphic communication in CT. These four teachers teaching both CT and EGD ought to have strong content knowledge of drawing and graphic communication as they studied Technical drawing as one of the major subjects in their tertiary education courses. Furthermore, their years of experience teaching these two subjects would have assisted them to develop their pedagogical knowledge.

An analysis of teachers' general teaching experience and experience of teaching CT was done to establish if this could have a bearing on their practices of promoting active learning when teaching graphic communication. Six teachers had more than fifteen years' general teaching experience while two were novice teachers with less than five years general teaching experience during the time of data collection. Looking at their experience of teaching CT, it emerged that four of the teachers had more than 15 years' experience and the other four had less than five years' experience of teaching CT during the time data was collected. Research conducted by Juuti, Rättyä, Lehtonen, and Kopra (2017) on pedagogical content knowledge in product development focusing on engineering education in Finland shows that teacher content knowledge has a major impact on the efficiency of teaching and learning. In the contemporary world, the teaching of engineering manufacturing education, including graphic communication skills, should focus on producing more competent practitioners for the industry, people that will create new solutions for products and services for sustainable development (Juuti et al., 2017). Additionally, van As (2018, p. 418) points out that the knowledge and skills that students will learn whilst spending time in a technology class are heavily dependent on the skills and knowledge of those teaching them. Clearly, this implies that CT teachers' professional qualifications, requisite knowledge and skills to teach graphic communication have a huge impact on how they can effectively deliver graphic communication concepts and skills and at the same time promoting active learning in the classroom.

#### 4.2.1.3. Curricula encountered by CT teachers

In this section, I discuss different technology curricula that CT teachers have enacted in order to ascertain if their curricula enactment influenced their practices of promoting active learning when teaching graphic communication. It is evident from data presented in Table 4.1 that technology teachers in South Africa have encountered multiple curricular transformations in their teaching career. Findings from my data show that four teachers teaching CT for more than five years have encountered four different curricula and four teachers teaching CT for less than five years have encountered CAPS 2 curriculum. The different curricula encountered are discussed in detail below:

First, teachers teaching CT for more than five years have encountered the NATED 550 curriculum prior to 1994; in this period (prior to 1994), technology education was offered as a traditional technical craft-based learning area where subjects such as woodwork and metal work were offered for boys and home-economics was compulsory for girls (Ankiewicz, 2021). The second curriculum they encountered, in 1998, was curriculum 2005, known as the C2005 which focused on technology education at GET phase grades 7-9. Technology for FET phase grade 10-12 was implemented in 2006 under the curriculum NCS and the learning area known as manufacturing, engineering and technology. The NCS was reviewed following challenges experienced with content progression, and lack of clarity with regard to content depth to be covered. The review saw the implementation of a new and third curriculum, namely the CAPS 1 in 2011 (Ankiewicz, 2021). Currently, the curriculum that is operational for technology education is the CAPS 2, an amendment of CAPS 1. CAPS 2 has its emphasis on specialisation areas for each technical subject, and this was implemented in 2016 (Education, 2014).

Curriculum implementation hinges on teachers' practice of promoting active learning. The introduction of the NCS technology curriculum in 2006 was a challenge as teachers did not receive adequate training to teach a new school subject (Ankiewicz, 2021). Instead they were just equipped with the necessary skills and knowledge to make a paradigm shift from their old subjects to implement the new curriculum by means of short trainings through continuous professional teacher development programmes (Ankiewicz, 2021). Additionally, Singh Pillay and Alant (2015) assert that mediation of policy continues to be the 'just in time once off' professional development offered to practising teachers for curriculum implementation that impinges on curriculum implementation.

Research evidence shows that the implementation of technology as a school subject in the South African curriculum since 1998 has met with the challenge of inadequate training of technology teachers and their being equipped with the necessary skills to effectively enact the curriculum (Ankiewicz, 2021; Gumbo, 2020; Gumbo, 2013; Rankhumise, 2015; van As, 2018). Moreover, Engelbrecht (2016) also highlighted that the vast majority of technology teachers in South Africa did not receive formal hands-on training in the concepts, content and methods associated with the teaching of technology education. They pointed out that the implementation of technology education in South Africa since 1998 has posed challenges that include preparing new teachers to teach technology education as well as equipping existing teachers with pertinent skills even through continuous professional development programmes. Data in Table 4.1 resonates with Ankiewicz's findings that few qualified and competent teachers who had trained for traditional technical subjects such as home economics, woodwork, metalwork, Technika Civil, Building construction, Bricklaying and plastering, and industrial arts prior to 1998, were assigned the responsibility of teaching technology education; this was confusing as it implied adjustment from the traditional pedagogy of manipulating materials that they were used to, to embracing new technological processes, content coverage and new approaches to lesson planning (Ankiewicz, 2021). The situation is further exacerbated by a trend of decline in prospective student teachers opting for training in technology education subjects at university level (Grobler, 2021). This continues to impose a strain on the human resource pool of the technology education fraternity.

#### 4.2.1.4 CT teachers' experience of marking NSC examinations

A survey of teachers' involvement in marking CT national senior certificate examinations was done to find out the extent of their participation in marking national examinations as part of their professional development. From the sample of the eight CT teachers, only two have experience of marking NSC examinations. This reflects negatively on the professional development of CT teachers, particularly with regard to their exposure to learners' trends in understanding, interpreting and answering graphic communication questions in national examination assessments, and learners' misconceptions pertaining to GC. Experience and exposure to marking of NSC examinations is deemed a necessary part of CT teacher professional development. The experience can point them towards identifying learners' weaknesses and misconceptions with regards to graphic communication assessments, as well as recognize gaps in their teaching approach and methodologies and help them assume reflective teaching strategies and practices on an on-going basis. South Africa places an enormous emphasis on the NSC examinations to determine the performance of learners as they exit the secondary school system under a national regulatory body 'UMALUSI', to ensure the quality and integrity of the NSC examination (Le Roux, 2019). Markers are appointed not only to serve to ensure quality marking and exercise justice to candidates, but it also enhances the quality of education as it refines the teachers' competence and expertise in dealing with assessments and enables them to handle problem solving and critical thinking learners' responses (Le Roux, 2019).

#### 4.2.1.5 Teachers teaching CT and other subjects

I also inquired into teachers' workload to find out if this impacts their practice of promoting active learning when teaching graphic communication. Findings presented in Table 4.1 show that while teachers teach CT, the bulk of their time is spent teaching other subjects besides CT. Four hours of contact time is prescribed per week for CT and the time allocated includes time for both the theory knowledge component and the practical work (Education, 2014, p. 57). Over and above the CT teaching load, data in Table 4.1 shows that from a sample of eight teachers, seven are faced with an excessive workload of preparing lesson plans, teaching and marking other subjects. This negatively impacts on their practices of promoting active learning when teaching graphic communication as they are expected to handle multiple tasks of effectively planning and delivering content for multiple learning areas. One teacher (teacher H) who teaches CT and Technology grade 8 and 9 expressed that dealing with multiple roles constrains their teaching of graphic communication. This is evidenced from the excerpt below:

*"Having to handle multiple roles in the classroom like updating the subject to new demands, collecting materials, content presentation as well as bringing new creative approaches to meet the present educational trends constrains my teaching of graphic communication"* Teacher H (Questionnaire – See appendix C1).

#### 4.2.1.6 Attendance of professional development workshops

A survey on CT teachers' attendance of professional development workshops was conducted to ascertain their participation in professional development activities that empower them to enact the curriculum in a way that promotes active learning in the delivery of CT and graphic communication lessons. In South Africa, teachers have had 'once off just in time' training as part of professional development programmes (Singh-Pillay & Alant, 2015). Data collated shows that teachers have been engaged in professional development workshops organised by the department of education, with the duration varying from 1 day to 2 weeks long, and focusing on content and practical work. However, it is not certain whether the workshops arranged effectively assist and empower teachers with the skills to promote active learning when teaching graphic communication. Teachers require on-going and longer hands-on training to come to grips with curriculum content. Gumbo's (2020) empirical study on professional development of technology teachers established that technology teachers in particular show a lack of understanding of the requisite subject content, pedagogical knowledge, skills and competencies they need to produce outstanding learner results. Continuous professional teacher development remains a hallmark of the teachers' own competence and this ultimately influences the learners' performance (Gumbo, 2020). Similarly, Govender (2018) highlights challenges experienced in South Africa with regard to curriculum implementation as a result of the lack of sustainable professional development programmes that provide meaningful support for teachers in the classroom. Govender's (2018) empirical study reports on the discontentment of teachers regarding support from the department of education on curriculum implementation, which was characterised by professional development workshops that were too short and insubstantial to equip teachers to deal effectively with the changes that they needed to make in class and to improve learner performance. On the same note, one CT teacher expressed their concern regarding intervention and support for graphic communication curriculum implementation; this can be seen from the excerpt below:

*"The government needs to invest in people with skills and knowledge. If they do not have money to do that they can do it in other ways, say for example take a teacher away from the classroom for 2 or 3 months for intensive training, and when a teacher comes out of the session, then he has all the models and all the skills to come and teach the subject. You cannot get a teacher to go for a 1-week course and expect him to get back to the classroom and teach all the practical*

*aspects, it is impossible. Intensive teacher training is important if you want the positive outcome that you are anticipating."* Teacher C (Focus group interview – See Appendix C3)

## 4.3 Research question one

RQ1: How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication? This research question is answered by using data from the questionnaire and the semi-structured interviews, and analysis of lesson plan portfolios and recorded graphic communication lessons. Content analysis was used to make inferences to collated data to answer research question one.

When I was doing content analysis of data from the questionnaire and semi-structured interviews, three themes unfolded, namely, CT teachers' understanding of graphic communication and its significance in CT, ways in which teachers promote active learning of graphic communication, and how learners are engaged in graphic communication. Each theme is elaborated upon below.

### 4.3.1 Teachers' understanding of graphic communication and its significance in CT

CT teachers presented three different understandings of graphic communication, and these are expressed as follows:

a) Graphic communication conveys an idea or thought via drawings or sketches to be interpreted by a skilled person.

b) Graphic communication is a language spoken by architects and contractors.

c) A technological process that learners use to do a practical assessment task when designing to communicate ideas into paper or an article.

The teachers' understandings of graphic communication are discussed in line with excerpts below:

**Graphic communication conveys an idea or thought via drawings or sketches to be interpreted by a skilled person**

A comprehensive understanding of graphic communication and its significance to CT foregrounds the teachers' practices of promoting active learning during the teaching of graphic communication. The excerpts below show teachers' understanding of graphic communication:

*"Graphic communication conveys an idea or thought via a drawing or sketch to be interpreted by a skilled person to be made into reality. In the context of civil technology it refers to the built environment. Without a proper drawing or sketch with measurements we will not have a functional society. Imagine a society without roads, dams and fresh water supply."* Teacher C (Interviews – See Appendix C2)

*"I introduce drawing as language of symbols and conventions, understood by any speaker of any language with the basic understanding of these symbols. Learners are asked to learn the symbols in response to the need to communicate a certain thing for example a floor plan where the symbols they need are taken as instructions to a builder."* Teacher B (Questionnaire – See Appendix C1)

*"Graphic communication is the universal language of the whole technical world where ideas are communicated visually through sketches and drawings. It is a tangible way for designers to develop, analyse and express or communicate technical ideas and designs effectively to others."* Teacher H (Interviews – See Appendix C1).

Six teachers (A, B, C, D, F and H) out of a sample of eight showed that they comprehend graphic communication and its space in civil technology and related engineering fields as a language that involves communication of ideas through drawings, sketches and symbols used as instructions for manufacturing of real objects and this is seen from the excerpt by teacher C. The excerpts reveal that most CT teachers acknowledge that the nature of CT as a practical subject extensively involves design and communication of technical ideas and solutions through graphic means, and it plays a significant role in the design and construction of the built environment and provision of all essential services for livelihood. Studies conducted by Camburn et al. (2017) and Bertoline (2005), established that designers think about many features in their minds that cannot be communicated with verbal descriptions but rather dealt with using visual images and nonverbal processes that get translated into a drawing or picture depicting what is in the designer's mind. Subsequently, real objects are manufactured or constructed out of these drawings or graphic representations (Camburn, 2017). The teachers' comprehensive understanding of graphic communication displayed in the excerpts above plays a pivotal role in their being subject specialists, and in making decisive classroom practices that involve planning, organising, preparing and delivering graphic communication lessons in a way that promotes active learning. **Graphic communication is a language spoken by architects and contractors**

*"I elaborate graphic communication as a language of communication between architecture and contractors. Graphics as means of communication, to me it is a language spoken by architects as well as contractors because it integrates and bridges that gap from designing something and making something, because if one person designs something they could be talking their own language and contractors could be talking their own language."* Teacher G (Questionnaire – See Appendix C1)

Teacher G construes graphic communication as a language of communication between architects and contractors. He has an idea of some stakeholders who use graphic communication in the field of manufacturing engineering and construction; however, his concept of graphic communication seems to be divergent when he says designers talk their own language and contractors talk their own language. 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. Ideally, the stakeholders in the field of manufacturing engineering and the construction industry cannot speak contrasting languages of visual images, signs and symbols. Otherwise it defeats the whole purpose of interpreting the drawings for the purpose of manufacturing products and constructing designed structures. Such a misperception pertaining to graphic communication cripples the teacher's precision in promoting active learning when teaching graphic communication concepts. Teachers of a specific subject should possess special understanding of the content knowledge to be able to effectively transmit the knowledge to their learners (Kok, 2018). Undoubtedly, a teacher's comprehensive understanding of graphic communication and its significance in CT is imperative in promoting active learning in teaching graphic communication.

**A technological process that learners use to do a practical assessment task when designing to communicate ideas into paper or an article.**

*"The first thing I would say, graphic communication has a very important role in civil technology, because most of the time they have this technological process which is applied in most cases. For example if the learner has to do a practical assessment task, so all the learner needs to do is to follow this technological process. This technological process is clearly giving*

*a learner the direction to follow, so that is why when it comes to designing, that falls under graphic communication whereby the learner will be able to communicate his/her ideas into paper or into an article which will be something that is visible to everyone at the end of the day."* Teacher E (Interviews – See Appendix C2)

The extract from teacher E shows that his understanding of graphic communication is confined to the design process. Teacher E perceives graphic communication as a technological process that learners employ when engaged in practical assessment tasks and when designing to communicate ideas onto paper or in an article. 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 constricted understanding of graphic communication limits the teacher's creativity and ability to organise 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).

### 4.3.2 Ways in which teachers promote active learning of graphic communication

I interrogated the instructional methods that CT teachers use to ascertain if the methods incorporate and promote active learning of graphic communication. The findings show that teachers have different approaches and use different methods to teach graphic communication. This illuminates teachers' PK and PCK and displays the level of their competency in instructional planning and classroom practices that promote active learning when teaching graphic communication. The instructional methods and strategies were collated from questionnaires, semi-structured interviews, analysis of lesson plans as presented in the teaching portfolios and audio-recorded graphic communication lessons on interpretation of drawing; interpretation of site plan features are discussed next.

CT teachers use a standard lesson plan template that was designed and provided by the provincial department of education to guide their lesson preparation. The lesson plan template is provided as Appendix C4. Out of a sample of eight CT teachers, only three provided their lesson plan portfolios for grade 11 graphic communication lessons. Some teachers were reluctant to give their lesson plans, citing the reasons that they do not prepare lesson plans because no one monitors them. Instead they use a textbook to prepare lesson notes where necessary. Another teacher mentioned that he has taught the subject for many years and because of his vast experience, he has the content in his brain. See the excerpt below:

*"To be honest with you I do not prepare a lesson plan, I have long done away with that because no one monitors them. I only prepare for the sake of setting my file in order if hear the subject advisor is coming for monitoring."* Teacher A (interview)

*"Lesson plan!!! in this age? I do not use a lesson plan. Honestly after having taught the staff for more than 30 years, it is all in my brain."* Teacher B (interview)

The lesson plan template requires a teacher to indicate the dates for commencement and completion of the topic, specify the lesson type from the given options, specify the resources used, and tools and equipment required, specify the learner activities or written class work, and specify the homework or enrichment exercises to be completed by learners. Out of the three teachers, only one indicated the resources they needed for teaching the graphic communication content planned, and specified the resources, tools and equipment required. However, all three teachers did not specify any enrichment exercises beyond what is suggested in the lesson plan. Furthermore, methods of assessment and evaluation of the lesson are not stated in order to measure if objectives have been achieved. This observation suggests that teachers only follow what has been prescribed by the provincial department in the lesson plan templates, and they do not innovate in their teaching. Analysis of the questionnaires and semi-structured interviews, and analysis of lesson plans as presented in the teaching portfolios and audio-recorded graphic lessons reveals that the following instructional methods were used, namely:

a) Chalkboard illustrations/demonstration and learners draw
b) Explanation of concepts and field excursion
c) Learners draw and make projects to link theory with practical (e.g. after drawing a floor plan they go on site to set out a foundation; after drawing a roof truss, they make a roof truss)

**Chalkboard illustrations/demonstrations**

Findings from my data analysis show that the majority of teachers A, D, E and F (four out of eight teachers) focus mainly on chalkboard illustrations and demonstration of drawing techniques and then engage learners in drawing activities in class. I also discuss teachers' instructional methods as presented in lesson plan preparation.

"*Graphic communication in Civil is better be taught to someone who has a background in EGD. So in most times I explain whilst doing some rough sketches on the board. I also demonstrate and do scale drawings while they are watching and give them a chance to correct some mistakes made on purpose."* Teacher F (Questionnaire – See Appendix C1)

*"As a teacher, I should be able to, in fact I draw for the learners on the board and show them this is a 2D and 3D drawing. They also practice that, the more we give them practice of different activities where they convert 3D objects to 2D working drawings of first angle orthographic projection, it makes them understand more because they are now interpreting drawings from 3D object to a 2D drawing."* Teacher E (Interview – See Appendix C2)

*"I am going to give you an activity. I want you to draw the same site plan, to scale 1:200, as it is, then label the following features 1, 2, 3, 4, 5, and 6 as shown."* Teacher F (Lesson plan observation – See Appendix C4)

The above excerpts elucidate that these teachers lack diversity in their instructional approach. Predominantly, they rely on chalkboard illustrations and demonstrations, and these appear to be the conventional pedagogical strategies for teaching graphic communication. Teachers conscientiously draw diagrams on the board whilst learners are watching, then they are given the opportunity to practice the drawings. In other words learners simply replicate what the teacher has drawn, and that shows there is little room for learners to actively think and reflect on what they are drawing. Furthermore, the teachers are not explicit in the instructional approach of chalkboard illustration, and how they integrate theory of drawing and practical illustration of graphic communication concepts as a way of promoting active learning, through making models and simulations. Their approach is to simply follow the textbook, guided by the prescribed lesson plan, which lacks the teachers' innovative and creative input of how they can bring diversity in terms of the pedagogical strategies. As suggested by Stronge (2018), effective teachers must incorporate higher order thinking strategies and use a variety of activities that engage learners actively in the learning process. For example, in the lesson plan observed, teacher F made some chalkboard illustrations of how to draw a site plan, discussed with learners all features shown on a site plan, and at the end of the lesson requested the learners to redraw the same site plan to a specified scale of 1:200. This clearly shows that learners are recipients of knowledge through replication of what the teacher has illustrated on the chalkboard.

Demonstration focuses on knowledge transfer of technical processes and practical application of knowledge demonstrated by the teacher and replicated by learners (McLain, 2018). McLain further explains that demonstration cannot be used as a stand-alone pedagogical technique independent of other methods. It is a multifaceted skill that combines a range of pedagogical techniques that involves the teacher, as the expert, modelling or detailing step by step how to make something, while explaining the processes, procedures and the thinking involved to help learners understand how things are done (McLain, 2018). However, McLain (2018) warns that demonstration must be used with caution. A teacher should know when to demonstrate and when to create space to engage learners and allow for their mental development as they manipulate materials and tools to discover and learn new knowledge through self-reflection and collaboration with peers (McLain, 2018). In other words, the use of demonstration as a pedagogy has implications for how and when a teacher should demonstrate and leave room for learners to self-evaluate, and autonomously apply the knowledge learnt in solving problems rather than just replicating concepts and procedures they observed during the demonstration. Simply put, demonstration should be integrated with other instructional strategies that promote active engagement of learners in the learning process.

**Explanation of concepts and field excursions**

Two teachers (D & H) emphasised explaining graphic communication concepts to learners, and engaging learners in field excursions to identify different features drawn in class on existing building structures. Evidence is shown in the excerpts below:

*"I explain the techniques used to draw freehand sketches and I ensure that learners adhere to SANS requirements when drawing floor plans."* Teacher D (Questionnaire – See Appendix C1)

*"First, I explain to learners certain rules and regulations when it comes to graphic communication or drawing. For example, types of lines used when drawing, those things are very important. I really emphasize that because that's where graphic communication starts,*

*once they lose that understanding you find they will be struggling to actually illustrate their information in drawing."* Teacher D (Interviews – See Appendix C2)

*Educator to explain the technique used to draw freehand sketches of door frames. Educator must ensure that learners adhere to SANS requirement when drawing floor plans for a 3-bedroom dwelling.* Teacher D (Analysis of Lesson plan portfolio – See Appendix C4)

"*When I am introducing graphics as means of communication, I only associate the things that they know with their daily lives because graphics is everything that is around us. So I associate with something that they know and then they could see ukuthi this thing is this. The only thing I do usually is to explain to them the north direction, which is the direction how it works. Then the next thing is taking them out to see the views on the structure or building we are in, so they can see, Ok if we say this is the North point which one is the South elevation, which one is the East or West elevation regarding the building that we are in."* Teacher H (Interviews – See Appendix C2)

The excerpt from teacher D shows that the teacher lacks the didactics to incorporate and integrate theory of drawing with practical illustration of building components. Additionally, analysis of the lesson plan portfolio shows that teacher D emphasises explanation of graphic communication drawing techniques and proceeds to give learners class activities to draw. The teacher is not explicit about how he integrates the method of explaining graphic communication concepts with other instructional strategies, illustrations or analogies to reinforce learners' understanding of the graphic communication concepts taught. Their emphasis on explaining drawing techniques lacks a touch of how the drawings of door frames will be linked to any tangible objects, such as door frames around the classroom, to illustrate the door stile, rebates, frame head, lugs and such parts of a door frame. Similarly, teacher H talks about associating graphic communication with things that learners know, and taking them outside to see the north point, south, east and west elevations on existing buildings. Whilst it is a good practice to relate content taught with what learners already know, their approach of teaching the concept of geographical orientation of a building to the true geographic north pole leaves the topic or subject rather abstruse for learners to comprehend. Learners are passively engaged in the learning process because they are simply observers of building structures viewed outside, and recipients of what the teacher explains about the true north direction. Drawing from Shulman's theoretical categories of teaching knowledge, Almeida, Davis, Calil, and Vilalva (2019) posit that teachers need to be proficient with the content they teach; they must be able to construct or provide alternative representations of knowledge in form of illustrations, analogies, explanations, and intersect the content, organise and adapt it to various interests, skills and context of learners (Almeida et al., 2019). Simply put, CT teachers must have the art of making every aspect of the graphic communication lesson interesting through the diversity and integration of various instructional methods, even when teaching the most abstruse concepts.

**Learners draw and make projects to link theory with practical**

Only two teachers, B and C, out of eight, use multiple methods that include chalkboard illustrations, explanation of concepts and demonstrations, and deeply engage their learners in both individual drawing and making simulations and models to link theory with practical aspects when teaching graphic communication, as seen from the excerpts below:

*"I start with the use of drawing equipment, interpreting and drawing symbols, basic freehand drawings in isometric and orthographic projection, use of models to develop perception, move on to introduction of scale and instrument drawing, and make projects and models linking theoretical aspect with practicals."* Teacher C (Questionnaire – See Appendix C1)

*"In civil technology, we concentrate on house or building drawings, detailed drawings of various components of building practices and make template designs for sheet metal work."* Teacher B (Interviews – See Appendix C2)

*Class Activity 1 and 2 - Learners draw a floor plan of a 3-Bedroom house to scale, make freehand sketches of single and arched door frames, draw a semi-circular arch and build a model of a semi-circular arch in English bond using bricks.* Teacher C (Analysis of Lesson plan portfolio – See Appendix C4)

Contrastingly, excerpts from teachers C and E make evident that the teachers have an in-depth PCK as they are able to encapsulate their knowledge of the subject with pedagogical skills that promote active learning. The teachers display that they are able to select multiple methods and strategies that actively engage learners to develop both drawing skills and manipulation of tools and materials. Clearly, they are conscious about planning their teaching and learning in a way that promotes active learning and develops learners' graphic communication skills through the creative design of arches, single and arched door frames, visual communication of drawing the house plans and semi-circular arch to scale, and practically making models of a semi-circular arch in English bond and using bricks, centre piece and the required bricklaying tools as they interpret the drawings. The idea of engaging learners in design and implementation of complex and realistic learning tasks helps learners to construct their own knowledge through practice (McGlashan, 2018).

The research findings on ways in which CT teachers promote active learning when teaching graphic communication show that generally teachers have limited approaches to instructional delivery. While they construe graphic communication as a distinct non-verbal language used by engineers, designers, product manufacturers and system developers to communicate technical ideas and problem solutions (Camburn et al., 2017), their instructional approach to the teaching and learning of the content and skill is quite restrictive for the promotion of active learning. Drawing on Shulman's (1987) theories of pedagogical knowledge on professional knowledge that underpins teaching, Almeida et al. (2019) contend that pedagogical content knowledge (PCK) defines the nature of knowledge a teacher should possess, and the didactic approach of effectively presenting content that is understandable to learners. PCK encompasses the teacher's explicit knowledge of the particular subject content, various skills of organising and presenting the content in a meaningful way, and the use of analogies and illustrations, demonstrations and activities in which learners get actively engaged in the process of learning (Almeida, 2019). Almeida et al. (2019) argue that PCK is not simply formed by a set of knowledge forms or categories proposed by Shulman (1987), instead it must be the integration and consolidation of the different forms of knowledge that a teacher should acquire to become proficient in their classroom practices.

Based on the data collated in this study, it is evident that the majority of the CT teachers have a very rudimentary approach to the teaching of graphic communication concepts and skills. Some of the teachers' responses are not explicit on how they actively engage their learners in the acquisition of drawing skills when teaching graphic communication lessons. They do not reflect in-depth understanding, organisation and preparation of the content and skills to be taught in graphic communication. They perceive graphic communication concepts as involving merely drawing. Bertoline and Wiebe (2005, p. 17) express that "It may seem to be very simple a task to pick up a pencil and start drawing 3D images on 2D paper. However, it takes special knowledge and skill to be able to represent complex technical ideas with sufficient precision for the product to be mass-produced, and parts easily interchanged." This has implications for the teaching and learning of graphic communication. Teachers need to have a premeditated instructional approach to the teaching of graphic communication. The concepts and skills to be developed in learners must be clearly defined; teachers must organise and sequence the specific content and know the point of departure in terms of the skills to be imparted, and build up from the basics to the complex, with learner activities well planned and clearly outlined. Olmedo-Torre et al. (2021) assert that the use of active-learning methodologies, both inside and outside the classroom by means of planned activities, is a key factor in effective learning.

Relating to Shulman's (1987) model of PCK, findings from this study reveal that some grade 11 CT teachers lack diversity when it comes to didactics and instructional strategies especially with the teaching and learning of an abstract subject like graphic communication. Almeida et al. (2019) argue that PCK reflects teachers' comprehension of how to present content taught in a way that learners understand; the teacher must be able to identify distinct parts of knowledge and skills and how precisely to organise and present the particular knowledge and skills on a specific topic, as well as understand what facilitates or hinders the learning process, including strengths and misconceptions that learners present.

### 4.3.3 How learners are engaged in graphic communication

I also analysed how learners are engaged in graphic communication lessons. Data collated from questionnaires, semi-structured interviews, focus group interviews and lesson plan observations was examined in order to establish how teachers engage learners. Four learner engagement strategies came up from the findings, and they are discussed in line with excerpts provided below:

**Strategies of engaging learners**

a) Individual drawing activities completed in class
b) Group discussions and activities
c) Use of digital projector to show videos and pictures
d) Individual drawing activities, making models and simulations, enrichment exercises outside the classroom

Two out of eight teachers indicated that they promote active learning by engaging their learners through individual activities drawn in class. One teacher mentioned that he engages his learners through group discussions and activities. Three teachers emphasised the use of digital projectors to show learners videos and pictures related to graphic communication concepts.

Two other teachers use multiple strategies where learners get engaged in individual drawing activities, make models and simulations of drawings made in class, and they are given enrichments exercises to work on outside the classroom. Evidence is shown in excerpts below:

*"Learners must do, draw actively in the lesson. They are expected to research sizes of things like baths and showers, variations in materials and the hatching used, and other ways to relate the drawing to the physical world they inhabit."* Teacher B (Questionnaire – See Appendix C1)

*"I promote active learning through demonstration of activities on white board and group activities and feedback."* Teacher A (Questionnaire – See Appendix C1)

*"When it comes to site plan drawing, floor plans, elevations, sectional elevations, it is all about practice, practice, practice. They have to draw every single one of them a couple of times at least until they get familiar with it. Familiar with variation of questions and obviously the analytic questions, they have to be practiced a lot. I send them home with five analytic questions to do every day, everyone has to do the work."* Teacher B (Focus group interview – See Appendix C3)

*"Ours is a very practical subject. If you are drawing a roof truss you get learners to make a roof truss. For simulations, learners lay bricks in the various designs. They are first asked to draw and then practically demonstrate how the bricks are laid to achieve a specific pattern."* Teacher C (Interview – See Appendix C2)

*"When I am introducing graphics as means of communication, I only associate the things that they know with their daily lives because graphics is everything that is around us. So I associate with something that they know and then they could see ukuthi this thing is this. The only thing I do usually is to explain to them the north direction, which is the direction how it works. Then the next thing is taking them out to see the views on the structure or building we are in, so they can see, Ok if we say this is the North point which one is the South elevation, which one is the East or West elevation regarding the building that we are in."* Teacher H (Interviews – See Appendix C2)

*From all three lesson plans analysed, the method of engaging learners was to give them worksheets retrieved from learner workbook, to complete in class.* (Analysis of Lesson plan portfolio – See Appendix C4)

Findings on how teachers engage learners in graphic communication reveal that teachers employ various strategies to promote active learning. However, it is not clear whether they use the strategies in isolation or they combine different strategies to promote active learning. Teacher A, for example, indicated his preference of using group activities because he teaches a large class of 42 learners. Whilst group activities are good for peer interaction, they may not cater for the individual needs of learners. The excerpt from teacher H reflects a very rudimentary understanding of graphic communication concepts and skills, and lacks substantiation on the execution of the teaching and learning processes to develop and hone the relevant graphic interpretation skills, like explaining the rationale behind the concept of geographical orientation of a building structures to the true north pole, how to interpret the elevations on the drawing in relation to true north direction, and so on. As put across by Stronge (2018), an effective teacher who exudes enthusiasm and competence for a content area plans and organises the lesson, clearly states the objectives of learning whatever content, outlines activities and strategies to engage learners of various ability levels, and incorporates different learning modalities and styles. Analysis of lesson plan portfolios shows that learners get engaged by giving them worksheets to complete individually in class.

Excerpts from teachers B and C reflect the teachers' intricate and detailed understanding of graphic communication concepts and principles and how the skills can be taught effectively. The teacher shows their ability to organise content to be taught sequentially and in an iterative manner. Attention is paid to the drawing techniques and conventional symbols that learners need to know. Learners' are given drawing activities in class and enrichment exercises outside the classroom. The integration of theory with the practical through engaging learners in project-based problem-solving tasks allow learners to develop perception through the process of ideation via graphic communication, and learners finally make artefacts from drawings.

Active learning is a student-centred learning approach characterised by allowing students to be the main players in the learning process, and giving them space to perform meaningful activities and critically think about what they are learning (Hernández-de-Menéndez, 2019). CT teachers' CK and PCK displays their competency in instructional planning and classroom practices that incorporate and promote active learning. Lombardi et al. (2021, p. 10), claim that the concept of active learning is multifaced and learner engagement manifests in different dimensions. This includes social behaviour that involves participating in learning activities with classmates; the cognitive dimension, displayed by the willingness of the learner to engage in effortful and purposive thinking; the emotional dimension involving positive feelings like enjoying and having a sense of belonging and valuing the learning tasks done; and the learner's agency and autonomy to control their goals as constructors of knowledge. In other words, teachers' instructional strategies need to be diversified, consolidated and thoughtfully planned to ensure that learners' engagement and learning experience is optimised.

In view of the learner engagement strategies outlined by CT teachers, as illustrated in the excerpts above and the analysis of lesson plans, it can be noted that some teachers lack the didactics of teaching graphic communication concepts. Mtshali (2021) recommends that teachers must explore classroom discourse techniques that foster conducive instructional and learning experience to elicit knowledge. While the method of individual learner activities emphasised by two of the CT teachers provides a good measure to assess individual learner's ability and extent of grasping graphic communication concepts taught, it cannot be deemed the best and only teaching and learning strategy to guarantee optimal learning. Learners need more inclusive verbal interaction and engagement with the teacher and amongst themselves as peers in the classroom (Rymes, 2015). Such classroom interactions can help to learners to engage in critical reflection of what they are learning, help the teacher understand learners' logical reasoning in problem solving, identify any misconceptions during the process of learning, and are more likely to contribute to learners' success. One important point to note from Rymes (2015) is when he urges teachers to talk "with" rather than talk "to" their learners. He claims that talking "with" learners is one such way that teachers can learn what is relevant to their learners and provide them the tools they need to be active participants in society instead of just dictating instructions of what should be done without giving them space to think and reflect on what they are learning. On a similar note, Mtshali (2021) points out that the majority of technology teachers in South African schools lack the suitable instructional practices and classroom discourses to effectively teach analytical drawings related to graphic communication. Mtshali's (2021) study established that usually teachers strive to complete the curriculum rather than to impart core, transversal and general competencies. Recent CT diagnostic reports on NSC examinations by the department of education in South Africa reveal that learners performed poorly in analytical drawing on graphic communication, despite teachers teaching and covering all prescribed curriculum content in class (Education, 2019). This only suggests there is a missing puzzle piece in content delivery methods and strategies that promote active learning.

To sum up, it can be concluded that a few teachers think and consider amalgamating their instructional methods and strategies that incorporate active learner engagement through individual and group activities, making models and simulations, and practical assessment tasks as prescribed by the CAPS (Education, 2014). The rest of the teachers choose and implement their instructional methods and learner engagement strategies in isolation, making their teaching strategies to be more teacher-centred. Here, the teacher does the talking or lecturing, illustrating the drawing procedures on chalkboard, and learners copy or replicate the drawings with little understanding, and with little interaction with the teachers and amongst themselves as peers. Further, there is little or no practical simulation or modelling of the drawings into physical and tangible objects to enhance learners' understanding and demystify complex graphic communication features and concepts.

## 4.4 Research question two

RQ2: Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication? If so, what challenges do they encounter and why? The second research question comprises three parts that are answered in two sections using data from the questionnaire, semi-structured-interviews and focus group interviews. Data generated from these instruments were analysed in stages using a thematic analysis approach.

### 4.4.1 Part A:

**Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication**? **If so what challenges do they encounter?**
In order ascertain if CT teachers encountered challenges when promoting active learning in teaching graphic communication the following themes emerged and are discussed.

My data analysis reveals that all eight CT teachers encountered challenges when teaching graphic communication lessons. These include:

a) Challenges encountered when teaching theory and practical lessons

b) Learners’ misconceptions on site plans, floor plans and calculations of perimeter and area of site

**4.4.1.1 Challenges encountered when teaching theory and practical lessons**

In order to understand the challenges and experiences that CT teachers encounter when teaching theory and practical lessons, data collated from semi-structured interviews and focus group interviews is discussed with evidence from excerpts from the interviews. The challenges are listed as follows:

a) Translating a drawing into practical work (e.g. making an artefact to scale)
b) Lack of integration and proper progression of graphic communication skills from senior phase (Grade 8&9) to FET (Grade 10-12)
c) Lack of adequate tools and machinery to conduct practical activities.

**Translating drawings into practical work**

Findings from semi-structured interviews and focus group interviews show that three teachers find it challenging to make their learners understand how to translate drawings into practical work, particularly when they have to make projects and use scale to reduce or enlarge the object in relation to measurements on the drawing. Furthermore, reading or interpreting measurements correctly using a measuring tape is a challenge for learners. See the excerpts below:

*“Learners have a challenge of reading or interpreting a measuring tape and using scale correctly. If you ask a learner to measure, say a distance of 700mm, they want to open the whole measuring tape to see where its written 700, otherwise they get confused when they cannot see that 700 on the tape.”* Teacher E (Focus group interview – See Appendix C3)

*“Sometimes learners cannot follow the given dimensions correctly, so they end up taking wrong measurements especially where they have to convert millimetres to metres. Learners have a problem; I do not know if they are lazy or what.”* Teacher H (Interviews – See Appendix C2)

**Lack of integration and proper progression of graphic communication skills from senior phase (Grade 8&9) to FET phase (Grade 10-12)**

Teachers B and D share the same sentiment that there is a lack of sound background of drawing skills and proper progression from technology content at grade 8 and 9. This is illustrated in the excerpts below:

*"Learners are lacking information from previous classes. Remember that graphic communication does not start at grade 10, 11 and 12. As far as I know, it is there in technology grade 8 and 9, that is where they are introduced to this graphic communication 2D and 3D. So now it is giving me problems in teaching because you need to start again introducing this graphic communication. You think learners know isometric for example, but you find that learners are confused, they do not know what is isometric, talk about 3D, what is 3D? But I know very well that in technology grade 8 and 9 that is where they start the introduction of it."* Teacher D (Interview – See Appendix C2)

*"On that point, I am trying an experiment this year. In my grade 9 classes, I am introducing floor plans at grade 9 level to make learners understand symbols, doors, windows, floors, kitchen fittings, bathroom fittings, just to get them a little bit of step ahead to grade 10. We divide our grade 9s up into different groups and once a term we swop with different teachers. So I teach structure and materials and floor plans, the other teacher does orthographic projection along with fitting and turning, and then the electric teacher does isometric projection, and we do a bit of an extra. But we are bringing in aspects of floor plans into grade 9. Just trying it as an experiment to see if it improves the grade 10 graphic communication and ultimately grade 11 and 12 by familiarity."* Teacher B (Focus group interview – See Appendix C3)

*"We do teach them site plans and elevations and so on, but I still find that they are struggling when it comes to answering questions based on these drawings. In my view, I think learners lack the basic. Probably this kind of drawing like graphic communication should start at primary school level. May be if this subject could be introduced at primary level and learners are asked to draw house plans and start getting the knowledge, they will develop a better understanding."* Teacher D (Focus group interview – See Appendix C3)

The lack of integration and proper progression of graphic communication skills from the grade 8 and 9 technology curriculum to the FET phase grade 10-12 curriculum presents a significant challenge to CT teachers since they have to make tremendous effort to teach fundamental drawing skills from scratch at the FET phase.

**Lack of adequate tools and machinery to conduct practical activities**

From a sample of eight schools offering CT in uMgungundlovu district, research findings reveal that only two schools (teachers B and C) have workshops with a full complement of machinery, hand tools and equipment to carry out practical tasks. Six schools (teachers, A, D, E, F, G and H) have hand tools and a few portable power tools. One school (teacher G) does not have a dedicated workshop for conducting practical activities. Lack of tools and machinery in the schools is evident from excerpts below:

*"No machinery, no dedicated workshop for practical activities, I only have hand tools and a few portable power tools like jig saw, drill, angle grinder and circular saw. I would appreciate all the machinery that could make my life and work easier."* Teacher G (Questionnaire – See Appendix C1)

*"I teach in rural areas, and I have a workshop with only hand tools and no machinery. This forms part of the challenges when I want to do practical activities. My learners are not exposed to different things like construction machinery and modern-day construction processes unlike learners from suburbs who are more exposed where they see people doing construction, working on large construction projects."* Teacher D (Interviews – See Appendix C2)

*"It is very difficult working with inadequate tools and machinery. Most of the machines in my workshop are very old type, some are broken and just lying idle and not functional because of lack of servicing. I am trying to get an industry or company that can adopt our school, so that they can sponsor us or help us to secure resources that we need for practicals, or if we have to look for a place to visit for practical excursions, we can liaise with them."* Teacher A (Focus group interview – See Appendix C3)

The above excerpts show the teachers' huge challenge with regard to conducting practical lessons to reinforce learners' understanding of graphic communication because of a lack of equipment and resources. Availability of a workshop with machinery and hand tools is critical in promoting active teaching and learning of CT. Zooming in on graphic communication, learners' visual skills and understanding of any drawings as a means of communication needs to be complemented by manipulation of concrete materials through simulations, making models, constructing, fitting and dismantling blocks and shapes (Singh-Pillay & Sotsaka, 2020). Lack of adequate machinery and equipment in most schools offering CT suggests that teachers' teaching of graphic communication is mainly via static drawing (Singh-Pillay & Sotsaka, 2020). It lacks the dynamic aspect of reinforcing learners' visual perception, and their understanding of various drawing techniques by simulating what they have drawn; for example, making a model of site plan showing the boundary lines, building line, entrance gate to the site, positioning the proposed building, showing the drainage system and how it is connected to municipal sewer connections, and all such related features on a site plan. Modelling and simulating different building features requires learners to actively engage with materials like timber, bricks, steel and any other suitable materials where they relate their drawings and visualisation skills to tangible objects that they make. It is evident from the data collated that because of the lack of workshop machinery/equipment, teachers hardly engage their learners with practical activities like simulation and modelling of building construction features and facets drawn in graphic communication; thus, promotion of active learning is compromised when teaching graphic communication lessons. Instead all drawings remain a mental conception that can be mystifying to learners.

#### 4.4.1.2 Learners' misconceptions

CT teachers shared their opinions on learners' misconceptions pertaining to graphic communication. These include calculation of perimeter and area of site and proposed building, orientation of a building in relation to true north, and representation of drawing symbols used in the built environment. The misconceptions are discussed in depth in conjunction with the excerpts from focus group interviews and the questionnaire, as illustrated below:

*"What I have noted is that in most cases learners tend to have a confusion of calculating perimeter and area. For example, a question may ask for calculation of perimeter of a building, a learner will take the length and width of one side and add the two (Length + Breadth), then take the length of the other side and multiply by width (Length x Breadth), then multiply the results by two (Perimeter = (Length + Breath) x (Length x Breadth)). For Area, a learner can take both sides, add them together and put multiplication (Area = (Length + Breath) x 2)".* Teacher E (Focus group interview – See Appendix C3)

*"The same content is taught in the civil drawing component of EGD as in CT graphics module. The difference in detail needed for EGD and CT are confusing to the learners, and justifiably*

*so; I feel that EGD syllabus ignores the fact that civil drawings are instructions to builders who generally can tell the differences between steel and wooden window frames for example. The EGD content can be simplified substantially without losing the ability to communicate. The simplicity of CT graphics is admirable and adequate."* Teacher B (Questionnaire – See Appendix C1)

*"Scale drawings are sometimes difficult for learners to decode. They also find it difficult to define some abbreviations."* Teacher G (Questionnaire – See Appendix C1 )

*"The other issue I have is the disinclination of learners to actually study the symbols of these drawings, these symbols are not difficult."* Teacher B (Focus group interview – See Appendix C3)

*"When I teach this section, I will get the child to draw it, not just recognise it because it reinforces this thought process that I know how to draw it, I will remember it. But if you just say hey you know what, RE is a rodding eye and this is the symbol, a child cannot learn. So they have to draw it."* Teacher C (Focus group interview – See Appendix C3)

*"Yes, language barrier. Our school has IsiZulu as home language. So sometimes you find you would have to go 3 steps ahead and 1 step back just to break down most or some of the English words because they think construction vocabulary is different from English vocabulary. Yes terms are different, I mean its different terms used or rather same terms used for different purposes. For instance, a pillar, in English they would say …so and so is my pillar to cry on, my shoulder to lean on. Now if it is a pillar it means you can lean on. In construction a pillar is a vertical structure on which you can place something on top. Same meaning but different context. So language becomes a barrier because learners cannot take the language, lessons or words they use in other languages or learning areas."* Teacher G (Interviews – See Appendix C2).

The excerpts presented above show that many teachers find it challenging to make their learners understand the calculation of perimeter and area of a site and proposed building. Four teachers expressed that learners generally have a fear of numbers and the moment they are required to calculate something, they think it is mathematics; they shut down and show a negative attitude, to such an extent that some learners do not even attempt answering questions that require calculations. In some cases, learners get confused by the arithmetic operation they have to perform to get perimeter or area; they cannot figure out when and what to add, subtract or multiply looking at the shape and dimensions of the site or proposed building given in the drawing. This is an indication that CT learners grapple with solving mathematically-based problems of area and perimeter of sites and proposed buildings imbedded in graphic communication. Research shows that poor mathematical proficiency among most South African learners is attributed to the teacher's mathematical knowledge for teaching, and lack of proficiency in the dominant language of learning, teaching and assessment (English), among other factors (Robertson, 2020). A learner's proficiency in mathematical problem-solving is demonstrated by their capability to interpret the problem based on their language proficiency (Graven, 2018). Simply put, it means that learners' limitations in mathematical proficiency has implications for the teacher's pedagogical strategies and classroom practices; there is a need to optimize teaching and learning of mathematical concepts such as use of scale in drawing, understanding dimensions, units of measurement and related conversions from millimetres to metre, square metres ($m^2$), cubic metres ($m^3$) that are imbedded in graphic communication.

Two teachers pointed out the problem of understanding and interpreting the orientation of the building drawing in relation to the geographical true north point. Learners find it difficult to correctly determine whether an elevation is North, South, East or West elevation.

Two other teachers stated the problem of incorrectly representing the drawing symbols used in the built environment according to the code of building regulations regarding all drawings, the SANS 0143 code of drawing practices.

### 4.4.2 Part B:

**Why do CT teachers encounter challenges when promoting active learning in teaching graphic communication lessons?**

The second part of research question two sought to establish why CT teachers encountered challenges when promoting active learning in teaching graphic communication lessons. Two themes came out, and they are discussed next:

a) Factors that constrain teaching of graphic communication
b) Use of CAD software in teaching of 2D and 3D drawing

#### 4.4.2.1 Factors that constrain teaching of graphic communication

Teachers highlighted five different factors that constrain their teaching of graphic communication. These include lack of drawing equipment, time constraints, learners' lack of motivation with the subject and not submitting tasks, teachers' workload, and lack of modern technological resources such as internet to effectively teach graphic communication lessons. Excerpts presented below illustrate the challenges to promoting active learning:

*"Learners not having enough drawing equipment, when you are busy teaching a learner wants to borrow drawing instruments and that distracts their attention. You find homework is half done or not done at all because they do not have drawing instruments."* Teacher F (Focus group interview – See Appendix C3)

*"A double lesson per week is allocated for practical work. The reality is that in all my years of teaching, practical work has been done outside of normal teaching time. The demands of the theory aspect does not allow for this."* Teacher C (Interview – See Appendix C2)

*"Learners do not do their activity; they delay the lesson of the next day because they defeat the purpose of giving them the activity in the first place"* Teacher G (Questionnaire – See Appendix C1)

*"Learners really do not like EGD, and are forced to take it along with their choice of Civil Technology. This reluctance to embrace the subject spills over into C Tech, especially as there is a lot of duplication in the building drawing section"* Teacher B (Interviews – See Appendix C2)

*"Having to handle multiple roles in the classroom like updating the subject's new demands, correcting materials content representation as well as bringing in new creative approaches to meet the present educational trends."* Teacher H (Questionnaire – See Appendix C1)

Findings show that four teachers experienced a problem of lack of drawing equipment for learners. This is a huge drawback to the teachers' endeavour to promote active learning when teaching graphic communication. Drawing equipment is a crucial prerequisite of the subject, to enable learners to achieve the technical skills of making precision drawings using the different drawing techniques such as isometric and orthographic projection (Sotsaka, 2019). Unfortunately, teachers lack support from both the school management team and parents to ensure availability of the necessary resources to implement the curriculum and promote active learning when teaching graphic communication. The CAPS document clearly states that schools wishing to offer civil technology as a subject should ensure that human resources, equipment, consumables and sustainable support is rendered for effective implementation of the curriculum (Education, 2014). Teachers need to have agency and try to twin with schools or institutions around them that have resources, and initiate collegial and collaborative teaching in an effort to build and improve their classroom practices and teaching strategies that promote active learning (Singh-Pillay & Samuel, 2017).

One teacher indicated there is just not enough time to cover the expected content. Irrespective of the fact that time has been allocated for both theory and practical according to the CAPS document, the reality is that teachers are not finding it feasible to cover all aspects within the specified timeframe. Teachers have to sacrifice and create extra time outside the school working hours in order to cater for practical activities. This finding shows how the curriculum is overloaded with content that needs to be covered (Singh-Pillay, 2010; Singh-Pillay & Samuel, 2017).

Another teacher cited the problem of lack of motivation for the subject by CT learners. One teacher expressed that there is too much workload; this is an indication that the teacher feels overwhelmed by the amount of work they have to cover in the classroom as per curriculum expectations. As such, it compromised the attitude and practice of promoting active learning.

Another teacher mentioned their lack of access to modern technology, specifically internet. Despite the CAPS document specifying that the CT teacher should have access to the internet to be able to source, download and print relevant and new information – as the built environment is a dynamic industry with new trends and developments (Education, 2014) – such inadequacy of teaching and learning resources continues to be a challenge for effective implementation of the technology curriculum in South African schools.

#### 4.4.2.2 Use of CAD software in teaching 2D and 3D drawing

All eight teachers acknowledged that they do not use CAD software to teach graphic communication in the classroom at all. Five of the eight teachers confirmed that they do not know how to use the software, and they have never received any training on computer-aided draughting. Three teachers confirmed that they do not use the software with learners in class;

further, they lack the technological resources to be able to use it as a teaching aid. Data from the focus group interview has been analysed and evidence is provided in the extracts below:

*"I have gone through extensive AUTOCAD training, I have the software in my laptop, and I know how to use the programme and its highly beneficial for learners in this modern society. The problem arises from a teaching point of view, the department of education does not allocate enough time for this, it is a process, and we have to do this after hours, after school and it steals away your time. We have an AUTOCAD room here in our school that cost department millions of rands to set up 32 brand new computers and training the teacher, but now those rooms are non-existent. The teacher left the school, there is no replacement. While the department spent a lot of money developing sixteen schools in KZN, there is not a will on the part of the department to take the vision forward, allocate monetary resources for maintenance and further training because new teachers are coming in. It need not to be just written in the curriculum that you should teach using CAD, there should be time allocation for it, there should be people qualifying in it. What we do from our school is that if a child is interested in AUTOCAD, I load the program onto their individual laptop and it's a one-month trial version and we can't afford paying for renewal of the licence."* Teacher C (Focus group Interview – See Appendix C3)

*"Unfortunately no, we do not have equipment for using CAD software and we have not done it at all. My wish is to have it in the school, but it is not yet available. Even myself I still need to be workshopped on using CAD."* Teacher E (Focus group interview – See Appendix C3)

The excerpts above show a lot of loopholes and inconsistency when it comes to implementation of curriculum goals such as the use of CAD software in teaching and learning of CT in South African schools. It is clear that consistent professional development of teachers on the use of CAD software, provision of computers and maintenance of computer infrastructure are issues in the progress of effective implementation of the technology curriculum in the education system of South Africa. Curriculum goals continue to exist as drafted proposals if there is no follow up and support on implementation by teachers in the classroom. This is expounded by Singh-Pillay & Alant (2015) who assert that curriculum implementation is perceived as a complex networked process of transforming policy into classroom practice in South Africa. This is attributable to lack of inclusivity in the process of policy formulation by curriculum developers at national level and its implementation by teachers in the classroom. That disjuncture between policy formulation and its enactment continues to see curriculum initiatives fail in South Africa. In view of CT teachers' experience with regards to the use of computer-aided drawing software when teaching graphic communication in uMgungundlovu district, it is reasonable to assert that even if teachers have the willingness and drive to develop their learners and impart skills that align with modern day technology and industry demands, they lack the necessary support in terms of professional training and provision of resources. That technology curriculum goals are far from being realised.

### 4.5 Conclusion

In this chapter I aimed to answer the two research questions posed by this study. To answer the first research question (How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication?), data collated from questionnaires, semi-structured interviews, analysis of lesson plan portfolios and recorded graphic communication lesson plan was subjected to content analysis to make inferences. The findings of the study reveal that there are three ways in which grade 11 CT teachers promote active learning when teaching graphic communication. These are: chalkboard illustration/demonstration; explanation of concepts and field excursions; and learners draw and make projects to link theory and the practical. Teachers actively engage learners in graphic communication lessons in four ways, namely: giving learners individual drawing activities to complete in class; group discussions and activities; use of digital projector to show videos and pictures; and making models, simulations and giving learners enrichment exercises outside the classroom.

Data from questionnaire, semi-structured interviews and focus group interviews were used to answer research question two (Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication? If so, what challenges do they encounter and why?). The data was subjected to thematic analysis and the findings reveal that all CT teachers encounter challenges when promoting active learning in the teaching of graphic communication. These include challenges encountered when teaching theory and practical lessons and learners' misconceptions on site plans, floor plans and calculation of perimeter and area of site and proposed building. The challenges encountered emanate from contextual factors that constrain the teaching of graphic communication, namely: lack of drawing equipment; learners' lack of motivation with the subject and not submitting tasks; too much workload for teachers; lack of access to modern technology such as internet; insufficient time to cover the expected content; and under-resourced workshops in which to perform practical lessons. My findings illustrate that a combination of contextual factors and teachers' pedagogical knowledge, pedagogical content knowledge or subject matter knowledge and their classroom practices impede the promotion of active learning when teaching grade 11 graphic communication lessons. This problem manifests itself in poor quality of NSC results at matric level when learners exit the school system.

The findings of this study prompt me to think: What strategies can CT teachers adopt and adapt to promote active learning in the teaching of graphic communication in order to produce competent learners who, when they exit the school system, are on the cutting edge with respect to contemporary employability skills that are responsive to the needs of industry as well as global trends. In the last chapter, I discuss the implications of the findings of this study for teacher professional development and the development of professional learning communities.

# CHAPTER 5
# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

The purpose of this study, as mentioned in chapter one, was to explore grade 11 CT teachers' practice of promoting active learning during teaching of graphic communication theory and practical lessons using a case study of the uMgungundlovu district. As highlighted in the literature review in chapter two, the NSC examiners and moderators' diagnostic report for CT 2018 to 2019 confirmed poor graphic communication skills demonstrated by learners' continuous inaptitude in solving graphic communication related problems in CT. On that account, there are unanswered questions relating to teachers' practice of promoting active learning when teaching graphic communication, hence the need to probe into CT teachers' classroom practices through this study.

The purpose of the study was twofold. First, it sought to explore how CT teachers promote active learning when teaching graphic communication. Second, it attempted to ascertain if CT teachers encountered challenges when promoting active learning, and to discover possible reasons for challenges encountered. Data was collected in four stages using a questionnaire, semi-structured interviews, focus group interviews and analysis of teachers' lesson plan portfolios and analysis of lesson observation. Once data was collated, it was subjected to content and thematic analyses in order to answer the research questions posed.

In the next section, a summary of the research findings corresponding to each research question is presented. Thereafter some recommendations are suggested, and this concludes the chapter.

## 5.2. Summary of key findings

A summary of the themes that emerged from the data, organized according to the two research questions, is given in Table 5.1:

**Table 5.1: Summary of key findings**

| **Research question** | **Themes** |
|---|---|
| 1. How do grade 11 Civil Technology teachers promote active learning when teaching graphic communication? | • Teachers' understanding of graphic communication and its significance in CT |
| | • Ways in which teachers promote active learning of graphic communication |
| | • How learners are engaged in graphic communication |
| 2. Do grade 11 Civil Technology teachers encounter challenges when promoting active learning in teaching graphic communication? | Yes |
| If so, what challenges do they encounter and | **Challenges encountered when teaching theory and practical lessons**<br>• Translating drawings into practical work<br>• Lack of integration and proper progression of graphic communication skills from senior phase (Grade 8 and 9) to FET phase (Grade 10-12)<br>• Lack of adequate tools and machinery to conduct practical activities.<br>• Learners' misconceptions on site plans, floor plans, calculations of perimeter, area of site and proposed building. |
| Why? | **Factors that constrain teaching of graphic communication**<br>• Lack of drawing equipment, time constraint, learners' lack of motivation with the subject, teachers' workload, access to internet |

| | |
|---|---|
| | • Use of CAD software in teaching 2D and 3D drawing |

**Source: Author**

Analysis of data collated to answer research question one elucidates that grade 11 CT teachers in uMgungundlovu district use different teaching and learning strategies when teaching graphic communication. The teaching and learning instructional methods include chalkboard illustration or demonstration, explanation of concepts and field excursions, and learners drawing and making projects to link theory and the practical. The findings show that although CT teachers have knowledge of different instructional methods, most of the teachers seldom practice the pedagogical skills of integrating different instructional methods to optimise their teaching and learning of graphic communications skills in a way that promotes active learning. Predominantly, CT teachers rely on chalkboard illustrations and demonstrations of drawing techniques on the chalkboard while learners watch and observe; subsequently, learners are given the opportunity to practice or replicate the drawings. The chalkboard illustration and demonstration appears to be the conventional pedagogical strategies for teaching graphic communication as some teachers perceive graphic communication as merely drawing. They lack the didactic and pedagogical skills of diversifying the instructional methods and integrating teaching and learning strategies to merge the drawing techniques with practical illustration, through making models and simulations of what is drawn as a way of reinforcing learners' understanding and promoting active learning. Graphic communication skills are underpinned by spatial visualization ability. Spatial visualization includes the ability to understand how objects appear in different positions as presented through drawings or graphical text, the ability to conceptualise how objects relate to each other, and the ability to visualize mental rotation of objects in 2D and 3D space (Singh-Pillay and Sotsaka, 2020). Therefore, the integration of different instructional methods of teaching and learning graphic communication helps learners to make the connection between abstract drawing concepts and real-life objects, as they manipulate materials and tools to make models and simulations of building construction structures from the drawings made in class.

Findings from this study indicate that CT teachers engage their learners in graphic communication lessons in four ways, namely: individual drawing activities completed in class; group discussions and activities; use of digital projector to show videos and pictures; and individual drawing activities coupled with making models, simulations and enrichment exercises outside the classroom. However, some shortcomings that impede the promotion of active learning when teaching graphic communication were identified from the study in relation to teachers' classroom practices and learner engagement. The findings of this study reveal that the preparation for graphic communication lessons for both theory and practical lessons is seldom done, with some teachers even admitting that they do not use lesson plans at all because of their experience in teaching the subject, and also because no one monitors the lesson plans. This suggests that teachers use a casual approach to their teaching of graphic communication. Their approach lacks an amalgam of content and pedagogy in identifying and organising distinct parts of knowledge for teaching, methods of presenting the content and skills in a way that is understandable to learners using illustrations, analogies, explanations, demonstrations, and use of projects and simulations (Almeida, 2019). Teachers need to have a thorough knowledge of the subject that they teach, comprehend what facilitates or hinders the learning of specific content, and effectively plan for their lesson in a way that would elicit learners' knowledge and promote active learning of graphic communication. From the few lesson plans that were available for observation and analysis, findings show that there is little or no planning for graphic communication lessons. Most teachers use a prescribed lesson plan template, which they pay very little attention to in terms of how they engage learners actively in the learning of graphic communication concepts. The lesson plan is designed and structured in such a way that as they plan for the lesson, teachers need to think and specify the type of written activities and enrichment exercises that learners will be engaged in, ranging from worksheets, notes, drawings, practical tasks and prior reading. It is important to note that from the three lesson plan portfolios observed and analysed, only one teacher precisely outlined their plan of action, detailing the drawing activities that learners are expected to complete, and the related practical task of building a semi-circular arch in English bond using bricks and the centre piece – showing an integration of instructional methods and learning strategies to reinforce learners' understanding of graphic communication. The other two teachers' lesson plan portfolios were not explicit about their plan of action regarding learner engagement on assessment activities and enrichment tasks to promote active learning, except to follow the prescribed content on the lesson plan template. The rest of the teachers were reluctant to avail their lesson plan portfolios, which is likely an indication that they do not plan for their graphic communication lessons.

Data analysis for research question two reveals that all eight grade 11 CT teachers encounter challenges that impede their practices of promoting active learning during the teaching of graphic communication. CT teachers encounter challenges when teaching graphic communication and they also experience learners' misconceptions with regards to drawing and interpretation of site plans, floor plans, calculations of perimeter and area of site, and proposed building, as presented on drawings.

The challenges that CT teachers are faced with emanate from a combination of contextual factors. These are linked to: lack of drawing equipment; under-resourced workshops that lack tools and machinery to conduct practical activities, projects and simulations; lack of access to modern technology like internet, computer infrastructure and software to aid spatial visualization and the teaching of graphic communication skills such as 2D and 3D drawing techniques; learners' disinclination and lack of motivation with the aspect of drawing and calculations embedded in graphic communication; insufficient time to cover content in-depth and too much workload for teachers, characterised by teaching multiple subjects and managing oversized classes.

The theoretical framework that guided this study was underpinned by Stronge's (2018) qualities of effective teaching. Stronge (2018) argues that students' achievement profoundly pivots on the teachers' effectiveness to deliver the subject content and leave imprints of knowledge on their students. While I was working with Stronge's qualities of effective teaching to explore how CT teachers promote active learning when teaching graphic communication, other factors emerged from my research findings that have implications for teachers' effective teaching apart from what Stronge highlighted. My research findings are juxtaposed with Stronge's qualities of effective teaching, as depicted in Figure 5.2.

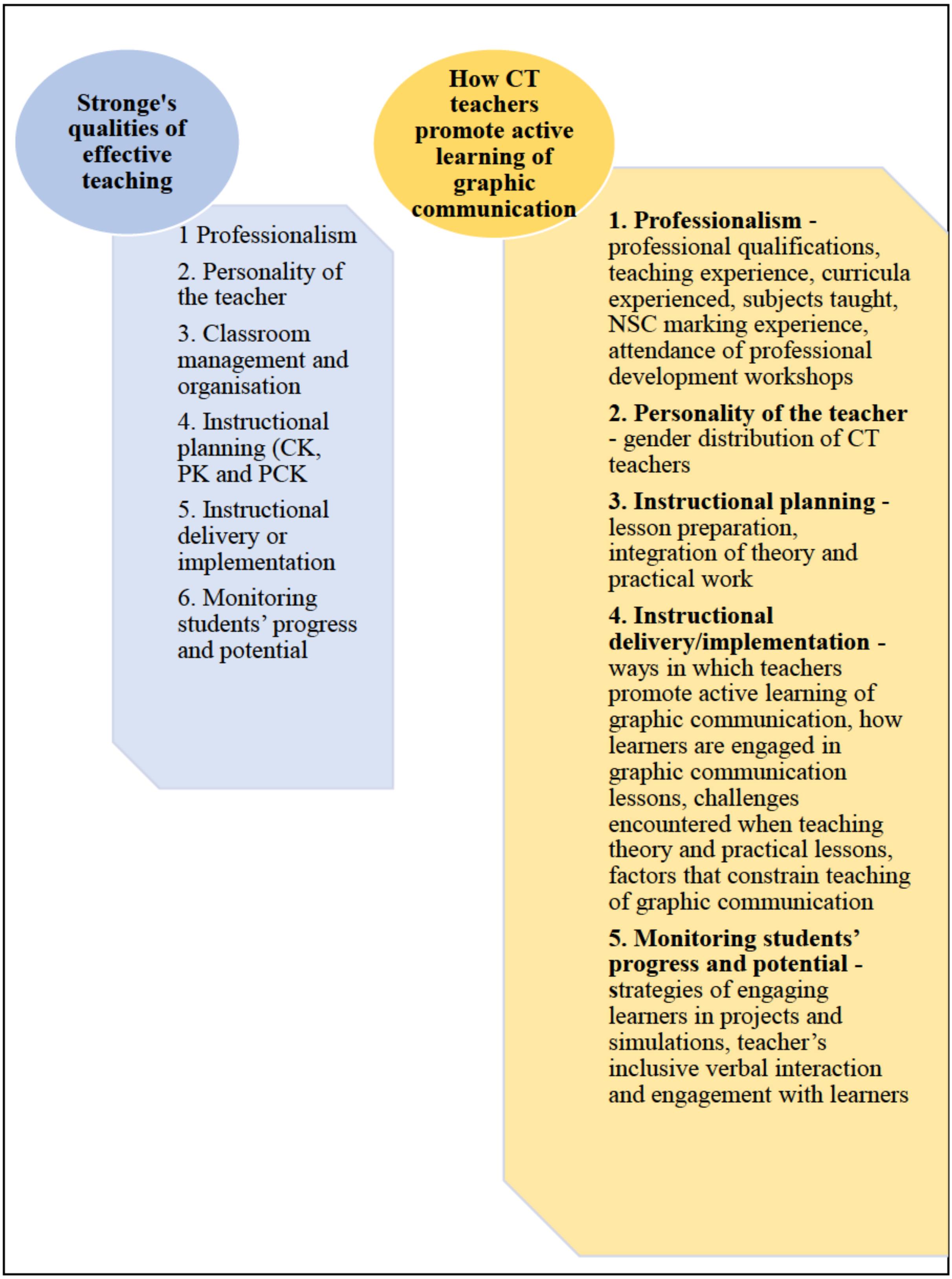


**Figure 5.1 Juxtaposition of Stronge's qualities of effective teaching with CT teachers' practices of promoting active learning of graphic communication**

Source: Author's own drawing

Stronge's (2018) findings on qualities of effective teachers are limited to characteristics of teacher responsibilities and behaviour that teachers exhibit with regard to planning and delivery of the lesson, as determinants of their effectiveness in the classroom and ultimately how these responsibilities and behaviour impact on learners' achievement. However, based on my research findings, I found that there is a gap that exists in defining teachers' effectiveness in the classroom. That gap needs to be addressed and included in defining qualities of effective teachers, in order to find ways to provide the necessary support that enables them to be effective teachers that promote active learning as they enact the curriculum. It emerged from my research findings that there are contextual factors that present as challenges and constrain effective teaching of graphic communication. These include lack of provision of resources such as internet and CAD software for teaching 2D and 3D drawing, lack of support from the parent component in providing learning resources like drawing equipment, and time constraints for teachers. CT teachers pointed out that it is virtually impossible to effectively conduct practical activities during the school time allocation for CT; instead, they create extra time outside the school hours in order to conduct practical lessons. This signals that the processes of curriculum policy formulation lacks coordination with the realities of policy implementation in the classroom, and this has implications for teachers' classroom practices. As such, the contextual factors that affect the process of teaching and learning cannot be overlooked because they have implications for the effective delivery of the curriculum.

In this chapter I reflect on the implications of this study. I also outline recommendations for appropriate teacher professional development interventions, based on the findings from the study. I also present suggestions for further research.

## 5.3 Implications of the study

### 5.3.1 Professional development and ongoing support

Continuous professional teacher development (CPTD) intervention programmes for in-service teachers should be on an on-going basis, considering the fact that technology education in South African has undergone and is still likely to experience further curriculum reforms in pursuit of improving the education system to match the demands of industry and society. Thus it is particularly crucial for CT teachers to upgrade and reinforce their content knowledge, specifically conceptual and procedural knowledge in graphic communication. Biographical data from this study elucidates that CT teachers' qualifications vary, from a technical teacher qualification with a junior secondary diploma, a diploma in education, a higher diploma in education to a bachelor of education degree in a CT related area, with some qualifying as tradesmen or artisans. Their profiles show that they have formal training as teachers of technical subjects; however, having these qualifications does not confirm their ability to teach graphic communication. CT teachers indicated their participation in short 'just in time' professional development workshop, but little has been established on how effective the training sessions are to equip teachers with adequate knowledge to handle situations and challenges arising in the classroom. On that note, teachers need continuous professional development intervention programmes that provide intensive training and in-depth understanding of graphic communication concepts and techniques of how to teach the drawing skills and enhance the teacher's pedagogical skills and classroom practices.

### 5.3.2 Reflective practices

The impact teachers have on their learners' achievement is anchored on the teacher's PCK, their responsibilities and behaviour as classroom practitioners, and their reflective practices in relation to their core pedagogical values and beliefs, on an ongoing basis (Benade, 2015; Stronge, 2018). Teachers need to engage in reflective teaching where they proactively think about their teaching strategies as they plan for their lessons, be open to new ideas and teaching methods, realign themselves with new knowledge and contemporary skills, and develop such skills sets in their learners. Teaching and learning that prepares young people for engaging in a complex and dynamic world should be reflective and develop appropriate skills and competencies that are sustainable for lifelong learning and employability (Benade, 2015).

## 5.4 Recommendations for classroom practice

Having established different challenges that CT teachers encounter in promoting active learning when teaching graphic communication in uMgungundlovu district in KwaZulu-Natal, I recommend that DBE review the 'just in time' CPTD intervention programmes that they currently offer to CT teachers, evaluate the effectiveness of the programme, and rather increase the frequency of training to cater for the novice teachers coming into the system. DBE should consider conducting needs assessment for poor under-resourced rural schools in uMgungundlovu district and engage and liaise with private sector/companies to fund the construction of technology workshops, and provide machinery, tools and equipment, and computer labs, to alleviate the problem of lack of resource for conducting CT practical activities. Some private companies are willing to engage in community development programmes through assisting needy schools upon request. Additionally, CAPS recommends the use of ICT applications for teaching and learning, particularly the use of CAD software for teaching CT (DBE Civil Technology CAPS, 2014, p.15). Therefore, I recommend that the use of CAD software for teaching graphic communication in schools be prioritised, considering that learners need to exit the school system with the right mix of skills and technical competencies that are sustainable for employability (Ismail, 2019). This idea resonates with Mtshali (2020), who argues that the technology education curriculum focus and delivery in South Africa needs to be realigned; it needs to provide skilling, reskilling and upskilling of teachers, and be responsive to the needs of the fourth industrial revolution. Teachers need strong support from the relevant support structures within the school community, and these include school management, the school governing body, parents and subject advisors. Parents need to be conscientized to take their responsibility of providing learning material for their children, to mitigate the problem of lack of drawing equipment for teaching and learning of graphic communication. I also recommend that teachers organise and engage in peer teacher learning discussions or meetings that are conducted in a collegial atmosphere, within their clusters, to share their experiences, challenges and ideas on how best they can teach graphic communication, rather than just meeting for moderation purposes only.

## 5.5 Recommendations for further research

Further research should be conducted to ascertain the effectiveness and relevance of current teacher training programmes for in-service CT teachers in South Africa. Research should be conducted to establish if organisers of the current CPTD programmes evaluate and engage with teachers to find out CT curriculum content that poses implementation challenges in the classroom, so that they draw their professional development training programmes inclusively and pay attention to problematic areas – such as graphic communication that is persistently proving to be poorly performed by learners. The frequency and effectiveness of CT 'just in time' professional development workshops should be further researched to establish their efficacy in equipping teachers to handle graphic communication concepts and achieve intended learning outcomes. This study should involve relevant actors in curriculum policy reform and implementation, such as subject teachers, subject advisors, subject specialists and curriculum designers to allow for proper coordination and successful implementation of curriculum reforms.

## 5.6 Conclusion

The findings of the study reveal that grade 11 CT teachers do encounter challenges when promoting active learning during teaching of graphic communication lessons. These challenges relate to their classroom practices and some contextual factors that require support and external intervention in order to successfully achieve learning outcomes. In order to improve the implementation of CT curriculum and ensure that learning outcomes are successfully achieved in the teaching and learning of graphic communication, the challenges identified can be mitigated by putting in place intervention programmes aimed at upgrading and improving teachers' pedagogical knowledge and subject matter knowledge in graphic communication on an ongoing basis. The DBE and schools must make concerted efforts to source all relevant resources required to successfully teach practical subjects such as CT.

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# APPENDICES:

## A1: ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

05 September 2021

Mrs Sithembile Hove (219095250)
School Of Education
Edgewood Campus

Dear Mrs Hove,

**Protocol reference number:** HSSREC/00003011/2021
**Project title:** An exploration of grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic communication: A case study of the uMgungundlovu district
**Degree:** Masters

### Approval Notification – Expedited Application

This letter serves to notify you that your application received on 11 July 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

**Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.**

<u>This approval is valid until 05 September 2022.</u>
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

---------------------------------------

**Professor Dipane Hlalele (Chair)**

/dd

**Humanities and Social Sciences Research Ethics Committee**
**Postal Address:** Private Bag X54001, Durban, 4000, South Africa
**Telephone:** +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

INSPIRING GREATNESS

## A2: EDITING CERTIFICATE

6 July 2022

Re: Editing of Master's thesis

This letter confirms that the following Master's thesis by Sithembile Hove was edited: **AN EXPLORATION OF GRADE 11 CIVIL TECHNOLOGY TEACHERS' PRACTICE OF PROMOTING ACTIVE LEARNING DURING TEACHING OF GRAPHIC COMMUNICATION: A CASE STUDY OF THE UMGUNGUNDLOVU DISTRICT**.

Cordially

[redacted]

Dr Karen Buckenham (PhD)

kbuckenham@mweb.co.za

## A3: TURN IT IN CERTIFICATE

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# Turnitin Originality Report

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**B1: CONSENT LETTER**

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

23 January 2021

Dear prospective participant

**INFORMED CONSENT LETTER**

My name is Sithembile Hove, I am a registered Masters student at the University of KwaZulu-Natal Edgewood campus, in the Science and Technology Education cluster. I am pursuing a masters study conducting a research entitled: **Grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic Communication: A case study of the uMgungundlovu district. The aim and purpose of the research** is to understand grade 11 Civil technology teachers' practice on teaching of graphic communication and possibly, improve the quality and style of teaching this particular section of the subject.

You are being invited to consider participating in this study. There are no potential risks associated with your participation in this study. Should you agree to participate in this study, data will be generated from you using individual interviews, questionnaire, focus group interviews, recorded lesson on teaching graphic communication and past lesson plans for theory and practical lessons on graphic communication via online platforms such as Zoom, emails and WhatsApp. Please note that data collection will not disrupt the normal teaching and learning activities since it will be done during times flexible and convenient to you. The duration of your participation is expected to be approximately 90 minutes (1 Hour 30mins), split into individual interview (35 minutes), focus group interview (45 minutes) and completion of questionnaire (15 minutes). The data will be generated on separate days at times that are convenient to you. The online questionnaires will be emailed to you for completion a week prior to the agreed upon schedule interview.

I am also requesting your permission to audio record individual interviews and video record focus group interviews to allow me to concentrate on the interview rather than focusing on writing voluminous notes.

**PLEASE TAKE NOTE OF THE FOLLOWING:**

- All information obtained in connection with this study will be treated with strict confidentiality and pseudonyms will be used; participants are therefore assured they will remain anonymous.
- Any information you provide towards the study cannot be used against you.
- Participation is voluntary; therefore, you are free to withdraw at any time you so wish without incurring any prejudice or penalty for such action.
- There will be no financial benefits that participants may enjoy as a result of their participation.
- Only the researcher directly associated with this study will have access to this information for the purpose of data analysis during the study.

In the event of any problems, concerns or questions, please do not hesitate to contact me or my supervisor for more information or clarity regarding the study. My contact details: Cell **071 783 3236**, email: thembiefish@gmail.com OR my supervisor Dr A. Singh-Pillay, Academic Leader B Ed Programme, Senior Lecturer Technology Education, Edgewood Campus, University of KwaZulu-Natal. Tel: 031-2603672

email: pillaya5@ukzn.ac.za

**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**
**Research Office, Westville Campus**
**Govan Mbeki Building**
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Thank you for your support and contribution to this research.

Yours sincerely

Sithembile Hove (Researcher)

## B2: PERMISSION TO CONDUCT RESEARCH

### B2-1

EDENDALE TECHNICAL HIGH SCHOOL

**Phone/Fax (033) 3995506**
**E-mail:** edendaletechhighschool@yahoo.com

**P.O.Box 225**
**Edendale**
**3217**

25 Septermber 2020

**TO WHOM IT MAY CONCERN**

This serve to confirm that Mrs Sthembile Hove is granted permission to conduct her research on Senior Phase classes on matters related to Civil Technology. Mr Marshal Chimombe is going to work with her for the duration of the study.

Thank you

[redacted]

Mr T.F. Ngubane
**PRINCIPAL**

EDENDALE TECHNICAL HIGH SCHOOL
2020 -09- 25
PHONE/FAX 033 39...
P.O. BOX 225 - EDENDALE - 3217

Principal: Mr T.F Ngubane Deputy: Mrs N.J Mdletshe Deputy: Mr P.D.Njokwe

**B2-2**

# Gobindlovu comprehensive High School

POSTAL ADDRESS
P.O.BOX 44058
ELANDSKOP
3226

TELEPHONE/FAX
033 936 1964

PHYSICAL ADDRESS
D123 SERVONTEIN PRISON ROAD
ELANDSKOP
3226

CELL NUMBER
082 404 2587

WORK & PRAY TO SUCCEED

28 August 2020

Dear Ms Sithembile Hove

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Permission is hereby granted for you to conduct research at Gobindlovu Comp. High School on your research topic: **Grade 11 Civil Technology.**

I would like to wish you good luck in your studies

Yours faithful

KZN DEPARTMENT OF EDUCATION & CULTURE
GOBINDLOVU SECONDARY SCHOOL

[redacted] 020

SKOP 3226

Mr Nkabini M.J.
Principal

SIGN:

**B2-3**

# Ikusaselihle High School


STREET ADDRESS
1532 Unit EE
IMBALI
3219
Email: ikusaselihlehighschool@gmail.com
Tel: 081 5188 137
Enq: ZDS Dlamini

POSTAL ADDRESS
P.O.Box 3574
Pietermaritzburg
3200
emis no.: 500181818
Fax: 086 231 6868
Principal: E.T.Kwanini


To : Ms Sthembile Hove

From : Ikusaselihle High School

Date : 03 September 2020

Subject: **PERMISSION FOR THE CONDUCTION OF RESEARCH**

Dear Sir

The above subject has reference. This letter seeks to respond in to your letter you have sent to the school.

We are granting you a permission to conduct research/interviews with learners, educators and management of the above named institution.
We are not just permitting you, but also with an aim to assist the school for more information in a form of reporting in to the school with the recommendations if possible.

We wish you all the best for you Master's Degree.

For further information and arrangements, please contact Mr ZDS Dlamini (072 610 1987/ 081 275 1782)

[redacted]

Dlamini ZDS (Deputy Headmaster-**Academic Affairs**)

[redacted]

DEPARTMENT OF EDUCATION
IKUSASELIHLE HIGH SCHOOL
2020 -09- 03
P.O. BOX 3574 • P.M.BURG 3200
TEL/FAX : 033 - 321 0009

**B2-4**

Linpark High School

Tel (033) 3441544/3441545
P O Box 21477
Fax (033) 3442219
Mayors Walk
3208
principal@lhspmb.co.za

27 August 2020

Dear Ms Sithembile Hove

REQUEST FOR PREMISSION TO CONDUCT RESEARCH

Permission is hereby granted for you to conduct research at Linpark High School on your research topic: **Grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic Communication theory and practical lessons: A case study of the uMgungundlovu district.**

I would like to wish you good luck in your studies.

Yours faithfully

[redacted]

**Mr. A. Mangalparsad**
Principal

THE PRINCIPAL
Linpark High School
Pietermaritzburg
Tel.: 033 3441544/3441545
Fax.: 033 3442219
Email: info@linparkadmin.co.za

**B2-5**

**M.L. SULTAN (PMB) SECONDARY SCHOOL**
8 Dr Chota Motala Road
Pietermaritzburg
**Postal Address:**
P.O. Box 8337
Cumberwood
3235

Telephone / fax: (033) 3420039
Fax to email: 0866353757
email: mlsultan@telkomsa.net

For Attention: Mrs S. Hove
317 Alexandra Road
Pelham
Pietermaritzburg
3201

26 August 2020

Mam,

**RE: Request to Conduct Research at M.L. Sultan (PMB) Secondary**

I, Mr P. Sha grant Mrs S. Hove permission to conduct research at the above-mentioned school. It is envisaged that you will conduct your research with professionalism and integrity while observing confidentiality of your subjects.

Congratulations on your study and I wish you every success in your research.

Yours in education

[redacted]

P. Sha
Principal

DEPARTMENT OF EDUCATION & CULTURE
M.L. SULTAN (P.M.BURG)
SECONDARY SCHOOL
26 AUG 2020
P.O. BOX 8337, CUMBERWOOD 3235
PROVINCE OF KWA-ZULU NATAL

**B2-6**

**KZN Department of Education**

*uMnyango: weMfundo*

**ISIFUNDAZWE SAKWAZULU-NATALI**

Address: Mthuli Secondary School
P.O Box 187
Ozwathini
3242
Tel : 081 483 4402
Fax : None
Enquiries: Sishi SB

Dear Mrs S.Hove

We the undersigned received your letter dated 06 August 2020.

We are glad to inform you that your request is successful. You are free to conduct your research.

We are looking forward to seeing you very soon.

Yours in service

[redacted]

S.B. SISHI
PRINCIPAL

[redacted]

B.F. KHUMALO
SGB CHAIRPERSON

[redacted]

L.S. MATHIYA
SGB TREASURER

SCHOOL
P.O.Box 187
OZWATHINI
3242
Date:

MTHULI SECONDARY SCHOOL
P.O.Box 187
OZWATHINI
3242
Date: 26-08-20

**B2-7**

# NGCEDOMHLOPHE HIGH SCHOOL

STRIVE FOR EXCELLENCE

**RE- ACCEPTANCE OF MS SITHEMBILE HOVE'S REQUEST**

Kindly be informed that your request on a letter dated 06-08-2020 is accepted.

The school management team wishes your success on this research which we think will help our schools to progress

Thank you

Yours faithfully

[redacted]-----------

M.K. Mnikathi (Acting Principal)

B2-8

**ZIBUKEZULU TECHNICAL HIGH SCHOOL**


FJ SITHOLE
IMBALI
3219

PO BOX 29260
IMBALI
3219

TEL:033 3272014


27 August, 2020

Dear Ms Sithembile Hove

REQUEST FOR PREMISSION TO CONDUCT RESEARCH

Permission is hereby granted for you to conduct research at Zibukezulu Technical High School on your research topic: **Grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic Communication theory and practical lessons: a case study of the uMgungundlovu district.**

I would like to wish you good luck in your studies.

Yours faithfully

[redacted]

Mr C.J Madlala
pp Pri[redacted]l

DEPARTMENT OF EDUCATION
ZIBUKEZULU TECHNICAL HIGH SCHOOL
26 -08- 2020
P.O. BOX 29260 ... 3219
...EPHONE: 033 ... 327 2014

## B3: TEACHERS' INFORMED CONSENT LETTER

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

23 January 2021

Dear prospective participant

**INFORMED CONSENT LETTER**

My name is Sithembile Hove, I am a registered Master's student at the University of KwaZulu-Natal Edgewood campus, in the Science and Technology Education cluster. I am pursuing a master's study conducting a research entitled: **Grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic Communication: A case study of the uMgungundlovu district. The aim and purpose of the research** is to understand grade 11 Civil technology teachers' practice on teaching of graphic communication and possibly, improve the quality and style of teaching this particular section of the subject.

You are being invited to consider participating in this study. There are no potential risks associated with your participation in this study. Should you agree to participate in this study, data will be generated from you using individual interviews, questionnaire, focus group interviews, recorded lesson on teaching graphic communication and past lesson plans for theory and practical lessons on graphic communication via online platforms such as Zoom, emails and WhatsApp. Please note that data collection will not disrupt the normal teaching and learning activities since it will be done during times flexible and convenient to you. The duration of your participation is expected to be approximately 90 minutes (1 Hour 30mins), split into individual interview (35 minutes), focus group interview (45 minutes) and completion of questionnaire (15 minutes). The data will be generated on separate days at times that are convenient to you. The online questionnaires will be emailed to you for completion a week prior to the agreed upon schedule interview.

I am also requesting for your permission to audio record individual interviews and video record focus group interviews to allow me to concentrate on the interview rather than focusing on writing voluminous notes.

**PLEASE TAKE NOTE OF THE FOLLOWING:**

- All information obtained in connection with this study will be treated with strict confidentiality and pseudonyms will be used, participants are therefore assured they will remain anonymous.
- Any information you provide towards the study cannot be used against you.
- Participation is voluntary; therefore, you are free to withdraw at any time you so wish without incurring any prejudice or penalty for such action.
- There will be no financial benefits that participants may enjoy as a result of their participation.
- Only the researcher directly associated with this study will have access to this information for the purpose of data analysis during the study.

In the event of any problems, concerns or questions, please do not hesitate to contact me or my supervisor for more information or clarity regarding the study. My contact details: Cell **071 783 3236**, email: thembiefish@gmail.com OR my supervisor Dr A. Singh-Pillay, Academic Leader B Ed Programme, Senior Lecturer Technology Education, Edgewood Campus, University of KwaZulu-Natal. Tel: 031-2603672

email: pillaya5@ukzn.ac.za

**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**
**Research Office, Westville Campus**
**Govan Mbeki Building**
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Thank you for your support and contribution to this research.

Yours sincerely

Sithembile Hove (Researcher)

**CONSENT FORM**

I ………………………………………………………………. have been informed about the study entitled: **An exploration of grade 11 Civil Technology teachers' practice of promoting active learning during teaching of Graphic Communication: A case study of the uMgungundlovu district** by Sithembile Hove (Researcher). I understand the purpose and procedures of the study. I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to. If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at Cell: **071 873 3236** or email: thembiefish@gmail.com. If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researcher then I may contact:

**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**

**Research Office, Westville Campus**

**Govan Mbeki Building**

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

**Additional consent**

I hereby provide consent to:

Audio-record my interview / focus group discussion YES / NO

Video-record my interview / focus group discussion YES / NO

Use of my recorded lessons for research purposes YES / NO

_________________________ _______________________

**Signature of Participant** **Date**

_________________________ _______________________

**Signature of Witness** **Date**

## C1: QUESTIONNAIRE

**Instrument 1.**

### Questionnaire

**Please complete the information below:**

**Show by means of a tick (✓) in the relevant space and furnish with details where necessary.**

| | | | | |
|---|---|---|---|---|
| Personal attributes | | | | |
| Gender: | Male | Female | | |
| General Teaching Experience (No of years) | 0 - 9 | 10 - 19 | 20+ | |
| Civil Technology teaching experience (No of years) | 0 - 5 | 6 - 9 | 10+ | |
| Professional qualifications: | | | | |
| Marking experience:<br>Have you ever been appointed to mark NSC Grade 12 Civil Technology Examinations? (No of years) | 1 - 3 | 4 - 6 | 7+ | None |
| Nature of appointment:<br><br>Are you on permanent or temporary appointment? | Permanent | Temporary | | |
| Level on which you are employed:<br>e.g. Post level 1 Educator | Post level 1 | Post level 2 (HOD) | Post level 3 (Deputy principal) | Post level 4 (Principal) |
| **Other subjects taught:**<br><br>Do you teach any other subjects? Please list them | | | | |
| Have you attended any professional development workshops for Civil Technology? Please provide a brief outline about the content and duration of training | | | | |

| | |
|---|---|
| **Workshop, machinery and maintenance:**<br><br>Do you have a dedicated workshop with tools and equipment to conduct practical lessons? Please highlight types of machinery available | |
| Do you have an assistant that helps with servicing and maintenance of machinery? Briefly outline some of their duties | |
| **Workload:**<br><br>How many periods of Civil Technology do you teach per week? | |

How do you teach graphic communication? Please explain

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

What do you do to promote active learning during the teaching of graphic communication?

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

How do learners respond to your teaching strategies in terms of: learning styles, understanding of concepts, academic performance, classroom management? Please elaborate on each aspect

Learning style:_______________________________________________

_______________________________________________

_______________________________________________

Understanding of concepts/content:_______________________________________________

_______________________________________________

_______________________________________________

Academic performance:____________________________________________________________________

Classroom management:____________________________________________________________________

Do you feel you are adequately equipped in terms of content knowledge to teach graphic communication? If yes, please elaborate, if no please elaborate what aspect/s you need help with

What is the common misconception/problem areas learners' encounter with graphic communication? Please elaborate

What enables your teaching of graphic communication?

What constrains your teaching of graphic communication?

**C2: SEMI-STRUCTURED INDIVIDUAL INTERVIEW SCHEDULE**

**Instrument 2.**

## Interview schedule:

Semi-structured interview questions designed for Civil Technology Educators to be conducted via WhatsApp video call for a duration of approximately 30 minutes.

1. In brief, can you discuss your understanding of graphic communication in the context of Civil Technology.
2. What is the significance of graphic communication in Civil Technology?
3. Reflecting on your civil technology CAPS curriculum, what is your point of view on the theoretical knowledge and practical skills that learners are expected to acquire from teaching and learning of graphic communication?
4. Can you discuss your approach in teaching graphic communication (Elaborate on the practices and methods you use to make sure your learners understand the drawing concepts you teach for example 2D and 3D drawing)?
5. Besides the textbook, what other resources do you use to teach graphic communication to enhance learners understanding?
6. How do you merge the theory of drawing with practical illustration of the concepts to facilitate learners' understanding? Elaborate by giving examples
7. According to your timetable, how many lessons or hours do you allocate for practical activity per week?
8. Do your learners' make models or simulations to illustrate the building components drawn in class? Can you further explain by giving examples?
9. Can you identify any contextual factors that you consider as obstructions to your effective teaching of graphic communication?
10. Do you think you need refresher courses to improve your knowledge and skills and learn about new developments related to graphic communication in line with current demands of industry?

Thank you for your input and time you spent.

## C3: FOCUS GROUP INTERVIEW

**Instrument 3.**

### Focus group Interview schedule

Focus group interview questions designed for Civil Technology Educators to be conducted via zoom meetings for a duration of approximately 45 minutes to 1 hour.

1. What is your opinion on teaching and assessing of site plan, elevations and floor plan analysis including calculation of perimeter and area of site and proposed building? Can you highlight learners' misconceptions on these aspects?
2. Do you enjoy teaching and assessing learners in this section? Please clarify
3. In your view what are the learners' strength in graphic communication concepts?
4. What would you cite as learners 'misconceptions and weaknesses in relation to 2D and 3D drawing, interpretation of drawings and correct use of conventional signs and symbols (SANS Code of drawing practices) in graphic communications?
5. What type of tasks or class activities (both theory and practical) do you engage your learners with, to reinforce their graphic communication skills?
6. Do you use CAD Software to aid your teaching of 2D and 3D drawing besides manually drawing and demonstrating on the chalkboard? If yes, explain its benefit in your teaching and enhancing learners' understanding.
7. How would you evaluate the graphic communication skills acquired by grade 12 learners as they exit the school system as prescribed by the CAPS curriculum? Are they at a competitive advantage to engage in related careers, venture into entrepreneurship or advance in further studies in different engineering fields with ease?
8. Drawing from your experience of teaching graphic communication, what challenges do you encounter when teaching both theory and practical lessons?
9. How do you think these challenges can be mitigated?
10. What kind of intervention or support would you expect from your subject advisor or colleagues towards improvement of your teaching of graphic communication in terms of curriculum expectations, your teaching practices and learner engagement?

Thank you for your input and time you spent.

**D1: QUESTIONNAIRE RESPONSES**

**I :** How do you teach graphic communication? Please Explain

**T A:** Demonstration and classroom activities using textbooks.

**T B:** I introduce drawing as language of symbols and conventions, understood by any speaker of any language with the basic understanding of these symbols. Learners are asked to learn the symbols in response to the need to communicate a certain thing for example a floor plan where the symbols they need are taken as instructions to a builder.

**T C:** I start with use of drawing equipment, interpreting and drawing symbols, basic freehand drawing of orthographic and isometric projection, use of models to develop perception, introduction of scale, then move on to instrument drawing.

**T D:** I demonstrate the correct techniques to draw to scale different types of drawings. I explain the techniques used to draw freehand sketches. I ensure that learners adhere to SANS requirements when drawing floor plans.

**T E:** Using drawing equipment which include drawing board, set squares, resource materials provided by department of education, etc

**T F:** Graphic communication is incorporated in every lesson that has some drawings. I always emphasise the use of isometric drawing and highlight the use of correct convention lines when drawing. So in most times I explain whilst doing some rough sketches on the board. I also demonstrate and do scale drawings while they are watching and give them a chance to correct some mistakes made on purpose.

**T G:** I elaborate graphic communication as a language of communication between architect and contractors.

**T H:** By using traditional techniques which involves the use of technical drawing equipment

**I :** What do you do to promote active learning during teaching of graphic communication?

**T A:** Through learner demonstration of activities on white board and group activities and feedback.

**T B:** Learners must do, draw actively in the lesson. They are expected to research sizes of things like baths and showers, variations in materials and the hatching used, and other ways to relate the drawing to the physical world they inhabit

**T C:** Making of projects and models, linking theoretical aspects with practicals

**T D:** I use videos and photographs to promote active learning. Learners discussions

**T E:** I engage learners with activities which include everyday life like building plans, machinery etc.

**T F:** In the presence of a digital projector, I prefer showing learners real pictures to show different methods of graphic communication. I give them tasks and motivate them by positive reinforcement where they perform well and correct positively where they make mistakes.

**T G:** I mostly take my learners to the part of a school where I can show the actual object that has been drawn in the diagram.

**T H:** Graphic communication give learners control of the content and liberates them to see different relationships between pictures and words, which stimulates their critical thinking in multiple dimensions.

**I :** Do you feel you are adequately equipped in terms of knowledge to teach graphic communication. If yes, please elaborate. What aspects do you need help with?

**T A:** Since my learners also do EGD as a subject, I would say we are not that badly equipped.

**T B:** After 30 years of teaching Technical drawing and EGD, I think I have adequate subject knowledge to teach content required in civil technology.

**T C:** Yes, teaching comes with experience.

**T D:** No, graphic communication has advanced. I only know how to teach learners using drawing instruments and freehand drawing. I need to learn how to draw using computer.

**T E:** No, since technology is constantly improving and evolving everyday

**T F:** I feel I am adequately equipped because I do not have any problems teaching the level of graphic communication in my learning area. however, I feel I need more knowledge on site plans.

**T G:** I am sufficiently equipped with hand and power tools. I would appreciate all the machinery that could make my life and work easier.

**T H:** No, I do feel that there are gaps that exist in my knowledge and skills. Although I am confident in my content knowledge; it would be best to read at least one content related article per month to stay sharp.

**I :** What are the common misconceptions/problem areas learners encounter with graphic communication? please elaborate.

**T A:** Maintaining a good scale throughout the assignment, pencil work and neatness.

**T B:** The same content is taught in the civil drawing component of EGD as in CT graphics module. The difference in detail needed for EGD and CT are confusing to the learners, and justifiably so, I feel that EGD syllabus ignores the fact that civil drawings are instructions to builders who generally can tell the differences between steel and wooden window frames for example. The EGD content can be simplified substantially without losing the ability to communicate. The simplicity of CT graphics is admirable and adequate.

**T C:** Learners do not see the drawing as a form of communicating an idea or thought. Orthographic projection-first angle or third angle placement of views in terms of imaginary planes

**T D:** Visual communication, learners are struggling to communicate ideas graphically.

**T E:** Do not co-relate with information gained in other subjects loke EGD

**T F:** The problem area is that learners at grade 10 level struggle with basic 3D isometric, oblique or perspective drawing.

**T G:** Scale drawings are sometimes difficult for learners to decode. They also fine it difficult to define some abbreviations.

**T H:** Some learners find it difficult to develop their spatial ability to visualise and this results in failing to make connections between drawing and the design of the product itself**.**

**I : What constrains your teaching of graphic communication?**

**T A:** There just not enough time

**T B:** Three things bother me. Firstly, the learners who conveniently forget their boards when this module is being taught. Secondly, the difference in detail required between Civil Technology and EGD in this regard. Thirdly, the question always asked, as to why this section has to be covered in both subjects, when all learners taking Civil Technology also take EGD.

**T C:** The lack of drawing equipment provided by both the school and parents.

**T D:** Teaching learners who are not interested, learners who do not have drawing instruments, and learners who are not exposed to graphic communication.

**T E:** Latest method to use like smart board, no internet, etc

**T F:** Most learners do not have the required drawing instruments.

**T G:** Learners who do not do their activity. They delay the lesson of the next day because they defeat the purpose of giving them the activity in the first place.

**T H:** Having to handle multiple roles in the classroom like updating the subject to new demands, collecting materials, content presentation as well as bringing new creative approaches to meet the present educational trends constrains my teaching of graphic communication.

## D2: INDIVIDUAL INTERVIEW RESPONSES

**I:** In brief can you discuss your understanding of graphic communication in the context of Civil Technology?

**T A**: Graphic design is a crucial tool that makes sure we communicate technical information in an efficient manner. it serves to deliver our message to the target audience as drawings and symbols.

**T B**: Graphic communication is the use of drawings and symbols to transfer information between two or more people, in a way that uses no, or a few words. This requires no translation, as long as the drawer and the reader understand the same set of symbols. In C Tech, we concentrate on house or building drawings, detailed drawings of various components of building practices, and template design for sheet metal work.

**T C**: Graphic communication conveys an idea or thought via a drawing or sketch to be interpreted by a skilled person to be made into reality. In the context of civil technology it refers to the built environment. Without a proper drawing or sketch with measurements we will not have a functional society. Imagine a society without roads, dams and fresh water supply

**T D**: I think the way I understand it is to communicate ideas graphically by using freehand drawing, drawing instruments and also computer aided drawing to make basic drawings related to building industry.

**T E**: The first thing I would say, graphic communication has a very important role in civil technology because most of the time they have this technological process which is applied in most cases. For example if the learner has to do a practical assessment task, so all the learner needs to do is to follow this technological process. This technological process is clearly giving a learner the direction to follow, so that is why when it comes to designing, that falls under graphic communication whereby the learner will be able to communicate his/her ideas into paper or into an article which will be something that is visible to everyone at the end of the day.

**T F**: Graphic communication is a way of showing or communicating ideas using drawings, sketches and symbols

**T G**: Graphics as means of communication to me is a language spoken by architects as well as contractors, because it integrates and bridges the gap form designing something to making something, because if one person design something they could be talking their own language, and contractors could be talking their own language. So we need graphics as means of communication to bridge the gap from designing to actually making what is required to be made or constructed

**T H**: Graphic communication is the universal language of the whole technical world where ideas are communicated visually through sketches and drawings. It is a tangible way for designers to develop, analyse and express or communicate technical ideas and designs effectively to others.

**I :** Can you discuss your approach in teaching graphic communication. (Elaborate on the practices and methods you use to make sure your learners understand the drawing concepts you teach, for example 2D and 3D drawing)

**T A:** I find the method of bringing a physical model to explain the different drawings/views quite effective

**T B:** I tend to emphasize the logic of drawing as a communication tool, and stick to the basic concepts. EGD is too hung up on details. For example, if a floor plan is an instruction to a builder, does that builder really need to see the dimensions of the window frame section? Isometric views have very little value in Civil Tech, unless explaining to a person unfamiliar with drawing practices. It is essential for the learners to appreciate the reason for, and usefulness of the drawing they produce, and not treat drawings as a mark collection exercise.

**T C:** Orthographic projection, be it 1$^{st}$ or 3$^{rd}$ angle, is taught using the plane system so that learners can visualise or conceptualise that every object has a specific place in space. Place an object within a model of the planes and show how the line of sight is projected on the various planes and subsequently how the planes are opened out to be represented in 2D. Pictorial views or 3D enhances perception. To teach to learners, start by showing the three axis and that the object is tilted. Fill in the views from the appropriate line of sight and project the lines parallel to the axis until the object is formed.

**T D:** First, I explain to learners' certain rules and regulations when it comes to graphic communication or drawing. For example, types of lines used when drawing, those things are very important. I really emphasize that because that's where graphic communication starts, once they lose that understanding you find they will be struggling to actually illustrate their information in drawing.

**T E:** As a teacher, I should be able to, in fact I draw for the learners on the board and show them this is a 2D and 3D drawing. They also practice that, the more we give them practice of different activities where they convert 3D objects to 2D working drawings of first angle orthographic projection, it makes them understand more because they are now interpreting drawings from 3D object to a 2D drawing.

**T H:** When I am introducing graphics as means of communication, I only associate the things that they know with their daily lives because graphics is everything that is around us. So I associate with something that they know and then they could see ukuthi this thing is this. The only thing I do usually is to explain to them the north direction, which is the direction how it works. Then the next thing is taking them out to see the views on the structure or building we are in, so they can see, Ok if we say this is the North point which one is the South elevation, which one is the East or West elevation regarding the building that we are in.

**I :** Besides the textbook, what other sources do you use to teach graphic communication to enhance learners' understanding.

**T A:** Models of structures

**T B:** Full size house plans, original blueprints, and lots of examples and sketches on the whiteboard.

**T C:** The use of models enhances understanding. The integration of practicals with theoretic knowledge is paramount.

**T D:** I use models, also computer and pictures. Using projector and pictures from the internet, also you-tube has a lot of isometric drawings and 2D

**T E:** I use a lot of house plans that I display in the workshop so that learners can see. I have not tried computers because of time and also lack of these computer resources. It is only my laptop that is available and using this one laptop on 60 learners is a challenge.

**T F:** I use a lot of internet to get even some activities which make learners to understand and also some activities that are a bit challenging for learners. even you-tube videos, I can download and show them in class.

**T G:** Apart from textbook, I use day to day examples. I let us say I am teaching learners about distance; I would then use perimeter as basically my example…..

**T H:** I use projectors. I download videos and put them on the projector so that learners can see.

**I :** How do you merge the theory of drawing with the practical illustration of the concepts to facilitate learners' understanding. Elaborate by giving examples**.**

**T A:** For example I can take the model of a house, and let learners draw the views from there having worked out a good scale.

**T B:** By knowing how much detail is required, how much information can be assumed by the reader, and by constant familiarity, for example of elevation naming by geographic direction, the use of conventional scales, and the placing of elevation in first angle projection.

**T C:** Ours is a very practical subject. If you are drawing a roof truss you get learners to make a roof truss. For simulations, learners lay bricks in the various designs. They are first asked to draw and then practically demonstrate how the bricks are laid to achieve a specific pattern.

**T D:** I teach learners theory, let us say to draw English bond, I demonstrate it using bricks to assimilate the wall by dry packing. In drawings, for example house plans, we use scale to draw any drawing. Once the learner understands how to draw the house plan then we apply that in practical and do a practical of it ……

**T E:** When you have taught a learner how to draw a plan, you can actually ask them to draw a small hose plan e.g. 3 roomed house plan, put dimensions, draw the elevations, the practically go outside and do the setting of the foundation. That is a very important aspect of civil technology. A learner once they learn graphic communication, they should be able to interpret it and bring the drawing onto the actual ground. That is how I merge theory and practical.

**T G:** I always use a house in this instance, I will tell them to draw a foundation (substructure), I explain a substructure is everything in a dwelling that you cannot see. I then ask them to draw a super structure. I will then relate to the building we see and occupy and tell them this is how we see the components and how they sit or are positioned.

**T H:** When I am introducing graphics as means of communication, I only associate the things that they know with their daily lives because graphics is everything that is around us. So I associate with something that they know and then they could see ukuthi this thing is this. The only thing I do usually is to explain to them the north direction, which is the direction how it works. Then the next thing is taking them out to see the views on the structure or building we are in, so they can see, Ok if we say this is the North point which one is the South elevation, which one is the East or West elevation regarding the building that we are in.

**I :** According to your timetable how many lessons or hours do you allocate for practical activity per week?

**T A:** None, we have to utilise weekends.

**T B:** This is very flexible, according to the section being covered. At times, theory takes all the lessons, at others we finish the drawings before moving on.

**T C:** A double lesson per week is allocated for practical work. The reality is that in all my years of teaching, practical work has been done outside of normal teaching time. The demands of the theory aspect does not allow for this.

**T D:** Unfortunately, practical lessons are not allocated on the timetable in my school. For grade 11 there 50 minutes per lesson x 4 lessons per week.

**T E:** We have 4 periods per week for CT. 2 hours practical every week and 2 hours for theory. If learners do not finish the task during the week, then they come over the weekend where they have enough time to finish their practical task. Most case we need extra 3 hours.

**T F:** Time allocated for practical work is 2 hours per week, but it is practically not feasible to complete practical activities. Practical need more time, so we end up using weekends for that.

**T G:** 4 hours is allocated for both theory and practical work. But it is difficult to complete practical activities in the time allocated

**T H:** 2 hours per week is allocated for practical. But more often there challenges completing the practical tasks within the allocated time. I usually arrange to meet learners on Saturdays for practical activities.

**I :** Do your learners make models or simulations to illustrate the building components drawn in class? Can you further explain by giving examples

**T A:** Yes. All PATs must be accompanied by elaborate drawings before construction.

**T B:** The learners no longer make useful models of components, except in their simulations and PAT requirements. In previous times, some very useful models were made, which are kept for demonstration purposes. Shoring, brick forms, truss shapes, septic tank cutaway models are some available.

**T C:** Yes. Laying bricks in the various designs. Learners are first asked to draw and then demonstrate practically.

**T D:** No they do not make any models. The problem is time and insufficient materials to do the models. I use my own model to explain to them, learners do not make any models.

**T E:** Yes they do. Learners make models and simulations of what we do in class.

**T F:** Yes if I am only referring to matriculants.

**T G:** Yes they do. A house mostly we draw to a certain scale.

**T H**: Yes learners make modes and simulations. For example attaching steel to concrete, sometimes they build brick piers using English or Stretcher bond.

**I :** Can you identify any contextual factors that you consider as obstructions to your effective teaching of graphic communication.

**T A:** The vast difference in cognitive behaviour among learners in the same class and trying to cater for them all in the limited time given.

**T B:** Learners really do not like EGD, and are forced to take it along with their choice of Civil Technology. This reluctance to embrace the subject spills over into C Tech, especially as there is a lot of duplication in the building drawing section.

**T C:** Learners do not bring proper drawing equipment. Budgetary constraints by the school in purchasing models. Time constraints.

**T D:** Learners are lacking information from previous classes. Remember that graphic communication does not start at grade 10, 11 and 12. As far as I know it is there in technology grade 8 and 9, that is where they are introduced to this graphic communication 2D and 3D. So now it is giving me problems in teaching because you need to start again introducing this graphic communication. You think learners know isometric for example, but you find that learners are confused they do not know what is isometric, talk about 3D, what is 3D?But I know very well that in technology grade 8 and 9 that is where they start the introduction of it. Another problem is that I teach in rural areas, and I have a workshop with only hand tools and no machinery. This forms part of the challenges when I want to do practical activities. My learners are not exposed to different things like construction machinery and modern-day construction processes unlike learners from suburbs who are more exposed where they see people doing construction, working on large construction projects."

**T E:** Lack of equipment, drawing boards, drawing benches, set squares etc make it very difficult to effectively teach graphic communication.

**T F:** Yes there are some contextual factors. Learners have a challenge of drawing instruments. They do not have adequate drawing equipment. We really need support from parents to organise drawing instruments for their children.

**T G:** Yes, language barrier. Our school has IsiZulu as home language. So sometimes you find you would have to go 3 steps ahead and 1 step back just to break down most or some of the English words because they think construction vocabulary is different from English vocabulary. Yes terms are different, I mean its different terms used or rather same terms used for different purposes. For instance, a pillar, in English they would say …so and so is my pillar to cry on my shoulder to lean on. Now if it is a pillar it means you can lean on. In construction a pillar is a vertical structure on which you can place something on top. Same meaning but different context. So language becomes a barrier because learners cannot take the language, lessons or words they use in other languages or learning areas.

**T H:** Sometimes learners cannot follow the given dimensions correctly, so they end up taking wrong measurements especially where they have to convert millimetres to metres. Learners have a problem; I do not know if they are lazy or what.

**I :** Do you think you need refresher courses to improve your knowledge and skills and learn about new developments related to graphic communication in line with the current demands of industry?

**T A:** Yes definitely, this must be hands on and a continuous exercise.

**T B:** Although I have attended courses on CAD, the requirements of the NSC at present do not make teaching CAD a real option, as learners who cannot drive a pencil cannot be expected to know how to instruct a computer. Timetables, and financial restrictions preclude all but the richest schools from pursuing this path. I feel that I seldom need refresher courses, as in 30 years of teaching I have seen more concepts in drawing leaving the syllabi than joining them.

**T C:** Yes I do. Industry is demanding that learners have CAD knowledge. Perhaps a course in AutoCAD will be beneficial.

**T D:** I do need refresher courses. I do not have the knowledge to use computers for drawing. If I can learn to use AutoCAD, I can teach my learners.

**T E:** Definitely we need refresher courses, like myself I need refresher courses in AutoCAD. If the department can organise to have all trades and EGD teachers to go through AutoCAD training that would be great.

**T F:** Yes refresher courses will be very much ideal because you find like now when it comes to site plans as part of graphic communication, there quite a lot of things that I think I would need refresher course on. It would help me understand the new technologies that are there that would be very much helpful.

**T G:** Yes obviously. The subject that we are teaching is forever evolving. You can never say I know everything.

**T H:** Yes I need refresher courses on the practical aspect. For example, construction of open eaves. I need some practical illustrations that involve making models or simulations of what we are teaching and drawing.

Thank you for you input and time spent.

**D3: FOCUS GROUP INTERVIEW RESPONSES**

**I :** What is your opinion on teaching and assessing of site plan, elevations and floor plan analysis including calculation of perimeter and area of site and proposed building. Can you highlight learners' misconceptions on these aspects.

**T C:** I think that teaching this section, especially before you even start with symbols, learners must have a thorough knowledge of why we sue certain symbols and what is the South African Bureau of Standards. Get the children do draw the symbols first because they will use these symbols in the building drawings. Teach them from the things they know, for example with site plan, ask them to measure the size of their land at home, next door neighbour, explain to them the concept of boundary lines, building lines etc and show them how to represent details on a site plan.

**T D:** We do teach them site plans and elevations and so on, but I still find that they are struggling when it comes to answering questions based on these drawings. In my view, I think learners lack the basic. Probably this kind of drawing like graphic communication should start at primary school level. May be if this subject could be introduced at primary level and learners are asked to draw house plans and start getting the knowledge, they will develop a better understanding.

**T E:** Learners have a challenge of reading or interpreting a measuring tape and using scale correctly. If you ask a learner to measure, say a distance of 700mm, they want to open the whole measuring tape to see where its written 700, otherwise they get confused when they cannot see that 700 on the tape.

**I :** What would you cite as learners' misconceptions and weaknesses in relation to 2D and 3D drawings, interpretation of drawings and correct use of conventional signs and symbols (SANS Code of drawing practices) in graphic communication?

**T B:** The other issue I have is the disinclination of learners to actually study the symbols of these drawings, these symbols are not difficult.

**T C:** I think that in grade 8 and 9 technology, the ay teachers teach isometric and orthographic projection is not adequate, so the child has this misconception that this is how you see the front view and left view. If you teach orthographic projection the correct way how views are projected, using the imaginary plane (e.g. vertical planes, auxiliary planes), learners will understand it. But teachers struggle with the perception and concept of planes in the system.

**T E:** What I have noted is that in most cases learners tend to have a confusion of calculating perimeter and area. For example, A question may ask for calculation of perimeter of a building, a learner will take the length and width of one side and add the two (Length + Breadth), then take the length of the other side and multiply by width (Length x Breadth), then multiply the results by two (Perimeter = (Length + Breath) x (Length x Breadth)). For Area, a learner can take both sides, add them together and put multiplication (Area = (Length + Breath) x 2)

**T G:** When it comes to 1st angle and 3rd angle orthographic projection, Learners seem not to be very clear with how to position or layout views.

**I :** What types of tasks or class activities (both theory and practical) do you engage your learners with, to reinforce their graphic communication skills?

**T B:** When it comes to site plan drawing, floor plans, elevations, sectional elevations, it is all about practice, practice, practice. They have to draw every single one of them a couple of times at least until they get familiar with it. Familiar with variation of questions and obviously the analytic questions, they have to be practiced a lot. I send them home with five analytic questions to do every day, everyone has to do the work.

**T C:** I think our subject is a wonderful subject, it lends itself in a way that theoretical aspect is related to practical. Before you start making any artefact, you have to do the drawings. In all our technical subject, we have practical assessment tasks (PAT). Children draw to scale, then make a small project from the drawings using an appropriate scale.

**T D:** I ask them to draw their own house (site plan, floor plan and also elevations), then analyse the drawing. We do many activities.

**T G:** In grade 11, I give learners tasks on site plans, where they analyse features on a site plan and answer questions, calculate perimeter and area of site. When it comes to brickwork, I give them the sketches or information on what to draw, for example English bond, then they practically build the walls in the specifies pattern using bricks.

**T H:** I always give theory tasks from previous question papers. For practical, they do dry packing of views, cutting bricks into queen closers and all those types of bricks.

**I :** Do you use CAD software to AID your teaching of 2D and 3D drawing besides manually drawing and demonstrating on the chalkboard? If ye, explain its benefit in your teaching and enhancing learners' understanding.

**T A:** I do not use CAD officially, but I do have some computer applications for calculating timber quantities for cabinet making.

**T B:** I do not know if you a going to get any answer to this. I do not use CAD at all.

**T C:** I have gone through extensive AUTOCAD training, I have the software in my laptop, and I know how to use the programme and its highly beneficial for learners in this modern society. The problem arises from a teaching point of view, the department of education does not allocate enough time for this, it is a process, and we have to do this after hours, after school and it steals away your time. We have an AUTOCAD room here in our school that cost department millions of rands to set up 32 brand new computers and training the teacher, but now those rooms are non-existent. The teacher left the school, there is no replacement. While the department spent a lot of money developing sixteen schools in KZN, there is not a will on the part of the department to take the vision forward, allocate monetary resources for maintenance and further training because new teachers are coming in. It need not to be just written in the curriculum that you should teach using CAD, there should be time allocation for it, there should be people qualifying in it. What we do from our school is that if a child is interested in AUTOCAD, I load the program onto their individual laptop and it is a one-month trial version and we cannot afford paying for renewal of the licence.

**T E:** Unfortunately no, we do not have equipment for using CAD software and we have not done it at all. My wish is to have it in the school, but it is not yet available. Even myself I still need to be workshopped on using CAD.

**T G:** Yes, but that is done by me not the learners.

**T H:** No I do not have the software.

**I : Drawing from your experience of teaching graphic communication, what challenges do you encounter when teaching both theory and practical lessons?**

**T A:** It is very difficult working with inadequate tools and machinery. Most of the machines in my workshop are very old type, some are broken and just lying idle and not functional because of lack of servicing. I am trying to get an industry or company that can adopt our school, so that they can sponsor us or help us to secure resources that we need for practicals, or if we have to look for a place to visit for practical excursions, we can liaise with them.

**T C:** From my point of view, I think that to articulate when you have done a drawing and you want to translate it into practical work, the perception the concept of scale in terms of enlarging or reducing makes it difficult to explain to children

**T G:** Calculating number of bricks required to build a structure. The concepts of using 50 bricks per square meter per half brick wall is very confusing for learners.

**T H:** I would say taking learners to the picture or making them understand what I am talking about.

**I : How do you think these challenges can be mitigated?**

**T B:** On that point, I am trying an experiment this year. In my grade 9 classes, I am introducing floor plans at grade 9 level to make learners understand symbols, doors, windows, floors, kitchen fittings, bathroom fittings, just to get them a little bit of step ahead to grade 10. We divide our grade 9s up into different groups and once a term we swop with different teachers. So I teach structure and materials and floor plans, the other teacher does orthographic projection along with fitting and turning, and then the electric teacher does isometric projection, and we do a bit of an extra. But we are bringing in aspects of floor plans into grade 9. Just trying it as an experiment to see if it improves the grade 10 graphic communication and ultimately grade 11 and 12 by familiarity.

**T C:** The government needs to invest in people with skills and knowledge. If they do not have money to do that they can do it in other ways, say for example take a teacher away from the classroom for 2 or 3 months for intensive training, and when a teacher comes out of the session, then he has all the models and all the skills to come and teach the subject. You cannot get a teacher to go for a 1-week course and expect him to get back to the classroom and teach all the practical aspects, it is impossible. Intensive teacher training is important if you want the positive outcome that you are anticipating.

**T H:** I think it can be solved by employing technology teachers who are interested in Technology and studied Technology in tertiary institutions because most of the technology teachers at grades 8 and 9 do not like the subject at all. They just go for the sake of going to class.

Thank you for you input and time spent.

## D4: LESSON PLAN TEMPLATES

## TEMPLATE 1

| | |
|---|---|
| **SUBJECT:** | **CIVIL TECH** |

| | | | |
|---|---|---|---|
| **GRADE:** | **10** | **11** | **12** |

| | |
|---|---|
| **SECTION:** | **GRAPHICS AS MEANS OF COMMUNICATION (Specific)** |
| **TOPIC:** | INSTRUMENT DRAWING |

| | | | |
|---|---|---|---|
| **DATE COMMENCED:** | 05/04/2022 | **DATE COMPLETED:** | 14/04/2022 |

**LESSON TYPE:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| THEORY | X | PRACTICAL | X | DRAWING | | REVISION / REMEDIAL | X |
| OTHER: EXCURSION / LECTURE / TALK / DEMONSTRATION / ______________________ | | | | | | | |

**RESOURCES USED:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TEXTBOOKS | | MODELS | | WORKSHEETS | | VIDEO / CD | |
| CHALKBOARD SUM. | | PRACTICAL DEMO | X | PRACTICAL TASK | | DATA PROJECTOR | X |
| OTHER (Specify): Chalkboard drawing instruments | | | | | | | |

**RESOURCES / EQUIPMENT / TOOLS REQUIRED (Specific to topic):**

| | | | |
|---|---|---|---|
| Text Book Pages 106, 109-112 | Drawing boards, set-squares, compass set, pencil, A4 drawing paper | | |

**SPECIFIC CONTENT TO BE TAUGHT:**

| EDUCATOR ACTIVITY | LEARNER ACTIVITY |
|---|---|
| **Educator to demonstrate the correct techniques to draw to scale the different types of arches.**<br>**Educator to explain the technique used to draw freehand sketches of door frames.**<br>**Educator must ensure that learners adhere to SANS requirements when drawing floor plans for a 3-bedroom dwelling.**<br>**Learners to complete scaled and freehand drawings**<br>**Educator demonstrates construction of a semi-circular arch using a center piece and all necessary bricklaying tools (PAT)** | Scale drawings of the following:<br>• Semi-circular arch<br>• Semi-circular rough arch<br>• Gauged segmental arch<br>Freehand sketches of the following:<br>• Wooden single door frame<br>• Wooden arched door frame<br>Scale drawing of the following:<br>• Floor plan of a house with 3 bedrooms, a sitting room, a kitchen, a toilet, and a bathroom<br>Practical Assessment Task<br>• Learners make a model of a semi-circular arch in English bond using bricks. |

**ACTIVITIES / WRITTEN CLASSWORK:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHALKBOARD SUM. | | WORKSHEETS | X | NOTES | | PRACTICAL TASKS | |

| |
|---|
| Specify: Draw different types of arches learnt, Draw wooden single door frame and arched door frame, draw floor plan of a 3-Bedroom house to scale. |

**HOMEWORK / ENRICHMENT EXERCISES:**

| COMPLETE WORKSHEETS | X | COMPLETE DRAWINGS | X | PRIOR READING | |
|---|---|---|---|---|---|
| Specify: Practical Assessment Task – Learners complete drawing of a semi-circular arch and build a model of a semi-circular arch in English bond | | | | | |

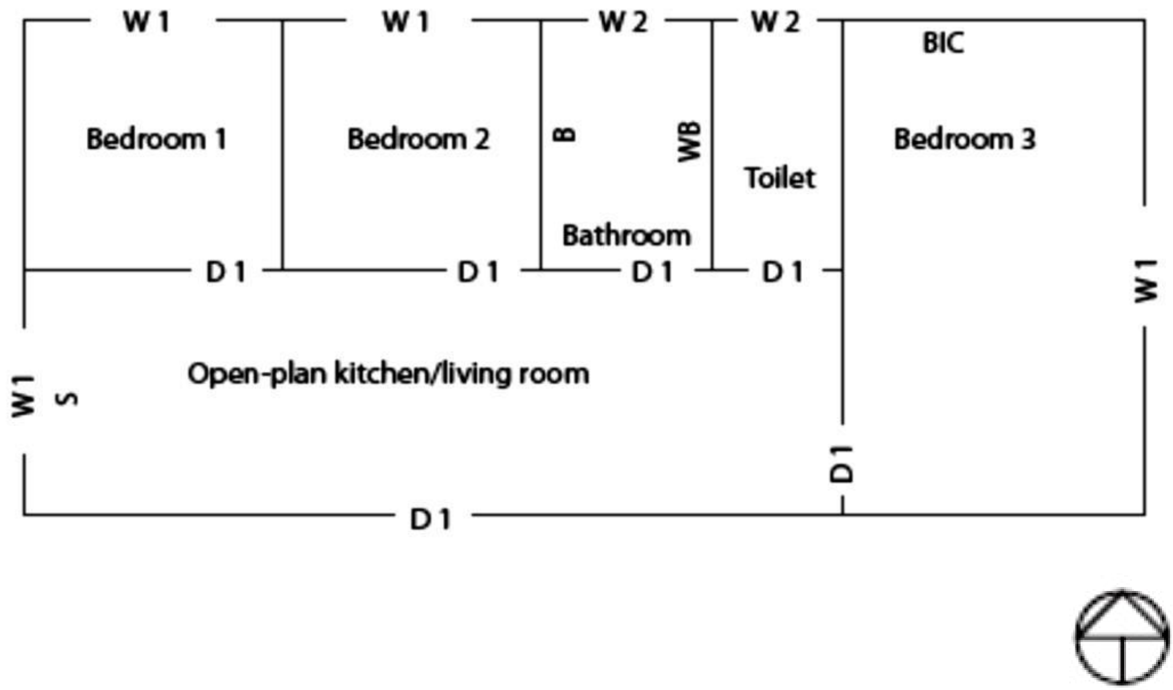
| Educator Name: | | HOD's Signature: | |
|---|---|---|---|

# Graphic Communication – Specific

## Class activity 1

## Grade 11

1.1 The figure below shows the line diagram of a floor plan of a three-bedroom house. Study this diagram carefully and the specifications that follow to answer the questions that follow




**Specifications:**

- All windows are positioned in the middle of the wall of each room.
- All inside doors are positioned 300 mm from the wall to the left of the door.
- The front door is positioned in the middle of the wall of the open-plan kitchen and living room.
- All external walls are 220 mm wide.

- All internal walls are 110 mm wide

| Window and door schedule | Breadth | Height |
|---|---|---|
| Window 1 | 1 500 mm | 1 200 mm |
| Window 2 | 600 mm | 900 mm |
| Door | 900 mm | 2 000 mm |

1.1.1 Develop and draw a floor plan of the building using a scale of 1:50.

Show the following on your drawing:

- The drawing symbols for a washbasin, water closet, built-in cupboard and a single bowl sink on the floor plan as indicated by the abbreviations on the line diagram
- Indicate all electrical fittings
- Three dimensions on the northern side of the house
- Indicate the roof line. (gable roof)
- The title and scale
- The windows and doors on the floor plan in the spaces indicated on the line diagram.
- Insert the north symbol in the bottom right-hand corner.

1.1.2 Draw the north and west elevations of the dwelling. (scale 1 : 100)

Specifications:

- Wall height from FFL to wall plate level is 2 750 mm.
- The house is fitted with a gable roof.
- The eave overhang is 500 mm
- The overhang on the gable end is 250 mm
- Width of the facia board is 200 mm
- Diameter of gutter and downpipe is 150 mm
- Galvanized roof sheeting is used for the roof covering.

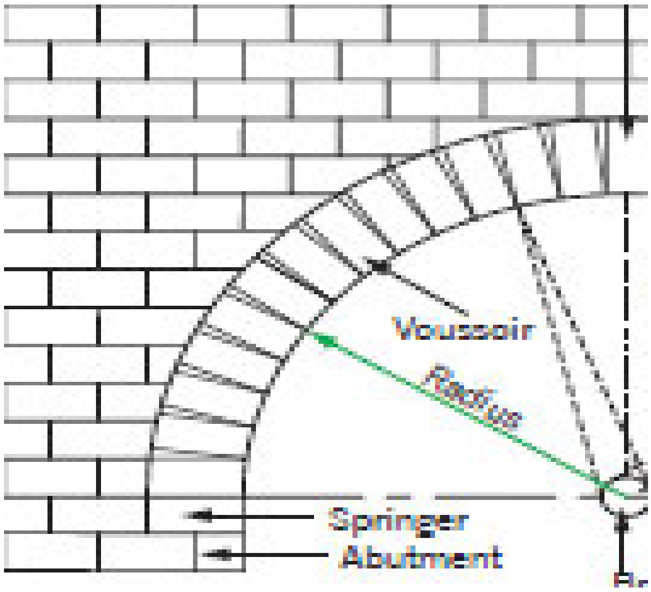
**GRAPHIC COMMUNICATION – SPECIFIC**

**CLASS ACTIVITY 2**

**GRADE 11**

2.1 Instrument drawing – Semi-circular Arch

2.1.1 You are given the LEFT half of a ROUGH ARCH in the figure below.
Project to a suitable scale the RIGHT HALF of the ROUGH ARCH.




2.1.2 Draw neatly Line diagrams to represent the following types of arches:

- Flat arch
- Segmented arch

**2.2 Model (Construction) - Semi-circular Arch (Practical Assessment Task)**

**Instructions:**

Learners should use their own discretion where details have been omitted.

Develop and compile a design portfolio to show the following:

- Cover page
- Table of contents
- Declaration of authenticity
- Research
- Definition of different types of arches
- Purpose of the different types of arches
- Different types of materials used for the semi-circular arch
- A list of tools to make the centre (formwork) for a semi-circular arch
- A list of materials to make the centre (formwork) for a semi-circular arch

FIGURE 2.2.1 is a photograph of a semi-circular arch with the surrounding brickwork in English bond.

Figure 2.2.1

Use the marking memorandum for the drawings as a guide and draw the following:

- A front view of the semi-circular arch with a span of 1 000 mm and surrounding brickwork in English bond to scale 1 : 10.
- Show the key brick and all the voussoirs.
- Show the striking point and method to draw the voussoirs.
- Show all relevant detail and labels.

**Model:**

Build the arch as shown in FIGURE 2.2.1 according to the measurements in the working drawings. Use building sand and lime as mortar.

**TEMPLATE 2**

| | |
|---|---|
| education<br>Province of KwaZulu-Natal<br>Manufacturing Engineering<br>& Technology Subjects | MANUFACTURING ENGINEERING & TECHNOLOGY - SUBJECTS<br>LESSON PREPARATION |

| | | | |
|---|---|---|---|
| **SUBJECT:** | **CIVIL TECH** | | |
| **GRADE:** | **10** | **11** ✓ | **12** |
| **SECTION:** | **GRAPHICS AS MEANS OF COMMUNICATION (Generic)** | | |
| **TOPIC:** | INSTRUMENT DRAWING | | |
| **DATE COMMENCED:** | WEEK 1 | **DATE COMPLETED:** | AS PER ATP<br>05/05/2022 |

**LESSON TYPE:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| THEORY | X | PRACTICAL | X | DRAWING | | REVISION / REMEDIAL | X |
| OTHER: EXCURSION / LECTURE / TALK / DEMONSTRATION / | | | | | | | |

**RESOURCES USED:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TEXTBOOKS | ✓ | MODELS | | WORKSHEETS | ✓ | VIDEO / CD | |
| CHALKBOARD SUM | | PRACTICAL DEMO | X | PRACTICAL TASK | | DATA PROJECTOR | X |
| OTHER (Specify): C-Tech (woodworking) pg 95–101 | | | | | | | |

**RESOURCES / EQUIPMENT / TOOLS REQUIRED (Specific to topic):**

| | | | |
|---|---|---|---|
| Chalkboard | chalks | Tee Squares | setsquares |

**SPECIFIC CONTENT TO BE TAUGHT:**

| EDUCATOR ACTIVITY | LEARNER ACTIVITY |
|---|---|
| **Educator must discuss the following with the learners using models or visual aids. (charts, videos, power point, etc.)**<br><br>**Educator should teach learners to make advanced drawings by applying various scales:**<br>• Instrument drawings (related to building industry)<br>• Orthographic projection with sections<br>• Different elevations of a building<br>• Vertical sections indicating labelling and measurements in accordance with the SANS for building drawings<br>• Isometric views applicable to construction<br><br>**Freehand sketches relevant to the super structure of a building**<br>Basic computer-aided drawings<br>**Educator should teach learners to Interpret** | Learners to complete worksheet on page 3 of the learner workbook. |

3

| | |
|---|---|
| drawings of:<br>• Site plan, floor plan and elevation of a basic single storey dwelling<br>• Basic drawing symbols relating to the built environment<br>in accordance with the SANS for building drawings | |

**ACTIVITIES / WRITTEN CLASSWORK:**

| CHALKBOARD SUM. | | WORKSHEETS | X | NOTES | | PRACTICAL TASKS | |
|---|---|---|---|---|---|---|---|
| Specify: | | | | | | | |

**HOMEWORK / ENRICHMENT EXERCISES:**

| COMPLETE WORKSHEETS | X | COMPLETE DRAWINGS | X | PRIOR READING | X |
|---|---|---|---|---|---|
| Specify: | | | | | |

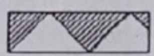
| Educator Name: | | HOD's Signature: | |
|---|---|---|---|

## GRAPHICS AS MEANS OF COMMUNICATION - GENERIC

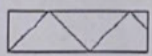
**QUESTION ONE**

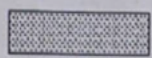
1.1 Identify the following drawing symbols which are used in the building industry, as specified by SANS.
**(Refer to page 95 Civil Technology Woodworking Grade 11 Learners Book)**

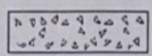
1.1.1 Symbols for materials.

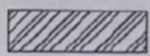
A 

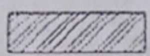
B 

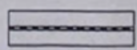
C 

D 

E 

F 

G 

H 

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