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TEACHING FOR VISUAL LITERACY BY MATHEMATICS TEACHERS IN TANZANIAN SECONDARY SCHOOLS

By

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DEDICATION

To:

My God, the controller of the universe, without whom the entire universe would be nonsense, I appreciate Your presence. By Your grace, I began this difficult journey and completed it safely.

My mother, Haruna Emily, and late father, Bakari Kundema, for raising me up in a good manner.

My aunt, Mary Mdehwa, and late uncle, Emanuel Mdehwa, for the sacrifices made to send me to school.

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ABSTRACT

In this study, I examined the topic of teaching for visual literacy by mathematics teachers in Tanzanian secondary schools. One of the goals of teaching mathematics in these schools is for learners to acquire mathematical knowledge and skills, which will be useful in their daily lives and future careers. Several studies have shown that visual literacy enables learners to acquire knowledge and skills that are also useful in their lives and future careers.

It is a well-known fact that mathematics plays an important role in human endeavours, and life in general. On the one hand, research persistently reports that mathematical concepts are too abstract and complex for learners, which makes it difficult for teachers to teach these concepts effectively. On the other hand, the literature suggests that teaching mathematics for visual literacy could assist learners in understanding mathematical concepts easily, and developing visual literacy skills. Learners could better understand the mathematical concepts being taught and acquire visual literacy skills through the use of both teacher-centred and learner-centred teaching styles and various teaching strategies, including traditional teaching; group work, in particular cooperative learning; discovery; problem-based learning; multimedia instruction; as well as providing an opportunity for learners to interpret visual information and use visual media.

Using a case study of three mathematics teachers from three schools, this study examined how Tanzanian secondary school mathematics teachers taught for visual literacy in Form 2 classrooms. The data was collected using classroom observations and interviews. The findings from the collected data have suggested that Tanzanian mathematics teachers do not meet the requirements for teaching mathematics for visual literacy due to various factors, such as the length of the syllabus, lack of pedagogical content knowledge, insufficient technology and dynamic media in schools, teachers' beliefs, National Examinations rules and regulations, and overcrowded classrooms. Recommendations for further studies based on this study have also been made.

Key words: Teaching mathematics for literacy, Tanzanian Form 2 mathematics teachers, teacher-centred teaching style, learner-centred teaching style, media-based teaching, problem-based learning, cooperative learning.

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DECLARATION OF ORIGINALITY

I, Imani Bakari Kundema, declare that the research involved in the dissertation, entitled **Teaching for visual literacy by mathematics teachers in Tanzanian secondary schools**, which I hereby submit for the degree Master of Education at the University of Pretoria, is my original work and has not previously been submitted by me for a degree at this or any other tertiary institution.

30 September 2016

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IMANI BAKARI KUNDEMA DATE

30 September 2016

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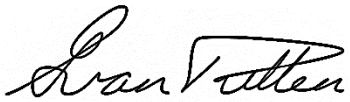
DR JJ BOTHA DATE



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DR LS VAN PUTTEN DATE

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LIST OF ABBREVIATIONS

AAAS	American Association for the Advancement of Science
CAL	Computer Assisted Learning
DBE	Department of Basic Education
ESDP	Education Sector Development Programme
LTVM	Learning and Teaching Through Visual Media
MoEC	Ministry of Education and Culture
MoEVT	(Tanzania) Ministry of Education and Vocational Training
NCTM	National Council for Teachers of Mathematics
O-level	Ordinary level secondary education
PBL	Problem-Based Learning
PEDP	Primary Education Development Programme
SEDP	Secondary Education Development Programme
TEDP	Tertiary Education Development Programme
TIE	Tanzanian Institute of Education
UPE	Universal Primary Education
V-A-K	Visual, Auditory, and Kinaesthetic learning styles

CHAPTER 1 INTRODUCTION AND CONTEXTUALISATION

1.1 INTRODUCTION

Mathematics instruction requires multiple modes of representation. Mathematical ideas can be communicated through the spoken and written word, through physical and bodily experience, visual images, both pictorial and diagrammatic, and also through symbolic representations. Some of the benefits of these multiple mathematical representations are that learners are able to make sense of mathematical ideas (Anthony & Walshaw, 2009; Suh & Moyer, 2007), and develop not only factual and procedural understanding, but conceptual understanding. When, for example, objects from the environment (like stones) are used to teach mathematical sets, learners can link their day to day experience with mathematical concepts. In this way, the learners realise the relevance of mathematics in their real life.

In this study, the focus was on the learning of mathematics through visual images and the associated advantages and challenges of this mode of mathematical learning. Visual information is predominant in the 21st Century world as people gather and disseminate information through various media such as the internet, television, tablets, and cellular phones. This modern development has caused people to depend more on visual media than on written or textual media for the reception of information. This phenomenon not only affects the lives of adults, but also those of learners. Avgerinou (2009) and Bleed (2005) state that a visual culture is created in the youth's lives because they spend more time looking for visual information than other types of information. Visual information and visual media should therefore form part of learners' everyday learning environment.

The transition or adaptation towards a greater emphasis on the visual teaching of mathematics requires what could be called 'visual literacy'. A number of researchers agree that visual literacy is a crucial skill in teaching and learning mathematics (Murphy, 2011; Budram, 2009; Rampersard, 2009; Stokes, 2002; Lowe, 2000). Once mathematics teachers are visually literate, they can use visual imaging as a vehicle for mathematics instruction as it has been found that children learn more easily when content is presented visually (Murphy, 2009; Avgerinou & Ericson, 2002).

Since mathematics can sometimes be viewed as a subject of abstract nature (the American Association for the Advancement of Science (AAAS), 1990), a teaching approach is required through which difficult concepts can be elucidated for learners in an easily understandable way.

Kuiper and Volman (2008) suggest that almost half of the information that young people acquire or grasp originates from imagery. Several factors contribute to learners' ease of learning through visual imagery. Firstly, pictures or visual materials stimulate learners' interest, and motivate learning (Clark & Mayer, 2011; Moore & Dwyer, 1994). Secondly, visual information expresses complicated ideas more easily than any other means of communication (Ajibade & Elemi, 2012; Murphy, 2011; Vasquez, 2010; Bleed, 2005; Bamford, 2003; Lowe, 2000) and thus assists in conceptual understanding. Thirdly, it has been scientifically verified that almost 90% of the information that enters the brain is visual, and this visual information is processed faster than textual information (Aisami, 2015; Roux, 2009). If, therefore, there is a lack of visual information in teachers' classroom practices, learners are deprived of one of the most prominent means of developing conceptual knowledge. This, in turn, may demoralise learners and reduce their interest in the subject.

It has been found that a visual approach to the teaching of mathematics, including the use of graphs, charts, tables, and other figures, makes even complex mathematical concepts clear in a simple and meaningful way (Murphy, 2011; Budram, 2009; Rampersard, 2009). In this study, it was found that graphs were useful tools in the teaching and learning of complex ideas, like functions, and in promoting learners' understanding (Rampersard, 2009). According to Murphy (2011), graphs in the mathematics classroom help learners to grasp mathematical concepts using their physical eyes and their mind's eye. Alternatively, the use of manipulatives, both physical and virtual manipulatives, has proven to have a significant advantage in learners' understanding of mathematical ideas. Takahashi (2002) reports that when the geo-board is used both virtually and physically during mathematics instruction at middle school level, learners gain significantly more knowledge.

The nature of mathematics makes it an ideal subject within which to incorporate visual teaching and learning instructional practices. The section below provides a short discussion of the nature of mathematics and the role of visual literacy in mathematics.

1.1.1 The nature of mathematics

Mathematics is both a logical and creative discipline (AAAS, 1990). Based on this perspective, mathematics possesses both characteristics as a practical and intuitive discipline. For both mathematicians and non-mathematicians, the beauty of mathematics is found in its intellectual reasoning and application in various fields such as medicine, engineering, business, agriculture,

social sciences and other fields (Gambari, Falode & Adegbenro, 2014; Mkomange, Ilembo & Ajagbe, 2012; Maliki, Ngban & Ibu, 2009; AAAS, 1990).

As a subject made up of pattern and relationships, mathematical concepts have been developed and refined for many years (AAAS, 1990). Mathematical concepts such as angles, ratios, shapes, number operations, among others, help people to be aware of their universe (AAAS, 1990). In reality, many mathematical concepts and theories have direct implications in real life. Plato (as cited in Dossey, 1992) indicates that mathematical theories exist in the real world and can be revealed by using the normal senses. To verify this, he made a clear clarification between arithmetic (the theory of numbers) and logistics (its application in the field of business) (Dossey, 1992). According to Plato, the learning of arithmetic has a direct impact on human life. Based on this, it is clear that mathematics plays a crucial role in human endeavours and everyday life.

Although the subject mathematics has shown to be significant in human life, this subject is oftentimes characterised as a theoretical subject that is dominated by symbols and abstract concepts (Rubin, 1999; AAAS, 1990). These symbols and concepts may be regarded as 'mathematical language'. According to Hammill (2010), the complexity of the mathematics language is one of the reasons for the difficulty that is experienced in obtaining a deep conceptual understanding of mathematical ideas. The complexity of the mathematics language, however, can be reduced by representing mathematical ideas in multiple ways (Barmby, Bolden, Raine & Thompson, 2012; Murphy, 2011; AAAS, 1990). The integration of various models could reduce the abstraction of mathematical concepts and contribute to learners' development of understanding, and ability to recall information (Naidoo, 2012; Murphy, 2011; Budram, 2009; Rampersard, 2009). An example of these models includes verbal explanations with 'visual language' such as graphs, charts, tables, gestures, pictures, diagrams and other visual representations or illustrations.

Learners need to be provided with opportunities to engage with visual information in various ways during classroom instruction in order to acquire visual literacy (Tillmann, 2012; Murphy, 2011; Knoell, 2006; Schönborn & Anderson, 2005; Bamford, 2003; Stokes, 2002). In this regard, there is a need for mathematics teachers to focus their instruction on the development of learners' visual literacy so as to improve their interpretation and understanding of mathematical concepts.

1.1.2 Visual literacy

The term visual literacy refers to a group of competencies that enables an individual to understand, interpret, use, generate, and evaluate visual images or messages (Hattwig, Bussert, Medaille & Burgess, 2012; Tillmann, 2012; Bleed, 2005).

Visual literacy in mathematics has multiple advantages, the first of which is that it plays a supportive role when new concepts are introduced. Secondly, being visually literate enables learners to create and use visual images for communication, both as the sender and as the receiver of information (Tillmann, 2012; Avgerinou, 2009; Knoell, 2006; Bleed, 2005; Bamford, 2003). The acquisition of this skill could, thirdly, enable learners to appropriately decode, encode, design and produce visual messages (Tillmann, 2012; Avgerinou, 2009; Knoell, 2006; Bleed, 2005; Bamford, 2003). Fourthly, this skill assists learners to better understand the complex information presented to them, as well as to use visual information such as graphs to express information appropriately (Tillmann, 2012; Vasquez, 2010; Bleed, 2005). Lastly, in a broader sense, it has also been found that visually literate learners can think logically and rationally, and therefore make more reasonable judgments (Hattwig, Bussert, Medaille & Burgess, 2012; Budram, 2009; Bamford, 2003).

In general, it appears that teaching for visual literacy promotes active learning in the classroom and also provides an opportunity for learners to demonstrate their talents and creativity when solving problems (Vasquez, 2010; Barnes, 2005). Visual learning as an innate tendency in children will be briefly discussed below.

1.1.3 Children as visual learners

It has been established that children are capable, even shortly after birth, to interpret visual images in their surroundings (Murphy, 2009). A number of studies verify that children acquire visual literacy earlier than they master other skills like speaking, kinaesthetic skills, or reading (Budram, 2009; Murphy, 2009; Boudreau, 2002; Stokes, 2002). For example, Bamford (2003) indicates that within the first three years of a child's life, the child is able to specify objects using visual signs. In reality, children habitually tend to relate words (texts) to real objects rather than real objects to words (Tarone & Bigelow, 2005). From these research findings, it can be reasoned that thinking through illustrations is an essential learning tool for children. According to Keegan (2007), the insertion of pictures in storybooks is done purposely to stimulate children's imaginations. Similarly, during learners' school years, it has been verified

that learners understand sophisticated mathematics information more readily when presented in visual form rather than in other forms (Murphy, 2009).

From the above arguments, we can say that to a large extent, "children are visual learners" (Hussain, Mutalib & Zainol, 2014, p. 3). The absence of visual imagery in the mathematics classroom could therefore inhibit learners' development of conceptual mathematics understanding because visual information does not only interest learners, but also plays a key role in learners' ability to form perceptions of the concept under study.

The literature clearly highlights the important role that pictures play in human understanding (Bamford, 2003; Bleed, 2005), as well as the fact that the use of pictures or visual representations during classroom instruction can facilitate the teaching and learning process (Rokni & Karimi, 2013; Ajibade & Elemi, 2012). An additional perspective is provided by the Dual Coding Theory, which specifies that sentences and words are processed in a single processing system (verbal system), but pictures are encoded and processed in both systems (imagery and verbal systems) (Keegan, 2007). It follows, in view of this theory, that instruction is more effective with pictures than without pictures.

1.2 MOTIVATION FOR THE STUDY

This study has been motivated, first and foremost, by my personal experience and the circumstances within which this experience was gained. I have been teaching mathematics in secondary schools in Tanzania for the past 17 years. In my opinion, most of the teachers at the schools where I taught use the traditional teaching approach of teaching by telling. I believe that this approach affects learners' performance as it renders learners mere receivers of knowledge rather than constructors of their own knowledge. This teaching approach neither stimulates learners nor urges them to effectively acquire and master mathematical concepts and skills. Consequently, many learners regard mathematics not only as a difficult subject, but also as a boring one. Using the traditional teaching approach, which is based on learning through listening to the teacher, deprives learners of the opportunity to explore and be active in building knowledge.

Scholars explain that the traditional teaching strategy implies that the teacher is the only source of knowledge, while learners are the receivers of knowledge (Hadžimehmedagić & Akbarov, 2013). Additionally, this teaching strategy encourages rote learning and limits learners' involvement, as well as their thinking ability (Banning, 2005). Kafyulilo, Rugambuka and

Moses (2012) report that the traditional teaching strategy is content orientated and is based on the memorisation of main facts and ideas, rather than on the understanding of concepts. Therefore, this approach does not facilitate the acquisition of basic skills (Boumová, 2008).

In mathematics, according to Güler and Çiltaş (2011), the main focus of traditional teaching is the acquisition of operational skills, rather than improving critical thinking and problem solving. Unlike traditional teaching, the main emphasis in a multimedia instruction strategy is on developing learners' visual literacy to enable them to acquire conceptual knowledge, create knowledge, enhance their problem solving skills, and apply their knowledge in real life situations (Naidoo, 2012; Tillman, 2012; Güler & Çiltaş, 2011; Murphy,2011). Within a multimedia instruction strategy, learners take a central position in their own learning (Moore, 2015; Boumová, 2008). In other words, it empowers learners to create their own understanding. To build their own understanding, learners are involved in the learning process through the provision of opportunities to fully participate in classroom discussions, control the pace of their learning, interact with other learners, and also perform several activities (Boumová, 2008).

In this research, I argued that it is important for mathematics teachers to transform their classroom practices from traditional teaching to teaching for the development of visual literacy as this would encourage learners to create their own knowledge and be active in the classroom. This argument is based on the current emphasis on the value of using visual representation in the mathematics class instead of using only traditional teaching and verbal descriptions (Murphy, 2011; Stokes, 2002). This was emphasised in this study as it could provide opportunities for active learning (Vasquez, 2010) and enhanced understanding.

1.2.1 The Tanzanian school curriculum

1.2.1.1 Historical background

After its independence in 1961, Tanzania inherited an education system that embraced the chalk and talk traditional teaching strategy. This teaching strategy is founded on a content-based curriculum (Wangeleja, 2010). Since then, there have been several educational reforms, the biggest being the adoption of Education for Self-Reliance (1967), which focused on preparing the youth for their future life. Education for Self-Reliance emphasised practical skills as an important component to make students self-reliant upon their graduation (Kafyulilo et al., 2012). Ten years later, in 1977, Tanzania initiated another reform known as Universal Primary Education (UPE), which aimed to provide more access to primary education. Since

the 2000s, the country has been implementing the Education Sector Development Programme (ESDP), which covers all levels of education. It includes the Primary Education Development Programme (PEDP), the Secondary Education Development Programme (SEDP), and the Tertiary Education Development Programme (TEDP) (Ministry of Education and Culture (MoEC), 2004).

In 2005, Tanzania reformed the content-based curriculum to a competency-based curriculum (Chediel, 2012; Kafyulilo et al., 2012; Wangeleja, 2010). The new curriculum was proposed to be used at all levels, from pre-primary school to teacher training colleges (Wangeleja, 2010). The main emphasis of the competency-based curriculum is on facilitating learners' learning rather than simply teaching content (Wangeleja, 2010). In teaching mathematics, prominence is given to teaching mathematics concepts for conceptual understanding rather than teaching for learners to memorise the content (Wangeleja, 2010). The teaching style required for a competence-based curriculum is more leaner-centred than teacher-centred in order for learners to acquire knowledge and skills that can be used in their future lives (Chediel, 2012; Kafyulilo et al., 2012; Wangeleja, 2010). Despite all these reforms, teachers are still using the chalk and talk, or traditional teaching, strategy at all levels. This is problematic as it has a serious impact on developing learners' learning skills and competencies (Kahyarara & Teal, 2008).

1.2.1.2 Visual literacy in the Tanzanian Mathematics Curriculum

The competency-based curriculum aims for the acquisition of knowledge, skills, and attitudes for future use (Kafyulilo et al., 2012; Wangeleja, 2010). The main focus in a competence-based curriculum is a change of behaviour in learners that could assist them in the effective application of knowledge in real-life situations (Kafyulilo et al., 2012). This is, therefore, one of the main goals of the Tanzanian Mathematics Curriculum (Tanzania Ministry of Education and Vocational Training (MoEVT), 2010). Interestingly, the main aim of visual literacy is congruent to this goal of enhancing the application of knowledge and skills in real life situations (Olson 2012; Tillmann, 2012). It is therefore completely justifiable to conclude that the idea of visual literacy is embedded within, and can therefore be aligned and incorporated successfully in the Tanzanian Mathematics Curriculum.

The competence-based Curriculum document furthermore proposes that teachers should use various teaching strategies, such as participatory and cooperative learning, problem-based learning, and discovery learning in teaching mathematics (MoEVT, 2010, 2007). Participatory

learning allows learners to be involved in various learning activities such as class discussions, class presentations, class work, small group discussions (Idris, 2012; MoEVT, 2010; UNESCO, 2001), and other classroom activities. Cooperative learning is a teaching strategy that allows learners to work together in small groups where they are responsible for their own, as well as for each other's learning. It is argued that cooperative learning is an effective teaching strategy for including learners with different learning styles (Alder, 2009). This idea is strongly supported by Aisami (2015), who finds that visual literacy enhances the acquisition of knowledge of learners with different learning styles.

The Tanzanian Mathematics Curriculum also points to the use of visual media such as still media (e.g. graphs), dynamic media (e.g. animations), and technological media (e.g. calculators), to teach various mathematical topics such as congruency, similarity, geometrical transformations, logarithms, and statistics. Once again, the alignment of the Tanzanian Mathematics Curriculum with visual literacy is striking, as many studies have shown that the use of technology by teachers and learners facilitates visual literacy in the learning process (Tillmann, 2012; Brumberger, 2011; Flynt & Brozo, 2010; Bleed, 2005; Stankiewicz, 2004; Stokes, 2002; Fransecky & Debes, 1972).

The existing importance that the Tanzanian Mathematics Curriculum assigns to competence based instruction, to participatory and cooperative learning strategies, and to the use of visual media paves the way for, and should prompt the Tanzanian Department of Education to integrate visual literacy in the curriculum as a potentially powerful step towards the improvement of learners' mathematical competence.

1.3 PROBLEM STATEMENT

The key motivation for the epistemological shift of the Tanzanian school curriculum away from being content-based towards being competence-based was to enhance learning (Wangeleja, 2010). Within the new curriculum, the ways that teachers teach and learners learn are given more significance than the actual teaching of content (Wangeleja, 2010), as was the case in the content-based curriculum. The role of the teacher is to facilitate learning, as well as to foster learners' understanding (Wangeleja, 2010). However, according to the research of Zilimu (2014), Chediel (2012), and Eskola (2009), Tanzanian teachers still use the traditional teaching strategy for classroom instruction, which is based on lecturing or telling. Although the Tanzanian Mathematics Curriculum implicitly and explicitly advocates visual literacy, little or

no evidence could be found in this study of how Tanzanian mathematics teachers teach for visual literacy development.

The cognitive centre of the competency-based curriculum is the shift away from teaching mathematics as factual and procedural knowledge through memorisation to teaching for conceptual knowledge through understanding (Wangeleja, 2010). In the classroom environment, the competence-based curriculum aims to provide classroom instruction that empowers learners in their own learning and understanding of concepts (Chediel, 2012; Wangeleja, 2010). Conversely, the main attribute of traditional teaching, as is commonly practised in Tanzanian schools, is the memorisation of learnt content where learners are not given an opportunity to fully participate in the learning process (Hadžimehmedagić & Akbarov, 2013).

This study makes a suggestion for filling the existing gap between policy and practice, which is supported through the evidence found in the literature study. The intention of this study was to explore Tanzanian teachers' understanding of visual literacy and how they contribute to the development of learners' visual literacy. An in-depth investigation through classroom observations, supported by semi-structured interviews, enabled a layered description regarding teachers' practices in teaching for visual literacy in Tanzanian secondary school mathematics classrooms.

1.4 AIM AND OBJECTIVES OF THE STUDY

As stated above, the aim of the study was to systematically investigate Tanzanian secondary school teachers' use of visual teaching in mathematics.

In order to reach this aim, the study intended to achieve the following objectives:

- To examine the teachers' understanding of teaching for visual literacy and the role that visual literacy played in their teaching of mathematics.
- To determine how the teachers' teaching styles and strategies contributed to developing learners' visual literacy skills.
- To identify the visual media that the teachers used to facilitate the development of learners' visual literacy skills.
- To investigate how the teachers used visual media to facilitate the development of learners' visual literacy skills.

1.5 RESEARCH QUESTIONS

The following primary and secondary research questions guided the study.

1.5.1 Primary Research Question

This study posits that there is a need for teachers to use visual material when teaching mathematics to enhance learners' understanding and acquisition of mathematical concepts and skills. Taking this into consideration, this study attempted to answer the following primary research question:

> *How do Tanzanian secondary school mathematics teachers teach for visual literacy in Form 2 mathematics classrooms?*

1.5.2 Secondary Research Questions

In order to answer the main research question, the following sub-questions guided the data collection process and formed the basis of this research in studying the theoretical underpinnings of such practices, as reflected in the literature review (Chapter 2):

1. What is the teachers' understanding of visual literacy and its role in the teaching of mathematics?
2. How do the teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?
3. How do the teachers combine visual media with text to facilitate the development of visual literacy in learners?
4. How do the learning activities facilitate the development of learners' visual literacy skills?

1.6 METHODOLOGICAL CONSIDERATIONS

For the purposes of answering the above questions, the study adopted a qualitative case study research design. This design requires the collection of thick, rich information about the issue under study (Haider, Joubish, Khurram, Ahmed & Syeda, 2011). A qualitative research approach assumes that there is no single reality, but that each reality is directed by the various and differing world views held by different individuals. Based on this, the data was collected from various sources using different methods such as semi-structured interviews, and classroom observations (Haider et al., 2011). Three Form 2 mathematics teachers from three

different government secondary schools were purposively selected as a sample for this study. The data analysis was deductively carried out by coding the emerging themes based on the conceptual framework of the study. The trustworthiness of the study was ensured in the credibility, transferability, dependability, and conformability of the collected data. Finally, ethical approval to conduct the study was obtained from the University of Pretoria's Ethics Committee, and permission to conduct the study was sought and obtained from the Tanzania Ministry of Education and Vocational Training, and the District Education officer. Informed consent and assent letters were also obtained from the teachers and learners respectively.

1.7 CLARIFICATION OF CONCEPTS

The following table presents the operational definitions of the terms used in this study.

Table 1.1 Clarification of concepts

TERM/CONCEPT	MEANING/ CLARIFICATION
Dynamic media	Learning material such as models, animations, audio, video, and other interactive media (Holzinger, Kickmeier-Rust & Albert, 2008).
Leaner-centred teaching style	A teaching style where learners are responsible for their own learning by participating in various classroom activities (Weimer, 2002).
Learning styles	The way in which an individual perceives and interprets information, e.g. In an auditory, visual or kinaesthetic way (Muhundan, 2011).
Multimedia learning	Learning from multimedia devices that attempt to foster learners' understanding (Mayer & Moreno, 2010; Mayer, 2005, 2003).
Teacher-centred teaching style	A teaching style where learners receive direct instruction from their teacher (Huba & Freed, 2000).
Multimedia	Access to information using a single device (Cartwright, Peterson, & Gartner, 2007). In the classroom environment, multimedia involves the use of models/objects, pictures, sound, and technological tools (i.e. computers and calculators) that are aligned with texts (written or spoken) in order to foster learners' understanding (Mayer & Moreno, 2010; Bleed, 2005; Schönborn & Anderson, 2005; Bamford, 2003; Sims, Cook & Butland, 2002; Stokes, 2002).
Teaching strategies	The methods, techniques or procedures that are used in the process of transferring knowledge. Some examples of these are cooperative/collaborative learning, lecturing, discovery learning, and problem-based learning (Wandberg & Rohwer, 2010; Prince, 2004). Traditional teaching and multimedia instruction are also teaching strategies that teachers use.
Teaching styles	The ways of teaching to develop learners' knowledge, for example, the learner- and teacher-centred styles (Grasha, 2002).

TERM/CONCEPT	MEANING/ CLARIFICATION
Technological media	Advanced tools that are used to simplify the performance of work (Merriam Webster dictionary, 2013). In teaching mathematics, these tools include computers, calculators, geo-boards, virtual manipulatives, and other technological tools that enhance mathematical instruction for both teachers and learners (Tajuddin, Tarmizi, Ali & Konting, 2009; Moyer-Packenham, Salkind, & Bolyard, 2008; Gebrekal, 2007; Ertmer, 2005).
Traditional teaching	A teaching approach in which the teacher is the source of knowledge and learners are the passive receivers of knowledge (Hadžimehmedagić & Akbarov, 2013; Schwerdt & Wuppermann, 2011).
Still media	Visual aids such as pictures, graphs, charts, tables and other visual illustrations used to explain or clarify concepts (Ajibade & Ilemi, 2012).
Visual literacy	The ability/competency/skill of understanding, interpreting, analysing, evaluating and creating visual messages and using visual information for communication (Baker, 2012; Tillmann, 2012; Bleed, 2005).
Visualisation	The capability of building a mental image or picture during the process of reading (Draper, 2012).

1.8 POSSIBLE CONTRIBUTION OF THIS STUDY

The findings of this study could provide insight for education stakeholders and curriculum developers in Tanzania, as well as for the mathematics teachers themselves into how classroom instruction is actually conducted in comparison with what is implicitly and explicitly suggested in the curriculum. It is hoped that, based on the findings of this study, some measures will be taken by the education authorities to improve the situation in Tanzanian mathematics classrooms. At the very least, it is anticipated that the findings of this study will contribute to teachers' awareness and knowledge of the value of teaching for visual literacy, and that this awareness may lead to them adapting their instruction accordingly.

1.9 LIMITATIONS OF THE STUDY

This study involved three Form 2 Mathematics teachers from three different secondary schools in the Dar-es-Salaam region, Tanzania. Since the number of participants was small, the findings of this study cannot be generalised beyond that of the present study. However, the findings of this study could be the basis for a similar investigation elsewhere.

1.10 CHAPTER SUMMARY

The literature supports the view that learners learn more effectively visually rather than verbally (Hussain et al., 2014; Murphy, 2009; Avgerinou & Ericson, 2002). The natural tendency of learners to be more interested when working with visual information rather than text starts soon after birth. Subsequently, since mathematics is often regarded as a complex and abstract subject, it is advised that mathematics instruction be visual rather than verbal. Teaching mathematics visually could promote in-depth understanding of mathematical concepts. However, for learners to understand visual information, this requires the development of visual literacy. The acquisition of this skill could enable them to understand concepts through visual information, and also to use visuals in expressing their ideas.

Although the literature (Murphy, 2011; Budram, 2009; Rampersard, 2009) supports the idea that visual literacy plays an important role in learners' understanding, particularly in mathematics, there is little or no evidence that Tanzanian mathematics teachers teach for visual literacy. In fact, studies have found that Tanzanian mathematics teachers transfer knowledge using traditional teaching where the emphasis is on the teaching of the subject content, instead of on how learners learn (Zilimu, 2014; Jidamva, 2012; Eskola, 2009). This kind of instruction hinders learners' understanding because the teacher dominates the teaching process and therefore it prevents learners from developing conceptual knowledge. With this background, this study attempted to conduct a thorough investigation through classroom observations and semi–structured interviews with Tanzanian mathematics teachers to investigate how they teachers teach for visual literacy, as prescribed in the Tanzanian Mathematics Curriculum.

1.11 STRUCTURE OF THE STUDY

This study comprises six chapters, a reference list, and appendices. The chapters are arranged in the order given in Table 1.2 provided.

Table 1.2 Structure of the study

CHAPTER	CONTENT
Chapter 1	Introduction, motivation of the study, aim and objectives of the study, research questions, and methodological considerations, clarification of concepts, possible contribution of the study, limitations of the study, summary, and structure of the study.
Chapter 2	A relevant literature review that includes the following themes: introduction, visual literacy, the role of visual literacy in teaching mathematics, developing learners' visual literacy skills, teaching and learning styles, teaching strategies to teach visual literacy, and a summary of the chapter. The study's conceptual framework is also discussed here.
Chapter 3	A discussion on the paradigmatic perspectives and assumptions, research approach and design, research site, population and sampling, data collection process and instruments, data analysis and interpretation, trustworthiness of the study, ethical considerations, and a chapter conclusion.
Chapter 4	The findings of the study are discussed in detail, and data collected from the lesson observations and interviews are presented and discussed.
Chapter 5	This chapter provides a discussion of the findings derived from the data presented in Chapter 4.
Chapter 6	Chapter 6 deals with the conclusion of the study, recommendations for further studies, and limitations of this study.

CHAPTER 2 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

This chapter comprises a review of the literature concerning the aspects involved in teaching for visual literacy. In this chapter, the meaning of visual literacy, the role of visual literacy in teaching mathematics, developing learners' visual literacy skills, teaching and learning styles, teaching strategies appropriate for developing learners' visual literacy are explored and discussed, where after I conclude the chapter with the conceptual framework and a brief summary of the chapter.

2.2 VISUAL LITERACY

As mentioned in Chapter 1 (Section 1.1.3), children learn from visual input from the first days of their lives, and within the first six months they can easily differentiate two sets that contain different visual items (Bransford, Brown & Cocking, 2000). Similarly, before children reach school-going age, they have usually already developed a very basic form of mathematical proficiency, such as addition, by using the visual items available in their surroundings (Bransford et al., 2000).

The fact that children learn from visual materials with ease can be utilised in teaching as it corresponds with the human nature of learning. Not only can learners' natural propensity for visual learning be used fruitfully in teaching, but visual literacy can be cultivated intentionally to improve learning (Tillmann, 2012; Murphy, 2011; Vasquez, 2010; Budram, 2009; Bleed, 2005; Avgerinou & Ericson, 2002; Stokes, 2002).

2.2.1 Defining visual literacy

Visual literacy has become globally prominent in various knowledge fields, including mathematics education. Although researchers define the term visual literacy differently, these definitions are mainly based on the purpose for which, and the contexts within which it is used (Hattwig et al., 2012; Velders, de Vries & Vaicaityte, 2007). Some of these definitions will now be discussed.

Hattwig et al. (2012), Tillmann (2012), Felten (2010), and Stoke (2002) view visual literacy as a group, a set, or a collection of competencies that enable individuals to understand, interpret, use, generate, and evaluate visual images or messages. Bleed (2005) and Bamford (2003) focus

on the ability to use visual messages for communication. According to Tillmann (2012) and Bleed (2005), a visually literate learner is a good visual communicator who can produce or compose visual messages. In this regard, visual literacy is also associated with the use of visual media, such as still media (i.e. graphs, charts), dynamic media (i.e. animations), and technological media (i.e. computers, calculators) for communication. It can be concluded that being visually literate enables a learner to communicate more effectively through various visuals and text.

The various competencies associated with visual literacy stem from natural human ability and can be further developed through various endeavours and experiences. Debes (as cited in Tillmann, 2012, p. 8), to whom the term 'visual literacy' is credited, views visual literacy as "a group of vision-competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences". Debes further states that the acquisition of visual literacy skills is essential for human learning (Avgerinos, 2009) and could enable an individual to communicate with others visually, and to understand and interpret visual cues or messages presented or encountered within the environment (Avgerinou, 2009; Bamford, 2003). It follows therefore that visual literacy is a powerful tool where different senses are used to come to an understanding of a concept. Thus, learners' different learning styles are addressed.

From a cognitive perspective, Felten (2010), one of the proponents of visual literacy, explains that a major requirement in visual literacy is to make meaning from images. This is in line with Bamford's (2003) and Yenawind's (1990) definition of visual literacy which include the ability to interpret and construct meaning from visual messages. The emphasis on meaning-making resonates with the aims of the present study as it is suggested here that making meaning in mathematics instruction could be facilitated by and enhanced through visual literacy. From this point of view, this study views visual literacy as the ability to construct meaning.

With this perspective in mind, the definition of visual literacy should include the ability to interpret and construct meaning from visual messages (Bamford, 2003; Yenawind, 1990). The emphasis on meaning-making resonates with the aims of the present study as it is suggested here that making meaning in mathematics instruction could be facilitated by and enhanced through visual literacy (previous work). From this point of view, this study views visual literacy as the ability to construct meaning.

Mathematical concepts that are regarded as difficult could be more readily understood if meaning were derived from the visual image that represents the concept. It has been shown that visual media, such as graphs, charts, symbols and calculators, not only help learners to enjoy the learning of mathematics, but also allows them perceive it as a fun and worthy subject (Naidoo, 2012). It can thus be concluded that visual literacy enables learners to not only develop a better understanding of mathematical concepts, but also to recognise the application value of the subject.

2.2.2 Progression towards visual literacy in mathematics teaching and learning

Mathematics touches every aspect of human life, is applied in many fields such as economics and politics, and plays an important role in the development of science and technology (Gambari et al., 2014; Njoroge & Githua, 2013; Maliki et al., 2009). Although it is considered to be a significant subject in human advancement and life in general, the teaching of mathematics remains a challenge for many teachers. Steedly, Dragoo, Arafeh and Luke (2008, p. 8) found that, "Mathematics instruction is a complex process that attempts to make abstract concepts tangible, difficult ideas understandable, and multifaceted problems solvable." These ideas reveal the need to reduce the complexity of teaching mathematics, a need that can be addressed in mathematics by starting to build concepts using a concrete and practical teaching approach.

Reddy (2007) indicates that children prefer to do practical activities and experiment with different things. Objects that can be physically handled and observed create a realistic teaching and learning environment, and also involve learners efficiently in the learning process (Ramirez, 2012; Reddy, 2007). Studies conducted on the teaching of mathematics affirm that mathematics knowledge and skills develop through learning mathematics practically rather than listening to or absorbing the teacher's direct instruction (Cai, Kaiser, Perry & Wong, 2008; Stokes, 2002; Portman & Richardon, 1997). It is through engaging learners effectively in the learning process that mathematical concepts can be conceptualised and grasped more easily.

It may be argued that the concrete mode of representing mathematical ideas and classroom instruction belongs to an earlier (than secondary school) phase of teaching, and to the learning of simple mathematical facts and concepts. I suggest a departure from the concrete mode of representing mathematical ideas and propose that an understanding of complex and abstract

ideas at secondary level should be through visual literacy and imaging. This idea is further elaborated on in Section 2.4 of this chapter.

2.3 THE ROLE OF VISUAL LITERACY IN TEACHING MATHEMATICS

As previously argued, visual literacy seems to play a significant role in the teaching and learning of mathematics. This includes enhancing communication by using visual media and text, simplifying the complexity of concepts, appreciating the value of mathematics (Naidoo, 2012; Murphy, 2011), increasing learner involvement in the learning process (Naidoo, 2012; Murphy, 2011), and inculcating critical thinking (Mudaly, 2010; Budram, 2009; Bamford, 2003). With this as the backdrop, in this section, learning and understanding complex ideas though visual imaging, the accommodation of learner needs, the logical and critical thinking promoted by visual images, and enhanced communication skills are discussed as major components of visual literacy in mathematics instruction.

2.3.1 Visual imaging contributes to the understanding of complex ideas

Mathematics is regarded as a language comprising symbols and concepts that need to be interpreted and understood (Department of Basic Education, 2011; Mudaly, 2010; Konyalioglu, Konyalioglu, Ipek & Isik, 2005; Rubin, 1999). These symbols and concepts, in their various configurations, are generally regarded as a complicated system. It is argued here that visual images such as graphs, charts and tables may reduce the complexity of mathematical concepts, if learners have the ability to interpret visual messages and derive meaning from these (Tillmann, 2012; Murphy, 2011; Ye & Lohr, 2010). However, there is more to visual literacy than merely seeing the image, since "seeing is not simply a process of passive reception of stimuli but involves active construction of meaning" (Felten, 2010, p.61).

The complexity of mathematics as a set of symbols and concepts could be attributed to its increasingly abstract nature at secondary school level. Many ideas at this stage cannot be explained by using physical objects and can only be explained using spoken language. Although it has been specified that representing mathematical ideas visually is one of the effective ways of teaching mathematics (Güler &Çiltaş, 2011), visuals cannot be used alone to make absolute meaning of a concept. Murphy (2011), and Suh and Moyer (2007) contend that mathematics knowledge and understanding are developed through different modalities. Visual media work more effectively in tandem with other modes of representation (Jewitt, 2008) to create comprehensive understanding.

If verbal explanations are accompanied by visual images, the dual modes of explanation could have a greater potential to enhance understanding, and may actually become inseparable (Farrell, 2013; Jewitt, 2008; Rakes, 1999). The verbal explanation of the trigonometric relations between the sides of a right triangle, for example, is unthinkable without the use of visual material. The use of a visual illustration reduces the complexity of the idea and enhances conceptual understanding (Naidoo, 2012; Murphy, 2011; Rampersard, 2009), mainly because the visual image makes these sophisticated relationships more tangible (Stoke, 2002). Another example is the traditionally complex concept of a function, which is hugely simplified by tabling and graphing it.

For complete understanding of complex ideas, Murphy (2011) reasons that mathematics teaching requires a combination of different modalities, particularly numbers, verbal explanations, and images, and all of these should be disseminated together for learning to take place effectively. Thus, the teacher should explain the concept first, then show a visual representation related to the concept, and ultimately represent the idea in symbolic (number) form.

The Tanzanian Mathematics Curriculum document (MoEVT, 2010) insists that teachers use various visual images such as graphs, charts, tables, diagrams and calculators to enhance the understanding of mathematical concepts so that learners can apply knowledge and skills in their future careers. However, it is clear from the research conducted that mathematics instruction in some countries such as Nigeria and Tanzania still relies on the traditional way of teaching (Zilimu, 2014; Festus, 2013; Mudaly, 2010; Eskola, 2009).

2.3.2 Visual imaging accommodates learners' needs

When different modalities of representation are employed in the mathematics classroom, learners with different learning preferences are able to access mathematical information and participate more fully in the learning process. In this way, not only the preferred method of learning, but also the different cognitive levels at which various learners function are accommodated through visual imaging. It is assumed that mathematics has to be understood at four cognitive levels, namely, factual recall, operational skill, conceptual understanding, and problem solving (Department of Basic Education (DBE), 2011).

As far as the cognitive level of factual recall is concerned, there is wide acknowledgement of the fact that visuals support memorisation. According to Aisami (2015) and Roux (2009), the

human brain is more capable of processing visual information than verbal information. Verbal information is more complex and difficult to process and retain in the brain as compared to visual information (Aisami, 2015). Drews (2007) affirms that the use of visual materials for mathematics instruction helps learners to retain information with ease and remember it when solving problems. Okita and Jamalian (2012) concur that usually learners remember more when the mode of classroom instruction is offered visually rather than orally or textually.

As for operational skills, which is the second cognitive level, mathematics learning requires learners' active involvement in order for them to acquire subject knowledge and skills. It also requires learners' full participation in various activities to build operational skills (Hoyles, 1992). It is argued in this study that visual literacy facilitates the active involvement of learners in the learning process.

As far as the affective and motivational aspects of mathematics learning are concerned, the use of visual images or materials in the classrooms could motivate learners to have a more positive attitude towards the subject. It has already been indicated that visuals promote learners' interest, motivation and attention, and stimulates their participation (Aisami, 2015; Ajibade & Ilemi, 2012; Murphy, 2011; Moore & Dwyer, 1994). Clark and Mayer (2011), Budram (2009), and Roux (2009) find that visual materials evoke learners' intrinsic motivation and makes them eager to learn of their own accord because they learn voluntarily (Sengodan & Iksan, 2012). In addition, Budram (2009), at a social or interpersonal level, reports that visual representations enhance support learning thorough interaction among learners. Visual images are also more useful in promoting learners' critical thinking, as discussed below.

2.3.3 Visual imaging promotes critical and logical thinking

Visual literacy in mathematics is a source of critical and logical thinking. Mathematics itself is regarded as a logical and creative discipline, requiring corresponding thinking skills (Alex & Olubusuyi, 2013; Ferguson, 2010; AAAS, 1990). It is contended by Bamford (2003) and Mayer (2014) that visual imaging is a source of critical thinking, and according to Mudaly (2010), the human brain functions more logically and critically in the presence of images. In this regard, the use of visual images could facilitate mathematics teaching. As indicated by Bamford (2003), one of the major methods of developing learners' critical thinking involves the teacher using visual images.

2.3.4 Visual imaging enhances communication

Communication is a process of transferring information from one person to another (Lunenburg, 2010). However, for communication to occur effectively, the sender of the message should use simple and clear language for it to be delivered successfully. Teaching is the process of transferring knowledge from the teacher to the learners, and as such, the teacher is expected to use simple and clear language for learners to achieve the intended learning outcomes.

One of the major aspects of visual literacy is the use of visual language such as graphs, diagrams, symbols, and other visual illustrations for communication (Rokni & Karimi, 2013; Ajibade & Ilemi, 2012; Murphy, 2011; Bleed, 2005; Bamford, 2003). Furthermore, visual language, according to Murphy (2011), expresses information more easily than other languages. Visuals are more easily absorbed, assimilated, and interpreted when compared to verbal information (Aisami, 2015; Rokni & Karimi, 2013; Ajibade & Ilemi, 2012; Bleed, 2005). Once the image or picture has been visualised, the information is sent immediately to the brain for interpretation, with the assistance of the other senses (Mudaly, 2010; Vasquez, 2010).

Murphy (2011) argues that visual language clarifies mathematical ideas more clearly than verbal explanations. A simple diagram, for example, can speak about a complex idea more clearly than words (Murphy, 2011; Vasquez, 2010). Visual language is more concise and precise, hence it can communicate sophisticated ideas more quickly and easily than other languages.

In summary, it is difficult for teachers to clarify and deliver mathematical ideas efficiently using verbal explanations alone. When visual aids are used to express the subject matter or content, it helps learners to understand complicated ideas in concrete ways (Sharma, 2008). However, for learners to easily understand the visual language used during classroom instruction, it is necessary for them to possess visual literacy skills. According to Vasquez (2010), an image or picture cannot clarify or speak clearly if a learner lacks visual literacy skills. Based on this fact, it is important for teachers to develop visual literacy skills in their learners. The next section discusses some measures that can be taken to develop visual literacy skills in learners.

2.4 DEVELOPING LEARNERS' VISUAL LITERACY SKILLS

This section deals with the need to cultivate visual literacy; skills training as a requirement for developing visual literacy; general measures to be taken to develop learners' visual literacy skills; and specific measures to develop their visual literacy skills.

2.4.1 The need to cultivate visual literacy

In the 21st Century, there has been an increase in the use of visual images in every aspect of human life (Murphy, 2011). The world has become saturated with visual images (Tillmann, 2012; Murphy, 2011; Bleed; 2005; Bamford, 2003). The evolution of visual images also affects the education sector since visual images have been integrated, not exclusively in teaching materials, but also in the learning materials that are available to each learner, such as text books. These tools require learners to understand and use them appropriately.

The advancement of visual images also brought the introduction of technology to schooling. According to Tran, Nguyen, Bui and Phan (2014), modern teaching and learning depend very much on technology. To some extent, technological media, such as computers, become a means of classroom instruction as these tools are rich in producing visual images such as graphs, tables, diagrams and other visual illustrations that need to be understood and interpreted by the learners appropriately. In line with this, Felten (2010) indicates that living in a visual era does not necessarily mean that learners possess visual literacy skills. Although, as previously indicated, visual learning and the interpretation of natural visual images is an inborn human ability, the application of visual images in the learning of sophisticated content and complex concepts needs to be systematically cultivated. It has been found that although learners are the main users of visual media, "they are not visually literate" (Metro, 2008, p.108). Studies have found that learners are not able to understand, interpret, analyse, examine or clarify visual images at the same level as they do with textual information. Similarly, they are not able to communicate visually (Hattwig et al., 2012; Metros, 2008). It is suggested in this study that schools should focus on assisting learners to understand visual images and communicate ideas visually, which could help them to derive meaning from visual resources.

Visual literacy is, however, a prerequisite skill, particularly in helping learners to conceptualise visual messages and communicate visually. Usually, learners naturally and spontaneously acquire a lower level of visual literacy skills through personal experience, however, at a higher

level and for sophisticated and complex subject content, such skills must be taught intentionally and systematically (Bamford, 2003; Avgerinos & Ericson, 2002).

2.4.2 Skills training as a requirement for visual literacy

Although there is a natural human tendency to learn from visual images, visual literacy, as argued in the previous paragraph, is not an automatic human skill and has to be developed and improved through training and practice (Felten, 2010; Roux, 2009; Stokes, 2002; Moore & Dwyer, 1994). It is through guided and practical work that learners can acquire visual literacy skills and employ them in various subjects. Based on this assertion, Tillmann (2012) and Murphy (2011) suggest that learners should be trained to be visually literate in the same way that they are taught to be verbally literate. As the main stakeholders in the field of education, teachers should develop visual literacy skills in learners.

2.4.3 General measures to be taken to develop learners' visual literacy skills

Several researchers suggest various ways of developing visual literacy skills in learners. Some scholars, for example, suggest that an appropriate starting point would be the receptive end of visual images, i.e. where the main task is decoding a given image. Learners are then guided to understand, decode, and evaluate visual messages from various perspectives (Cheunga & Jhaverib, 2014; Tillmann, 2012; Roux, 2009; Knoell, 2006; Bamford, 2003; Stokes, 2002). Following decoding, visual literacy training could advance to providing learners with the opportunities to generate or encode visual representations themselves (Vasquez, 2010; Schönborn & Anderson, 2005; Bamford, 2003; Lowe, 2000).

Likewise, learners must be given opportunities to use technological media, such as computers, for various subject content and ideas in their learning. Research has shown that the effective use of technological media in teaching and learning enhances the development of visual literacy skills (Bennett & Roblyer, 2014; Bamford, 2003; Sims et al., 2002). However, the results may be more effective in a particular discipline if the teacher employs specific measures to develop these skills in the learners.

2.4.4 Specific measures to develop learners' visual literacy skills in mathematics

Lowe (2000) points out that understanding visual messages that are used in a particular discipline requires learners to be knowledgeable about the subject elements, which can best be learnt through imagination. As a way of enhancing visual literacy skills, mathematics teachers

must therefore focus on activities where visual literacy is cultivated by constantly providing learners with stimulus to engage the brain.

From teachers' perspective, as pointed out by Murphy (2011), mathematics teachers could provide and employ visuals in every aspect of classroom instruction, for example, in introducing and explaining concepts, in applying concepts within problems, and in extending concepts to related ideas. Similarly, they should motivate learners to express ideas or solve mathematical problems visually (Murphy, 2011). They could also assign learners to work cooperatively in small groups to generate new mathematical ideas (Murphy, 2011). In addition, learning activities should make use of, or should even be based on drawing activities (Murphy, 2011).

It follows that the development of visual literacy skills in learners requires creativity from teachers in designing learning tasks that provide learners with opportunities to practise, such as solving problems using visual representations. Actually, the more learners practise, the better their acquisition of visual literacy skills. Although teachers should maximize the use of visual images and encourage learners to represent whatever they know visually (Felten, 2010), it is also important for teachers to adapt their teaching styles to learners' learning styles.

2.5 TEACHING AND LEARNING STYLES

2.5.1 Aligning teaching styles with learners' needs

Teaching and learning styles are important aspects of classroom instruction. However, effective teaching is teaching that is aligned with learner needs. Since individual learners' cognitive abilities differ, the teaching style has to take into consideration all learners' cognitive differences in order to fulfil their learning requirements (Zeng & Gao, 2012; Muijs & Reynolds, 2011; Franzoni & Assar, 2009; Idrisa, 2006). Furthermore, teaching has to be aligned with individual learner's learning styles, which is important in enhancing a learner's understanding. A mismatch between the teaching style and learning style could affect learners' acquisition of knowledge (Muhundan, 2011; Franzoni & Assar, 2009; Geche, 2009; Sankey, 2003).

2.5.1.1 Clarification of the term 'teaching style'

The term 'teaching style' refers to the way in which the teacher instructs the subject (Grasha, 2002). However, a proficient teaching style is one that takes into consideration all learners' learning preferences. The correspondence of the teacher's teaching style and learners' learning

styles can promote learners' attention; consequently, they could acquire the knowledge more readily (Adnan, Abdullah, Ahmad, Puteh, Zawawin & Maat, 2013; Sengodan & Iksan, 2012; Muhundan, 2011; Geche, 2009; Ford & Chen, 2001).

2.5.1.2 Types of teaching styles

Several teaching styles have been acknowledged in the literature (Grasha & Yangarber-Hicks, 2010; Grasha, 2002). In the expert teaching style, the teacher is central and is the owner of knowledge (Grasha &Yangarber-Hicks, 2010; Grasha, 2002). In the personal style, the teacher is merely a facilitator of knowledge, and the instruction is learner-centred (Grasha &Yangarber-Hicks, 2010; Grasha, 2002). In the style where the teacher is the delegator, learners work independently either individually or in small groups, while the teacher acts as a consultant and resource manager (Grasha &Yangarber-Hicks, 2010; Grasha, 2002).

Teaching styles differ in the way they have been designed to support classroom interaction (Canto-Herrera & Salazar-Carballo, 2010). However, the most effective teaching style actively involves learners in their own learning process, and allows learners to enjoy and value their learning. It has been found that learners who take an active and leading role in their learning are more successful in acquiring knowledge than those who do not and who stay passive receivers of knowledge (Sengodan & Iksan, 2012). The difference between a learner-centred and a teacher-centred teaching style will be briefly discussed.

2.5.1.3 The learner-centred teaching style

In the learner-centred teaching style, there is great emphasis on empowering learners in their learning (Brush & Saye, 2002; Weimer, 2002), thus it shifts the initiative and the responsibility of learning to the learners themselves (Brush & Saye, 2002; Weimer, 2002). In this teaching style, learners become the source of their learning by controlling and organising their learning activities while the teacher supervises them (Wangeleja, 2010; Brush & Saye, 2002; Weimer, 2002). Learners who are given the opportunity to take a central part in their learning are goal directed and work towards acquiring the intended learning goal.

The main focus of the learner-centred teaching style is learners' actions and not the teacher's actions (Weimer, 2002). The whole process of learning is based on carrying out learning activities rather than on only listening to the teacher (Wangeleja, 2010; Serbessa, 2006; Weimer, 2002). To facilitate this, the teacher creates opportunities for learning at learners' own

pace, offers short explanations, allows learners to discuss with their peers, and to do practical work (Boumová, 2008). By applying a learner-centred teaching style, learners become the source of productive ideas that will be useful in their future lives.

Primarily, learning in the learner-centred environment takes place in small groups where learners are involved in various learning tasks that focus on knowledge discovery (Azeem & Khalid, 2012; Foster, 2008; Serbessa, 2006; Brush & Saye, 2002; Weimer, 2002). The learning process in such an environment is dominated by discussion, interaction and doing practical work such as experiments (Azeem & Khalid, 2012; Boumová, 2008). The main aspect of the learner-centred teaching style is thus to promote self-exploration of knowledge so that learners can generate their own understanding and knowledge based on what they already know.

A learner-centred teaching style also takes individual cognitive abilities and representational preferences into consideration. Classroom instruction is offered here using multiple representations in order to fulfil learners' cognitive needs (Grasha &Yangarber-Hicks, 2010; Boumová, 2008; Forster, 2008; Sankey, 2003). However, since not all learners are self-driven, and some experience problems in taking the initiative in their own learning, learning may become difficult in the absence of the teacher's support. The role of the teacher cannot be ruled out completely and in some instances, the teacher-centred teaching style has a place in the classroom, as discussed below.

2.5.1.4 The teacher-centred teaching style

Unlike the learner-centred teaching style, the teacher-centred teaching style allows the teacher more authority. The teacher dominates the classroom instruction by disseminating knowledge to the learners (Azeem & Khalid, 2012; Kaur, 2011). In classrooms where the teacher-centred teaching style is used, learners are only partially involved in the learning process. According to Al-Zu'be (2013) and Azeem and Khalid (2012), a teacher-centred teaching style does not provide enough opportunity for learners to participate fully in the learning process, and thus they are supposed to accept whatever the teacher presents to them. Due to this, a teacher-centred teaching style hinders learners' creativity and contribution of ideas, encourages rote learning, and discourages learning from understanding (Azeem & Khalid, 2012; Covill, 2011; Kaur, 2011).

The main focus of teachers who use this teaching style is the completion of the syllabus rather than learners' acquisition of important knowledge and skills (Azeem & Khalid, 2012; Kaur,

2011). It is for these reasons that it can be said that a teacher-centred teaching style on its own does not equip learners with sufficient knowledge and the skills that they need to authentically solve the problems that emerge in society or in their lives.

2.5.1.5 Visual literacy and learning styles

Visual literacy draws on characteristics from both the teacher-centred and learner-centred teaching styles in classroom instruction, and acknowledges both styles as important for learning (Al-Qaisi, 2010). A learner-centred teaching style has obvious advantages over a teacher-centred style, however, without the teacher's assistance, learning may not take place effectively. As the facilitator of the learning process, the teacher plays an important role in designing the learning activities, inculcating learners' critical thinking through questions, facilitating cooperation and collaboration in the classroom, and promoting the active involvement of learners (Grasha & Yangarber-Hicks, 2010; Muijs & Reynolds, 2010). However, an effective teacher must make sure that all learners are involved in the learning process. This is not possible without taking into consideration learners' learning styles and their learning preferences. The following section discusses learners' learning styles and their modes of acquiring knowledge.

2.5.2 Learning styles

The term 'learning style' refers to the way in which an individual attains, perceives, interprets, organises, and remembers information (van der Wal, 2015; Adnan et al., 2013; Muhundan, 2011; Geche, 2009; Stokes, 2002). Learning styles are closely related to the learning preferences that motivate learners to be interested in classroom presentations (Muhundan, 2011). The classroom practice of a teacher should therefore suit all learners' learning styles.

2.5.2.1 Types of learning styles

Several learning styles have been acknowledged by a number of authors, however, the major styles are: visual, auditory, and kinaesthetic (V-A-K) learning styles (Aisami, 2015; Gilakjani, 2012; Muhundan, 2011). Primarily, visual learners acquire knowledge by observing existing images or visualising imaginary images. Learners with an auditory preference in learning acquire knowledge more readily by listening to direct instruction, such as a lecture, while kinaesthetically inclined learners acquire knowledge easier by being involved in hands-on activities (Aisami, 2015; Gilakjani, 2012; Muijs & Reynolds, 2011). It follows that good

classroom instruction should attempt to accommodate the various learning preferences or styles.

2.5.2.2 Learning styles and classroom instruction

If good classroom instruction takes account of all learners' learning preferences, there is no room for a rigid and monotonous teaching style. In fact, such a style could disadvantage those learners who cannot understand the delivered information. Maintaining a single teaching style could bore some learners and make them passive in the class; consequently, they could lose interest in the subject (Muhundan, 2011).

2.5.3 Visual literacy and learning styles

Multiple representations, as pointed out by Aisami (2015) and Schnotz (2002), support learning through varied learning styles. According to Oshinaike and Adekunmis (2012), learners acquire more knowledge when various teaching modalities are employed and when they are actively involved in their learning tasks. Multiple representations of learning content contribute to learner efficiency in executing various learning tasks. Teaching that includes visual literacy focuses on the use of different modalities to enhance learning for all learners.

As indicated in Section 2.3.1, visuals and verbal information are inseparable in classroom instruction. The use of visuals in the classroom adds a representational modality to teaching, which accommodates all learners according to their learning preferences. The following section discusses some teaching strategies that could promote visual literacy in the classroom.

2.6 TEACHING STRATEGIES FOR VISUAL LITERACY

The term teaching strategies refers to the approaches or methods used to deliver the message in order to achieve the intended learning goal (van der Wal, 2015; Wandberg & Rohwer, 2010). There is no single teaching strategy that can facilitate learning for all learners at all times (van der Wal, 2015). According to Portman and Richardon (1997), learners acquire knowledge more readily when different teaching strategies are employed and therefore good classroom instruction should consist of various teaching strategies.

Teaching mathematics to develop visual literacy skills requires the use of teaching strategies that enhance active participation and self-discovery of knowledge. Furthermore, the deliberate connection of classroom materials to real life experiences facilitates conceptual understanding

of mathematical concepts. Some teaching strategies that are promising in realising the goal of visual literacy in mathematics include traditional teaching; group work, in particular cooperative learning; discovery; problem-based learning; as well as multimedia instruction (van der Wal, 2015; Christopher, 2011; Wandberg & Rohwer, 2010; Mayer, 2005). It would be ideal to combine various teaching strategies to provide a wide range of learning perspectives in the classroom. Based on the views of different authors, these teaching strategies will now be discussed.

2.6.1 The traditional teaching strategy

The main characteristic of the traditional teaching strategy is that direct information is provided or delivered to the learners by the teacher (Hadžimehmedagić & Akbarov, 2013; Azeem & Khalid, 2012; Covill, 2011; Ferguson, 2010; Solso, 2009; Boumová, 2008; Serbessa, 2006; Peng, 2002). Additionally, the teacher provides rules and algorithms for solving problems, which learners must remember and apply in learning activities and in assessments (Boumová, 2008).

The typical protocol in a mathematics classroom where traditional teaching takes place is that the teacher revises the previous lesson, explains and defines new concepts, and solves a number of examples. Learners then do exercises and homework based on what has been taught (Kaur, 2011; Ferguson, 2010; Boumová, 2008). Thus, learners' involvement in contributing their ideas rarely occurs (Azeem & Khalid, 2012). The main focus of teachers who use a traditional teaching strategy is the achievement of the goals and objects of the syllabus rather than learners' understanding of the subject matter (Azeem & Khalid, 2012; Kaur, 2011). The result may be a lack of learner motivation to acquire the knowledge and skills used in problem solving, as all shortcuts, rules and formulae are readily provided.

Traditional teachers believe that learners can acquire essential knowledge and skills and use them by attending classroom presentations (Boumová, 2008). According to these teachers, when learners are able to use rules and procedures provided to them, they have already acquired the necessary skills and have reached the intended learning goals (Ferguson, 2010; Boumová, 2008). Nevertheless, the ability to apply rules and procedures when solving problems does not necessarily reflect learners' understanding. Learners who can memorise rules, formulae and facts, but who have not been given the opportunity to participate in the generation of meaning, have fewer chances of developing deep conceptual understanding.

A traditional teaching strategy results in a teacher-dominated learning process, where learners are involved at most through asking them questions and through allowing them, individually, to demonstrate an algorithm or a calculation on the chalkboard (Molefe & Brodie, 2010; Boumová, 2008). The value of a question-and-answer teaching strategy depends on the type of questions that teachers ask. Molefe and Brodie (2010) postulate that questions can involve learners effectively in the learning process, provided that the teacher uses higher-order questions. However, the typical simple, closed ended questions used in the traditional teaching environment are of a lower order and do not inculcate critical thinking in learners (Güler & Çiltaş, 2011; Molefe & Brodie, 2010). Questions of a lower order require lower level thinking skills like direct factual recall, short explanations, and direct procedures, which impact negatively on classroom participation and cooperative learning (Güler & Çiltaş, 2011; Kaur, 2011; Molefe & Brodie, 2010). In addition, they do not connect learners with real life or authentic problems, which are essential in influencing a problem-based learning environment.

2.6.2 Problem-based learning

In the problem-based learning (PBL) strategy, teaching is learner-centred and learners are involved in social activities based on their learning, mostly in small groups (van der Wal, 2015; Ari & Katranci, 2014; MacMath, Wallace, & Chi, 2009; Cazzola, 2008; Hung, Jonassen, & Liu, 2008; Savery, 2006). This learning strategy is primarily based on the various elements of a problem that calls for solutions and therefore the learning process focuses on learners solving problems (Ari & Katranci, 2014; Padmavathy & Mareesh, 2013; Hung et al., 2008). Conversely, the types of problems that serve as the basis of this strategy are real life or authentic problems and problems requiring higher-order thinking (Ari & Katranci, 2014; Padmavathy & Mareesh, 2013; Güler & Çiltaş, 2011; Molefe & Brodie, 2010; Hung et al., 2008; Savery, 2006). According to Ferguson (2010), when learners are able to connect new ideas with their prior knowledge or real life experiences, they may be able to understand concepts better and recall information more easily.

Problem-based learning (PBL) is an approach that is perfectly suited to teaching and learning mathematics because mathematics is basically centralised around the solving of problems. One of the main foci of teaching mathematics, as stated by Budram (2009), is to equip learners with the necessary knowledge and skills to solve problems. A PBL strategy affords learners the opportunity to solve open-ended mathematical problems by using their own strategies (Crowley, 2015; Budram, 2009). Since there is no preferred, specific or prescribed way of

solving the problem, learners become more creative and analytical in finding effective ways to solve the problem.

Budram (2009), citing Montague, states that solving mathematical problems is a challenging cognitive activity that encompasses various procedures and strategies. "It involves a puzzling situation that needs to be resolved although there is no clear and unique solution" (Budram, 2009, p.17). Solving mathematical problems is traditionally seen as a sophisticated process, however, with the use of PBL, problem solving may come within reach for all learners. Güler and Çiltaş (2011) argue that the modern strategy of teaching mathematics through PBL is a scientific method that requires learners to employ several cognitive processes. These processes include interpreting the problem, selecting relevant information for solving the problem, designing an appropriate plan, solving the problem, and presenting the possible solutions or the findings in the most suitable format (Padmavathy & Mareesh, 2013; Güler & Çiltaş, 2011; Budram, 2009). The fundamental goal of problem-based learning is to enhance in-depth learning. According to Budram (2009, p. 18), "Learning through problem solving will make learners better problem solvers, as they will discover for themselves." Studies have shown that problem-based learning is indispensable in other disciplines as well, for example, for learners who are doing medical courses, particularly in discovering medical solutions to patient problems.

PBL is closely related to discovery learning. Since the learning process requires several cognitive processes, learners often tend to try out several procedures and strategies for solving the problem before they come up with the appropriate answer(s). Through the process of trial and error, and ultimately improvement, learners may discover new ideas and knowledge.

2.6.3 Discovery learning

Discovery learning is an inquiry-based teaching strategy where learners generate new ideas based on what they already know (Tran et al., 2014; Yang, Liao, Chang, Cheng & Chen, 2010). Within an inquiry-based learning approach, learners go through the process of searching for relevant information about the problem, formulating hypotheses and providing findings that are based on what they have discovered for themselves (Tran et al., 2014). It is clear that discovery learning is also a learner-centred teaching approach (Tran et al., 2014). Supporters of discovery learning do not believe in the acquisition of useful knowledge and skills from instructional materials only or directly (Yang et al., 2010). Rather, they believe that effective

and deep learning can only take place when learners are given the opportunity to discover and generate important information about their learning, as well as the chance to explore the strategies that govern their learning (Yang et al., 2010).

Polya (as cited in Tran et al., 2010) states that the main purpose of mathematics education is to promote thinking, although this can be achieved only if learners take the initiative in, and responsibility for their own learning. One of the major aspects of discovery learning is for learners to take primary accountability for their learning, particularly in exploring and solving problems, which in turn could lead them in the process of discovering (Castronova, 2008). In this case, the teacher should typically pose a question based on the subject topic and challenge learners to find a solution (Tran et al., 2014).

The contribution of visual tools in discovery learning is mentioned by some authors (Budram, 2009; Castranova, 2008; AAAS, 1990) and described as being valuable within the discovery learning approach, for example, when a learner has a graph available, the trend (growth or decline) in a quadratic function can be observed. A complicated idea like a quadratic function, if graphically represented in a parabola, assists the discovery of the true meaning of the function. According to Budram (2009, p. 21), a visual representation gives the problem solver a clear understanding "of the structure of a problem", a notion with which Castranova (2008) concurs, adding that visual tools simplify discovery learning. Discovery learning has proved to be more successful when implemented in small groups (Tran et al., 2014). It is advisable therefore to implement cooperative classroom strategies where learners work in groups within the discovery learning approach.

2.6.4 Group work and cooperative learning

Cooperative learning is another useful teaching strategy where the emphasis is on learning that takes place cooperatively or collaboratively in small groups or pairs, and where learners teach one another to reach the intended learning goals (van der Wal, 2015; Flynn, 2013; Slavin, Sheard, Hanley, Elliott, Chambers & Cheung, 2013; Aziz & Hossain, 2010; Dooly, 2008; Eisenhauer, 2007; Hillen, 2006; Walmsley & Muniz, 2003). In the cooperative learning approach, each group member becomes responsible for his/her own learning and also for that of other group members (Dooly, 2008). According to the scholars who advocate this approach, cooperative learning does not suppress learning initiative, on the contrary, the primary goal of cooperative learning is to maximise learners' learning through their own initiative.

As indicated earlier, mathematics teaching requires that learners become actively involved in their own learning. Hillen (2006) claims that learner involvement is more effective in small groups rather than in a large group (a whole class), and learners are more active in a small group learning environment.

Ideally, the learning of mathematics is a collaborative process, requiring social interaction through communication among learners (Eisenhauer, 2007; Hillen, 2006). Eisenhauer (2007) further points out that cooperative learning in the mathematics classroom enables learners to assist one another at various levels of learning, including the understanding of mathematical ideas, procedures, strategies, as well as solving mathematical problems, which promotes their mathematical abilities and confidence. Flynn (2013, p. 2) adds that cooperative learning actively involves learners in learning mathematics and supports their learning by providing a learning environment where they can "discuss, justify, investigate and challenge their ideas," as well as communicate mathematical ideas with their peers. It has been found that when learners learn from their peers, their understanding improves more than when learning from their teacher (Hillen, 2006). Additionally, it helps them to identify various approaches to solving problems (Eisenhauer, 2007; Hillen, 2006; Walmsley & Muniz, 2003).

Learners' understanding is promoted when they are provided with opportunities to express their ideas, listen to others, ask, elaborate, hypothesise, defend their solutions, and explore other approaches to solving problems. This also promotes their reasoning ability (Eisenhauer, 2007; Hillen, 2006; Walmsley & Muniz, 2003) and helps them to identify their misconceptions (Slavin et al., 2013). However, cooperative learning, according to Slavin et al. (2013), is more efficient when teachers use multimedia instruction, an aspect of teaching that will now be discussed.

2.6.5 Multimedia instruction

In a multimedia approach to instruction, the educational message is delivered by using both verbal explanations (words) and visual images in order to facilitate learners' learning (Mayer, 2005). The words can be in the form of a text or narration, while visual images can be still images, such as charts, graphs and illustrations, or dynamic, such as animations or audio-video recordings (Mayer & Moreno, 2010; Mayer, 2005). In view of the fact that learning takes place more effectively when different modalities are employed, multimedia instruction seems promising for the promotion of enhanced learning (Mayer & Moreno, 2010; Mayer, 2005).

The Dual Coding Theory assumes that learning is facilitated when both verbal and visual information can be accessed and integrated (Mayer, 2005; Baddeley, 2004). This is because the human brain has two interconnected information channels, which are the verbal and visual channels (Mayer & Moreno, 2010; Mayer, 2005). The separation of visual and verbal information may lead to a cognitive overload in the learner's brain and hence may affect the process of learning in a negative way (Mayer & Moreno, 2010; Sankey, 2003).

In order to facilitate learners' understanding, the different modalities that can be employed in a multimedia approach to instruction are, amongst others, images, graphics, animations, and sounds, with the assistance of textual information (Oshinaike & Adekunmis, 2012). In other words, multimedia instruction offers the teacher the opportunity to combine text or verbal explanations with visual media such as still or technology or dynamic media, as discussed in the sections below.

2.6.5.1 Still media

Holzinger, Kickmeier-Rust and Albert (2008) define still media as written words and/or images, such as graphs. Still media also can be physical models that can be toughed, cut, folded and moved by the learner. Still media are among the essential tools of multimedia instruction in teaching mathematics. Apart from enhancing learners' understanding and involvement, still media such as pictures, graphs, charts, tables, maps and other visual information simplify the derivation of mathematical concepts (Budram, 2009). Budram (2009) goes as far as to speculate that classroom instruction could be ten times more effective by integrating visual information into the classroom discourse, either in a physical form or as an image, to clarify the classroom presentation. Researchers (Kang, 2004; Rakes, 1999) affirm that still images clarify and communicate complex ideas in a simple and meaningful way and that, by using them, learners could receive a fully rounded understanding of the subject matter.

2.6.5.2 Dynamic media

Dynamic media refers to animations, simulations, or models (Ainsworth, 2008; Holzinger et al., 2008) where there is an element of movement or even interaction. A concept model can be a three-dimensional representation figure or thing, a proposed structure, or something that can be changed. According to Holzinger et al. (2008), dynamic media is divided into two groups, namely, interactive media such as computers, and non-interactive media such as animations (Holzinger et al., 2008). This study takes into account both of these categories because they

both can be applied in mathematics instruction. Researchers such as Ainsworth (2008) and Holzinger et al. (2008) applaud dynamic media for its crucial role in helping learners to conceptually understand complex ideas.

One of the major characteristics of animations, as one form of dynamic media, is to display information that changes over time (Ainsworth, 2008). Some mathematical concepts such as trigonometric graphs, transformations, translations, speed and velocity, amongst others, possess the characteristic of change. Ainsworth (2008) further affirms that animations are instrumental in teaching dynamic concepts such as transformation, translations, and transitions. The effective use of animations in mathematics classrooms, according to Gambari et al. (2014), can promote learners' understanding and retention of mathematical ideas and facts since these tools promote attention, interest and engagement, and make learners susceptible to learning.

2.6.5.3 Technological media

Technological media, like calculators and computers, open up more pathways to present ideas in various ways (Gilakjani, Leong, & Ismail, 2013; Joshi, 2012; Okita & Jamalian, 2011; Niess, 2006; National Council for Teachers of Mathematics (NCTM), 2000). In fact, technological media facilitates multimedia instruction (Glenn & D'Agostino, 2008). By using a computer, for example, the teacher can coordinate and combine verbal explanations and visual representations (Gilakjani, 2012; Mayer & Moreno, 1999). Calculators, computers, and other technological media facilitate the delivery of mathematical concepts visually and effectively, as discussed in the section below.

2.6.5.3.1 Calculators

Some teachers do not regard calculators as efficient in mathematics learning, and reason that they pose a threat to learners' thinking abilities. Calculators have, however, become an indispensable mathematical teaching tool and may in fact contribute to understanding and the development of mathematical skills (Salani, 2013; Mason, 2010). Apart from supporting computational skills (Salani, 2013; Mbugua, Muthomi & Githua, 2012; Mason, 2010), calculators provide opportunities for interaction with the subject content. With calculators, learners become directly involved in mathematical activities and this provides them with a wide scope to explore and investigate various mathematical concepts (Mason, 2010). Learners can compute mathematical problems more easily, quickly, and effectively with calculators than with paper and pencil (Mbugua et al., 2012; Mbugua, Muthomi & Okere, 2011). Tedious

calculations with paper and pencil may demoralise learners and reduce their interest in mathematics. Calculators afford learners first-hand experience of exploring mathematical procedures for themselves instead of observing the teacher doing it (Salani, 2013; Tajuddin et al., 2009; Ye, 2009).

A further modern advancement is graphing calculators, which may be used in the teaching and learning of mathematical concepts such as finding the root of numbers, manipulating symbols, integrating complex numbers, finding determinants, solving problems, and performing various computations (Tajuddin, et al., 2009; Ye, 2009). Graphing calculators offer a wide range of opportunities for learners to generate various visual representations and to visualise graphic structures more vividly (Tajuddin, et al., 2009; Rubin; 1999). Graphing calculators offer multiple representations to explore, test, approximate, solve problems, and visualise different mathematical concepts, hence they promote the understanding of complex mathematical ideas (Mason, 2010; Tajuddin, et al., 2009; Ye, 2009; Roschelle, 2006).

2.6.5.3.2 Computers

Computers can be regarded as a dynamic medium, offering more visual and interactive material than traditional media (Bamford, 2003; Sankey, 2003). Computers provide a wide range of opportunities for learners to explore, inspect, and test mathematical concepts (Gebrekal, 2007; Rubin, 1999). Furthermore, the use of computers enables access to knowledge via various teaching modalities (Gambari et al., 2014), such as auditory, textual, and visual information.

Computers create opportunities for interactive learning in a pleasant and convenient learning environment. Unlike the traditional teaching environment, Okita and Jamalian (2011) reason that computer learning environments affect the degree of active involvement of learners in their own learning processes. Furthermore, computer-based learning may take place either individually or in small groups (Han, Halim, Shariffuddin & Abdullah, 2013; Achary, 2011), which could promote cooperative learning.

Teaching mathematics by using the computer has a number of advantages. Researchers (Okita & Jamalian, 2011; Aydin, 2010) have found that Computer Assisted Learning (CAL) enhances learners' understanding of new and complex mathematical concepts, as well as the use of those concepts. The visual aspect involved in mathematical CAL supports the transition from abstract ideas to tangible visual objects (Okita & Jamalian, 2011; Aydin, 2010). Mkomange, Ilembo and Ajagbe (2012) mention the quality of computers as being instrumental in the visualising

of abstract ideas, and in creating a virtual reality in the learning environment. Additionally, Gebrekal (2007) states that computer assisted mathematics teaching promotes problem-solving skills and creates the opportunity to generate graphs, in particular, graphic images of functions.

2.6.6 Visual literacy and teaching strategies

As discussed previously, teaching mathematics to develop visual literacy highlights a number of teaching strategies. As the main focus is to empower learners in their learning, both teacher-centred and learner-centred teaching styles are important in a learner's learning (Al-Qaisi, 2010). This implies that without a traditional teaching strategy, learning cannot take place effectively. As stated by Boumová (2008), some important aspects of learning, such as the clarification of concepts, definitions and examples, cannot be taught without the teacher's direct instruction. Similarly, in teaching mathematics, learners need proper guidance, especially with regard to new concepts, terminology, calculation strategies, and mathematical notation. The provision of information does not hinder learning, but actually plays a part in promoting a situation where the teacher may guide and facilitate the learning process and learners can solve various problems on their own.

Alternatively, the main characteristic of visual literacy is the application of knowledge in a real life situation. However, this can be achieved if the teacher uses authentic or higher-order problems or questions during classroom instruction. According to Molefe and Brodie (2010), these higher-order problems and/or questions influence cooperative learning in the classroom.

The efficacy of visual literacy in support of cooperative learning has been lauded in the research. Roux (2009), for example, points out that the integration of visual materials in classroom instruction, apart from developing visual literacy skills, also promotes discussion, negotiation, argumentation, involvement, and interaction amongst the classroom members. Naidoo (2012) observes that when visual tools are used for instruction, the classroom resembles a small community where learners discuss the topic as a group until they reach a consensus. In solving problems, Budram (2009) reasons that when learners have been given problems to solve visually, it could spontaneously result in cooperative learning.

The tendency to only use numbers and symbols in solving mathematical problems could strengthen the perception that mathematical problems are abstract and complex. However, if visual tools are used to support the problem solving process, it could serve to reduce the abstraction of mathematical problems, and clarify aspects of the problem during all of the

problem solving stages. Budram (2009) supports visualisation as a significant tool in problem solving to enhance learner understanding. Visual literacy is not only about the ability to use a visual illustration to explain textual information, but also about the ability to use visual illustrations in the process of discovering one's own strategies and procedures in solving mathematical problems.

In summary, through solving problems together cooperatively under the teacher's supervision, and with the aid of visual media, it will be easier for learners to discover and generate their own knowledge and understanding.

2.7 CONCEPTUAL FRAMEWORK

The conceptual framework of this study was generated from the collective views of researchers who put forward various perspectives, firstly regarding teaching for visual literacy in the mathematic classroom, and secondly, regarding the acquisition of visual literacy by learners. Three major components of teaching for visual literacy crystallised through the literature review, namely: teaching styles, teaching strategies, and the way teachers conduct classroom instruction using text and visual media. Learners' acquisition of visual literacy skills as the outcome of teaching for visual literacy was also part of the focus of this study.

From the literature review, it became clear that teaching styles, be it teacher- or learner-centred, are key to learners' understanding (Muhundan, 2011; Ford & Chen, 2001). It is argued here that a learner-centred teaching style creates a learning environment where visual literacy may be cultivated, however, the teacher-centred teaching style is not to be ruled out as obsolete, since learners need the teacher's presence and assistance. This notion is supported by a number of authors (Wangeleja, 2012; Grasha & Yangarber-Hicks, 2010; MoEVT, 2010; Weimer, 2002), who argue that in the learner-centred style, the teacher's facilitation and mentoring still play an important role in learners' understanding of the subject matter. It is argued here that effective teaching for visual literacy requires the accommodation of both teacher- and learner-centred teaching styles.

In a teaching environment that aims for the cultivation of visual literacy, various teaching strategies should be combined, such as traditional teaching, cooperative/collaborative learning, discovery learning, problem-based learning, and multimedia instruction (van der Wal, 2015; Christopher, 2011; Wandberg & Rohwer, 2010; Mayer, 2005; Prince, 2004). It is suggested here that the incorporation of such teaching strategies within Learning and Teaching Through

Visual Media (LTVM) influence learners acquisition of visual literacy skills by involving them in the various learning activities that could provide an opportunity to interpret visual information and use visual media (Cheunga & Jhaverib, 2014; Tillmann, 2012; Brumberger, 2011; Murphy, 2011; Vasquez, 2010; Yeh & Lohr, 2010; Knoell, 2006; Schönborn & Anderson, 2005; Bamford; 2003; Stokes, 2002; Lowe, 2000). These were therefore the core elements that informed the conceptual framework that was used in developing the data collection instruments and the data analysis of this study.

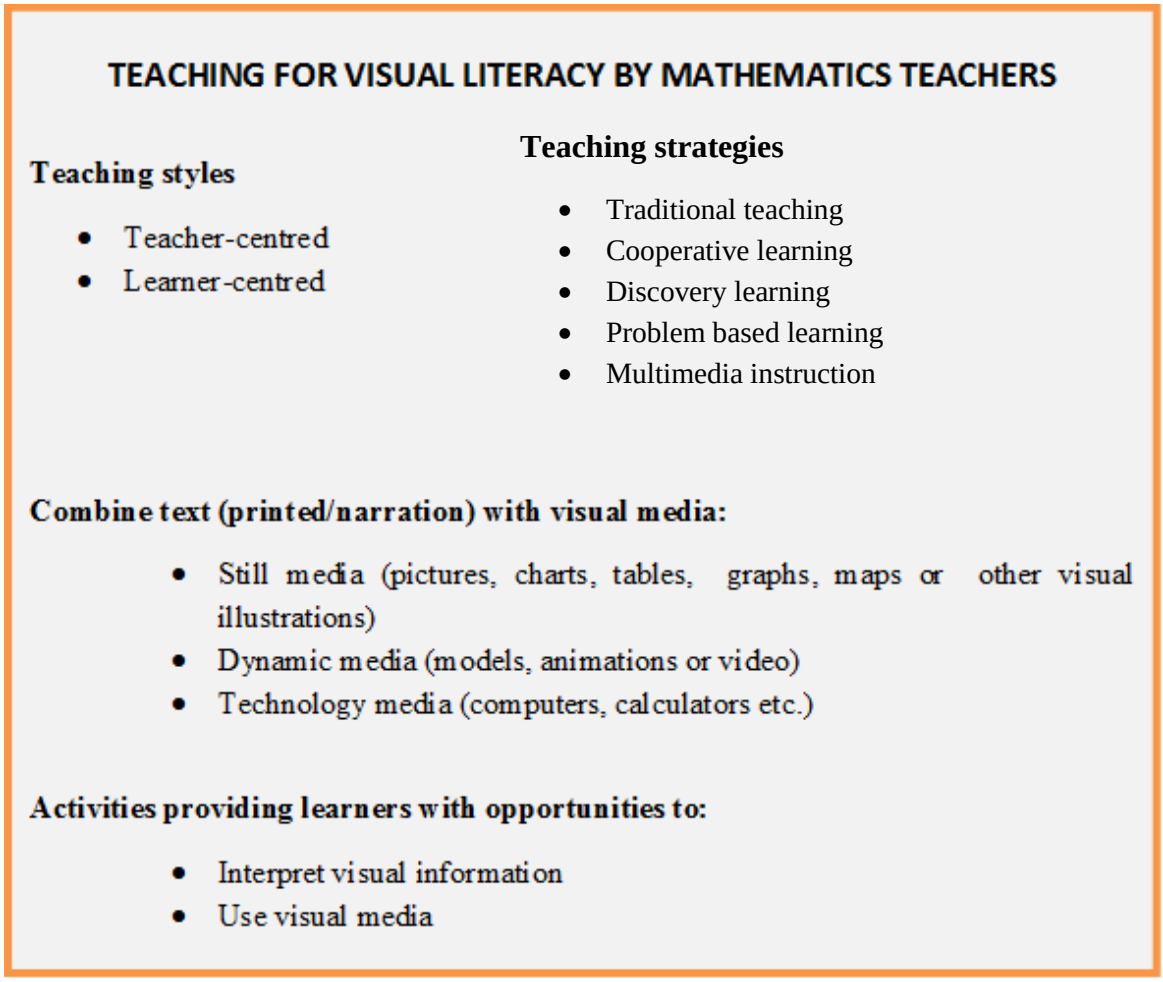

Figure 2.1 Conceptual framework: **Teaching for visual literacy by mathematics teachers**

2.8 CHAPTER SUMMARY

In this chapter, various aspects of visual literacy were addressed. The chapter began by presenting and discussing different views on the meaning of the term visual literacy and its roles in the teaching of mathematics. Moreover, the researcher discussed how teachers can develop visual literacy skills in their learners. Similarly, the issue of appropriate teaching styles

and learning for visual literacy classroom instruction was discussed in detail. In addition, the teaching strategies preferred for teaching mathematics to develop visual literacy skills were also examined. Finally, the conceptual framework of this study was presented. In the next chapter, the research design and methodology of this study are discussed.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The aim of research methodology is to give the researcher insight into how to carry out a study in order to achieve the study objectives. This chapter therefore details how this was done for this study in terms of the research design and methodology used. This includes the research paradigm and paradigmatic assumptions; the research approach and design; research site, population and sampling; the data collection process and instruments; data analysis and interpretation; the trustworthiness of the study; ethical considerations; and a conclusion to the chapter.

3.2 RESEARCH PARADIGM AND ASSUMPTIONS

This study investigated how Tanzanian mathematics teachers teach for visual literacy. In order to obtain an in depth understanding of the phenomenon being studied, as a researcher, I needed to ask myself how I view the world, and what I took understanding to be (Cohen et al., 2011). Based on these aspects, the research paradigm and three paradigmatic assumptions, namely, ontology, epistemology, and methodology will now be discussed.

3.2.1 Research paradigm

Knowledge is the product of collective ideas rather than a few unrelated ideas, and thus by interacting with the teachers in the study, I, as the researcher, could come to an understanding about the phenomenon. This study was based on a social constructivist paradigm that assumes that knowledge is socially constructed and is based on people's prior knowledge and experiences in a specific social setting (Creswell, 2014; Maree, 2012; Ültanır, 2012; Karagiorgi & Symeou, 2005; Swan, 2005). To construct meaning from the way in which these Form 2 mathematics teachers taught for visual literacy, I had to experience their instructional practices. Constructivists claim that knowledge cannot be transferred, but it should be constructed by people themselves (Gilakjani et al., 2013; Kunter & Baumert, 2004; Applefield et al., 2001). I came to construct meaning not only through observing what the teachers did in the classroom, but also by listening to their views, opinions and reasons for doing what they did in class. There should be a specific focus when constructing an understanding of the situation, and I therefore based the aspects that needed to be observed and interviewed on the literature that was reviewed. I believe that the mathematics classroom as a social learning environment requires learners to interact with the teacher, each other, the content, and instructional media to build

up their own mathematical understanding. Instead of the teacher delivering the material directly to the learners, the learners should rather help each other to create new mathematical understanding based on their prior knowledge or experiences. Since many mathematical concepts can be better understood when presented visually, teachers should include visual media in their instruction to give learners the opportunity to improve their learning and understanding.

3.2.2 Paradigmatic assumptions

The ontological assumption in this study was subjectivism as I understand the reality of teaching mathematics for visual literacy through my personal experience, and view reality as the outcome of social interaction (Creswell, 2014, 2007; Andrews, 2012; Maree, 2012; Karagiorgi & Symeou, 2005). In terms of the epistemological viewpoint, I came to understand the phenomenon through interacting with and observing the teachers. I subjectively described and interpreted the data from the observations and interviews in terms of how the teachers used visual material during instruction to develop their learners' visual literacy skills (Creswell, 2014, 2007; Maree, 2012). Finally, regarding the research methodology, this study took an interpretive stance in collecting and analysing the data, and answering the research questions. I was involved with the Tanzanian mathematics teachers in gathering information during the class observations, and also through the interviews where the teachers were queried about their views, opinions, beliefs, and experiences concerning the issue of teaching mathematics for visual literacy.

3.3 RESEARCH APPROACH AND DESIGN

A qualitative research approach and a case study design were used in conducting this study. More details on the research approach and design are provided below.

3.3.1 Research approach

A qualitative research approach was used to conduct the study. The selection of this approach was based on the nature of the study, which attempted to investigate how Tanzanian secondary school mathematics teachers teach for visual literacy in Form 2 classrooms. Thus, in-depth understanding of the issue being studied was required for both the researcher and the participants.

A qualitative research approach is more flexible in that it gives a wide range of opportunities for the researcher to interpret the findings. Several researchers (Maree, 2012; Cohen et al., 2011; Creswell, 2007) define qualitative research as an approach that attempts to gather descriptive data, is subjective, and provides intensive understanding of the phenomenon being studied. A qualitative research approach is usually conducted within a natural setting and mainly depends on multiple ways of collecting data (Cohen et al., 2011; Haider et al., 2011; Creswell, 2007). By using a qualitative approach, I was able to collect relevant information from the school environment using different data collection instruments. I was furthermore able to obtain an in-depth understanding of what was going on in these Tanzanian Form 2 Mathematics classrooms. A qualitative research approach primarily focuses on providing quality and in-depth information rather than breadth or scope of the information (Maree, 2012), which was the case in this study.

In order to explore the teachers' teaching strategies, a qualitative approach was therefore the most appropriate choice as it allowed me to provide in-depth information and detailed descriptions of their teaching, views, and understanding of the role that visual literacy plays in the teaching and learning of mathematics. As the researcher, I explored and drew meanings from the teachers' actions and words within their work place by observing them while teaching mathematics. I then explored their views through semi-structured interviews.

3.3.2 Research design

A research design is concerned with the outlines or procedures that the researcher carries out in conducting the research. It includes the selection of participants, data gathering instruments to be employed, and how the data is going to be analysed (Maree, 2012). In short, a research design is the compass that directs the researcher in the selection of the appropriate strategies to use in conducting the research.

This study adopted a case study as the research design based on the paradigmatic assumptions, research approach, and the nature of the research questions. Usually, a case study attempts to answer 'how' or 'why' questions (Maree, 2012; Cohen et al., 2011; Gray, 2009; Creswell, 2007). A case study is conducted within a real context, and thus it deals with distinctive cases of people and their environment (Cohen et al., 2011; Creswell, 2007). The cases in this study comprised three Form 2 Tanzanian mathematics teachers from three different secondary schools in the Ilala District. Using a case study, these teachers' endeavours and explanations

were contextualised within the school environment to analyse the reality of teaching mathematics for the specific purpose of developing visual literacy. To achieve this, two data collection instruments were used, namely, classroom observations and semi-structured interviews, to collect sufficient evidence from teachers, and thus provide detailed descriptions of the findings.

Creswell (2007) suggests that in conducting a case study, the researcher must determine the case or cases of the study. In other words, the researcher should identify the unit of analysis of the study (Baxter & Jack, 2008). According to Creswell (2007, p. 74), the case or cases (the unit of analysis) may encompass "an individual, several individuals, a program, an event, or an activity". The unit of analysis (the case) of this study was three Form 2 Tanzanian secondary school mathematics teachers who were investigated regarding how they taught mathematics for visual literacy.

The Tanzanian formal education system is categorised into five phases, viz.: Pre-primary education; Primary education; Ordinary level secondary education (O-level), which is from Form 1 to Form 4; Advanced level secondary education (A-Level), which is from Form 5 to Form 6; and Tertiary level (MoEC, 1995). The structure of these phases is two years of Pre-primary education, seven years of Primary education, four years of O-Level secondary education, two years of A-Level secondary education, and at least 3 years for Tertiary education (MoEC, 1995). However, this study only concentrated on Ordinary level (O-level) mathematics teachers as this level is the foundation for Tanzanian higher education. Therefore, teaching mathematics in the Ordinary level lays the foundation for learners' higher level education.

3.4 RESEARCH SITE, POPULATION AND SAMPLING

Qualitative sampling techniques based on non-probability sampling, particularly convenient and purposive sampling, were used in selecting the research site and participants of this study (Maree, 2012). Typically, a qualitative research approach uses non-probability sampling procedures and thus the findings of the study cannot be generalised (Maree, 2012; Cohen et al., 2011). Cohen et al. (2011) argue that non-probability sampling is generally used in a particular or targeted group, such as a group of learners or teachers, but does not represent the broader population.

3.4.1 The research site

The research site for this study was located in the Dar-es-salaam region, particularly in three government secondary schools in the Ilala District. These schools were conveniently and purposively selected because they were in close proximity to the researcher and were easily accessible to facilitate good management of the study. Additionally, the limitation of time was also considered.

3.4.2 The population, sample, and sampling procedure

The population of the study entailed all Form 2 Tanzanian Secondary school mathematics teachers. From this population, three Form 2 mathematics teachers from three different government secondary schools were purposively selected as the sample for this study. The participants or sample of this study were purposively selected using specific criteria, the first of which was the grade that they taught, namely, Form 2. A second inclusion criterion was the teacher's teaching experience, which had to be a minimum of five years as the researcher preferred to work with more knowledgeable and experienced teachers (Creswell, 2007; Bless, Higson, & Kagee, 2006). According to Cohen et al. (2011), it is important for the participants who were selected purposely using non-probability sampling to be knowledgeable enough of the issue under study. The third inclusion criterion was based on teachers' qualifications as they should hold a Bachelor's Degree of Education (BEd) or any other relevant degree. Compared to the novice teachers, the experienced and knowledgeable teachers are generally more skilled in analysing and providing relevant information (Cohen et al., 2011; Bransford et al., 2000). Since the principals of the schools were familiar with their staff, they assisted me in choosing the participants based on these criteria.

3.5 DATA COLLECTION PROCESS AND INSTRUMENTS

The study, having a qualitative research approach and a case study design, required multiple ways of collecting data (Creswell, 2014, 2007; Maree, 2012; Cohen et al., 2011; Yin, 2003). In this case, interviews and classroom observations were selected to fulfil this requirement. The teachers were observed while teaching their mathematics classes and were also interviewed individually immediately after the last observation to verify the consistency of their actions and their explanations regarding the issue of teaching mathematics for visual literacy. The data collection process and instruments used are further discussed below.

3.5.1 The data collection process

The first phase of the data collection process consisted of classroom observations. Each teacher was observed three times while teaching mathematics in a classroom setting in order to collect sufficient information on their instructional methods (Creswell, 2012; Maree, 2012; Cohen et al., 2011; Gray, 2009). According to Cohen et al. (2000, p. 314), "the greater the number of observations, the greater the reliability of the data might be". In general, the data were collected once a week for three consecutive weeks.

It was impossible to collect all of the necessary information merely using classroom observations. Thus, one semi-structured interview was conducted with each teacher immediately after the last observation to corroborate the data obtained from the classroom observations. Maree (2012, p. 87) indicates that more often, the data collected from semi-structured interviews are used "to corroborate data emerging from other data sources". By combining the classroom observations and semi-structured interviews, it was possible to validate the reality of teaching mathematics for visual literacy in Tanzanian secondary schools through the teachers' actions and words. The observations were carried out before the interviews were conducted in order to reduce the possibility of the teachers' behaving differently after they had been interviewed (Gray, 2009).

3.5.2 Observations

Observation, according to Maree (2012) and Cohen et al. (2011) is the systematic process of recording and observing participants, behaviours, actions, settings and other criteria without communicating or questioning them. Through the observation of participants, behaviour and level of experience can directly be observed either in a natural or structured environment (Teddlie & Tashakkori, 2003). Using classroom observations, the Tanzanian Form 2 mathematics teachers' actions, particularly their teaching styles and the strategies that were used in conducting their lessons, the classroom activities providing learners with the opportunity to encode and decode visual messages, and the way they involved learners in the classroom discussion were directly documented in a real classroom setting. The observations also revealed the way in which the teachers combined text (printed/narration) with visual media in their teaching (see Appendix G).

I attended the mathematics classes as a passive observer, which allowed me to focus on and closely observe the pre-determined issues rather than taking part in other aspects (Maree,

2012). This was beneficial as it allowed me to gain more insight into what was going on in these mathematics classrooms. Similarly, it provided me the opportunity to listen to, observe, and experience the reality of mathematics teachers' actions in the classroom setting without obstructing or influencing any changes taking place in the classroom setting (Maree, 2012; Gillham, 2001).

The observation, however, can have negative results when it is not implemented carefully. Actually, if the observation is not well prepared, organised, and planned, the researcher can rely too much on his/her personal interest and omit important aspects of the study. As indicated by Maree (2012), observation has a high risk of the researcher being selective and biased in selecting specific events or aspects. To avoid this, it was necessary for me to prepare an observation schedule in advance to make sure that all important aspects of the study were revealed and analysed.

In line with Creswell's (2007) suggestion, I designed an observation schedule in advance before conducting the observations. The preparation of the observation schedule simplified the observation process and ensured that all of the necessary information was collected and recorded. Cohen et al. (2011) support this practice, arguing that preparing the observation schedule in advance would enable the researcher to avoid some problems that might occur during the observation process, especially if there is a time gap between the action of observing and recording an event. Specific criteria (such as teaching styles and strategies, learners' involvement in activities, as well as visual media used) were observed and recorded in the schedule (see Appendix G). The observation schedule was designed based on the conceptual framework and the research questions, in particular Sub-questions 2, 3 and 4 that are as follows:

2. How do the teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?
3. How do the teachers combine visual media with text to facilitate the development of visual literacy in learners?
4. How do the learning activities facilitate the development of learners' visual literacy skills?

To ensure the validity of the collected data, the observation schedule also included an open space to capture all special events or actions that happened in the classroom that were noteworthy. The validity of the instruments is further discussed in Section 3.6.

All of the observed data were video recorded to obtain clarity and to obtain more insight during the data analysis process. According to Cohen et al. (2011, p. 470), a "video recording can offer a more unfiltered observational record than human observation". The video recorded information was viewed several times and time was taken to review and scrutinise the collected data.

3.5.3 Semi-structured interviews

Maree (2012) defines an interview as a two-way dialogue in which the interviewer poses questions to the interviewee for the purpose of collecting data and learning about the participants' ideas, opinions, views, beliefs, and behaviour. Based on this definition, the interviews were meaningful in getting to know the teachers' views and their level of understanding about the issue at hand. It is easy for the researcher to extract original and important information from the participants using an interview as the researcher can gather rich and relevant information from the participants' points of view (Cohen et al., 2011).

Maree (2012) identifies three types of interviews, viz. an open-ended interview, a structured interview, and a semi-structured interview. An open-ended interview can be defined as a conversation in which the researcher explores and collects the participants' ideas, views, beliefs and opinions of the issue being studied (Maree, 2012). A structured interview is normally employed in survey research and includes in-depth questions that are developed before conducting the interview (Maree, 2012). A structured interview is usually conducted in a large sample to ensure the validity of the collected data (Maree, 2012). Alternatively, a semi-structured interview is a set of predetermined questions where both the interviewer and the interviewee get asked a wide range of probing and clarifying questions (Maree, 2012). This was deemed the most appropriate form of interview method for this study.

As indicated earlier, the main focus of this study was to get an in-depth understanding of the issue of teaching mathematics for visual literacy. I purposely made use of semi-structured interviews to meet this objective. By using semi-structured interviews, I was able to probe the teachers for detail and collect sufficient information from them regarding their teaching of mathematics for visual literacy, for example, their motivation for using a particular teaching style and strategy, and the use of particular activities and media in teaching a certain mathematical concept or topic (see Appendix H). Moreover, the semi-structured interviews

enabled me to examine the teachers' level of understanding about the term visual literacy and its role in teaching mathematics (see Appendix H).

A semi-structured interview can be disadvantageous if it is not well prepared, particularly in collecting unrelated information about the study. To avoid this, as suggested by Cohen et al. (2011), it is necessary for the researcher to prepare an interview schedule with questions based on the study's objectives to ensure that all of the important aspects of the study are reflected. Based on Cohen et al.'s (2011) suggestion, an interview schedule with open-ended questions based on teaching mathematics for visual literacy was prepared in advance (see Appendix H), which contained information that guided me throughout the interview session. Open-ended questions are more flexible and provided a great opportunity for the teachers to express themselves, which enabled me to draw more information from them.

A probing strategy was used throughout the interview process to ensure the collection of rich and relevant data from the teachers. The interview and observation questions were approved by my supervisors and the University of Pretoria's Ethics Committee. The teachers' non-verbal cues were also observed during the interviews so as to collect meaning from their actions. An interview should typically be conducted in an environment that is conducive to effective communication taking place (Maree, 2012). To adhere to this requirement, the interviews were conducted in venues that were chosen by the teachers themselves to ensure that data was collected in a suitable and unobtrusive environment.

The interview information was recorded using a tape recorder. To adhere to the ethical issues raised by the University of Pretoria, permission was sought from the teachers before the interviews were recorded. The recorded information was then transcribed verbatim and the transcripts of the data were given to the teachers to verify whether what they had said was correctly captured.

3.5.4 Validation of the research instruments

To ensure the validity of the instruments used (observation schedule and semi-structured interviews schedule), my supervisors scrutinised the instruments before the actual data collection process to make corrections so as to meet the study's objectives. They also made critical comments on how the data should be collected. I triangulated the observational data from other sources, such as the literature, to further enhance the validity (Maree, 2012).

3.6 DATA ANALYSIS AND INTERPRETATION

Creswell (2007) highlights that analysing the collected data from different sources is a major challenge for the qualitative researcher. It requires the researcher's creativity, knowledge and skills in transcribing, coding, as well as organising the data appropriately. Maree (2012) suggests that qualitative data analysis should begin from the first day of data collection up until the last day of writing the report, which was followed in this study. The data from the observations and interviews were analysed according to the pre-determined themes and coded accordingly. These pre-determined themes were based on the conceptual framework of the study and included the following:

- The teacher's teaching styles.
- The teacher's teaching strategies:
    - Traditional teaching;
    - Cooperative learning;
    - Discovery learning;
    - Problem-based learning; and
    - Multimedia instruction.
- Combine text (printed/narration) with visual media:
    - Still media (pictures, charts, tables, graphs, maps or other visual illustrations);
    - Dynamic media (models, animations or video); and
    - Technological media (computers, calculators, among others).
- Activities providing learners with opportunities to:
    - Interpret visual information; and
    - Use visual media.

3.7 TRUSTWORTHINESS OF THE STUDY

Lincoln and Guba (1985) use the term trustworthiness to explain the extent to which a research process is valid and reliable in qualitative research. To ascertain the 'trustworthiness' of a study, Lincoln and Guba (1985) use unique terms such as 'credibility, 'transferability', 'dependability', and 'confirmability' to establish the term.

Credibility implies professional integrity, intellectual rigor, and methodological capability (Lincoln & Guba, 1985). To ensure the credibility of this study, the data were reviewed to ensure that the information collected was sufficient. Similarly, the interview transcripts were given back to the teachers to verify the correctness thereof, and corrections to the data were made where applicable. In addition, the initial transcriptions were sent to my supervisors for their perusal and recommendations for improvement were provided.

Dependability considers whether or not the same findings would emerge if a study was to be repeated, in other words, whether or not the findings could be replicated (Lincoln & Guba, 1985). To ensure the dependability of this study, the data were collected from different schools with different teachers, using various methods of data collection in order to verify the consistency of data. Maree (2012) affirms that collecting data from multiple sources is useful in ensuring the accuracy of the collected data.

Confirmability refers to the degree to which the findings of the study are the product of the focus of investigation and not the researcher's bias (Babbie & Mouton, 2001). The confirmability of the study was established by keeping the data in order to provide a chance for other researchers to have access to the data for inspection or validation of the study's findings.

Transferability refers to the degree to which the instrument measures what it is supposed to measure (De Vos, 1998). Since this study was a qualitative study, the findings could not be generalised. To ensure the transferability of the findings, an intensive clarification of the findings was presented with sufficient details so that the reader can easily get an in-depth understanding of the issue being investigated. Finally, my supervisors also provided input in the coding and interpretation of the findings to ensure the trustworthiness of the study.

3.8 ETHICAL CONSIDERATIONS

Educational researchers are supposed to abide by a number of ethical requirements before, during, and after the research has been conducted (Cohen et al., 2011). I received ethical clearance from the University of Pretoria's Ethics Committee. Furthermore, permission was sought from the Tanzania Ministry of Education and Vocational Training, the District Education officer of the area where the study was conducted, as well as from the principals of the schools (see Appendices D, E, and F). Informed consent letters were also given to the teachers requesting their voluntary participation in the study (see Appendix C). Consent letters were also provided to the learners' parents or guardians requesting them to grant permission

for their children to participate in this study (see Appendix B). Informed assent letters were written to the learners requesting their voluntary participation in the study (see Appendix A). The letters clearly stated that the participants had the right to withdraw from the study at any time if they wished to do so. Moreover, the consent letters informed the participants of the purpose of the study and their role in the study (see Appendices A, B, and C). The letters also ensured the confidentiality and anonymity of the information provided by the participants.

3.9 CHAPTER SUMMARY

In Chapter 3, the research approach, design and methodology were discussed. The study was based on a social constructivist paradigm. A qualitative research approach and a case study as research design were used to conduct an in-depth investigation regarding Tanzanian Form 2 mathematics teachers' ability to teach for visual literacy. The site, population, sample and data collection process were also discussed. Details about the data collection instruments, namely, observations and semi-structured interviews were given, while the data analysis strategies were also presented. Lastly, the trustworthiness of the study and ethical consideration were addressed in this chapter. In the following chapter, the findings of this study are discussed and explored.

CHAPTER 4 RESEARCH FINDINGS

4.1 INTRODUCTION

In the previous chapter, I discussed the research design and methodology underpinning this study. In this chapter, I present the research findings of the study according to the research sub-questions, which were informed by the conceptual framework, as presented in Chapter 2. The questions were:

1. What is the teachers' understanding of visual literacy and its role in the teaching of mathematics?
2. How do the teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?
3. How do the teachers combine visual media with text to facilitate the development of visual literacy in learners?
4. How do the learning activities facilitate the development of learners' visual literacy skills?

4.2 BIOGRAPHICAL DATA

Table 4.1 below provides an overview of the biographical information of the teachers. In order to ensure confidentiality and anonymity, I used pseudonyms for the participants' names.

Table 4.1 Biographical data of teachers

Teacher's name	Gender	Age	Education level	Mathematics teaching experience
Teacher A	Female	55	Bachelor of Business Administration with Education	31 years
Teacher B	Male	32	Bachelor of Science in Mathematics	8 years
Teacher C	Male	34	Diploma in Education	6 years

Table 4.1 above indicates that the teachers who participated in the study comprised two males and one female. The table also shows the teachers' mathematics teaching experience and their level of education. The teachers' teaching experience ranged between six and 31 years, thus complying with the inclusion criteria, as indicated in Chapter 3. Alternatively, their levels of education differed. Among the three teachers, one teacher held a Diploma in Education, while

the other two participants had Bachelor Degrees in different disciplines. Teacher A was a female with 31 years of teaching experience, who possessed a Bachelor of Business Administration with Education degree. Teacher B was a male with eight years of teaching experience and held a Bachelor of Science in Mathematics degree. Teacher C was also male, with six years of teaching experience and a Diploma in Education.

4.3 FINDINGS OF THE CLASSROOM OBSERVATIONS

Classroom observation was one of the primary data collection methods in this study. The three mathematics teachers were observed teaching Form 2 classes, which was the main focus of this study. The themes underpinning the study, as indicated in the conceptual framework, were used to design the observation schedule (see Appendix G). These themes are:

- The teachers' teaching styles;
- The teachers' teaching strategies;
- The combination of text and visual media during instruction; and
- Learning activities that facilitated the development of learners' visual literacy skills.

Each of the three teachers will now discussed according to these themes.

4.3.1 Observations of Teacher A

Teacher A was a young adult woman, who was observed while teaching the topics of similarity and statistics to a class of 40 learners. All three observed lessons were dominated by questions posed by the teacher and direct explanations from her. However, she encouraged learners to ask questions soon after she was done explaining the concept. During the lessons, Teacher A constantly assessed the learners' understanding by asking them: "Isn't it?" Whether or not learners understood the concept, they replied "yes". A very noticeable characteristic of Teacher A was that she spent a lot of time writing notes rather than involving learners in the discussion.

4.3.1.1 Teacher A's teaching style

Teacher A often started the lessons with an introduction to the topic, and an introduction of any new terms, for example, she defined the term statistics as the collection and systematic classification of information. Teacher A, however, did not provide the opportunity for learners to define the terms; she defined the terms herself. After the introduction, she continued with the lesson. However, during the lessons, she discussed, explained, and demonstrated

mathematical concepts to the learners. Learners had no chance to contribute anything, instead, they only received information from her. Throughout the lessons, they were seated at their desks listening carefully and taking notes. There was no opportunity for them to discuss the subject matter with their peers as they were required to answer short questions posed by the teacher. This was evident in the following episode during one of her lessons:

> Teacher A: *"Today we are going to discuss about similarity. If you remember the previous lesson we discussed about congruency. When we talk about similarity we talk about two figures that are alike. They have the same shape, but not necessarily the same size."*

After this definition, she continued:

> Teacher A: *"For example, we have these two triangles* (shows two triangles to the learners). *And these two triangles by physical appearance, they are similar. Isn't it?"*
>
> Learners (several): "*Yes."*
>
> Teacher A: *"This one is smaller and this one is larger. But when it comes to the sizes of the corresponding angles are equal, like this one* (she demonstrates) *when you fix here you can see the sizes are exactly equal. Isn't it?"*
>
> Learners (several): "*Yes.*"
>
> Teacher A: *"And when you fit it here you can see the sizes of the angles are equal…Isn't it?"*
>
> Learners (several): "*Yes.*"
>
> Teacher A: *When you fit it here you can see ……. "Isn't it?"*
>
> Learners (several): "*Yes.*"

She then wrote the conditions of similar triangles on the chalkboard and explained that learners could use them in solving problems, where after the learners copied these into their exercise books. Throughout the discussion, the learners appeared to accept whatever the teacher presented to them. All three of Teacher A's lessons were characterised by the teacher-centred teaching style. In general, she dominated the classroom discussions, and thus learners had no opportunity to contribute to their own learning.

4.3.1.2 Teacher A's teaching strategies

In all three lessons, Teacher A used a number of examples from the learners' textbook in order to reinforce their understanding. The teacher, however, worked out the examples by herself on the chalkboard. She also provided the steps and algorithms required to solve the problems. While she did this, the learners copied these into their exercise books. No opportunity was given to the learners to solve the problems themselves through their own ideas so that they could generate their own understanding. The learners were involved in the lesson through answering simple oral questions only, which was evident in the way she taught learners how to solve the following example:

In Δ ABC, M is on $\overline{AB}$ with $\overline{AM}$ = 4cm and $\overline{MB}$ =2cm. N is on $\overline{AC}$ and MN is parallel to BC.
i) Show that Δ AMN ~ ΔABC. ii) If BC =4.5 cm, find MN.

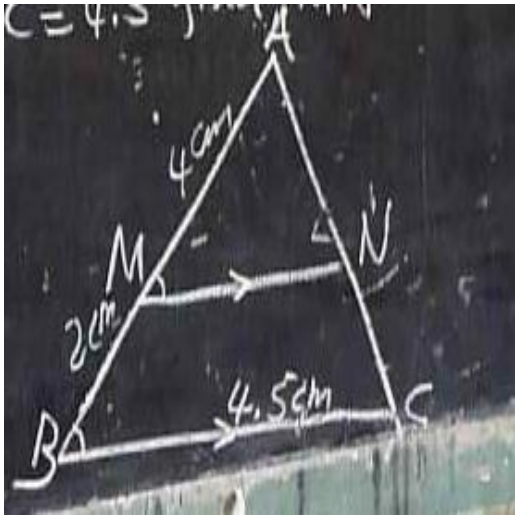

Figure 4.1 Similar triangles

After writing the question, she then started to solve it using the following steps:

$\hat{AMN} = \hat{ABC}$ (Corresponding angles)
$\hat{ANM} = \hat{ACB}$ (Corresponding angles)
$\hat{MAN} = \hat{BAC}$ (Common to both)

After reaching this point, she looked at learners and asked them:

> Teacher A: "*The two triangles are similar under which condition*?"
> Learners: "*AAA*" (*angle, angle, and angle*).

The learners copied the question and the solution into their exercise books before she moved on to another section. Generally, Teacher A's lessons relied heavily on a traditional teaching strategy.

The teacher frequently used oral questions to ensure learners' participation. Generally, there was moderate interaction between the teacher and her learners. However, the questions asked were too simple, short (low-level) and straightforward, and did not require the learners to think deeply in order to justify their answers, for example, she asked learners, "four plus two is equal to?" The learners then replied all together, "six". Such questions did not give learners the opportunity to share the possible strategies to solve the problems; hence, they were not provided opportunities to listen to other learners' ideas. Molefe and Brodie (2010) explain that higher-order questions increase interaction among learners through which they can share different strategies of problem-solving. In all of the lessons, the learners only gave chorus answers. The concrete evidence that was collected is demonstrated in the following dialogue that took place when she used the information on the poster (see Figure 4.2) to lead the discussion in a lesson on statistics:

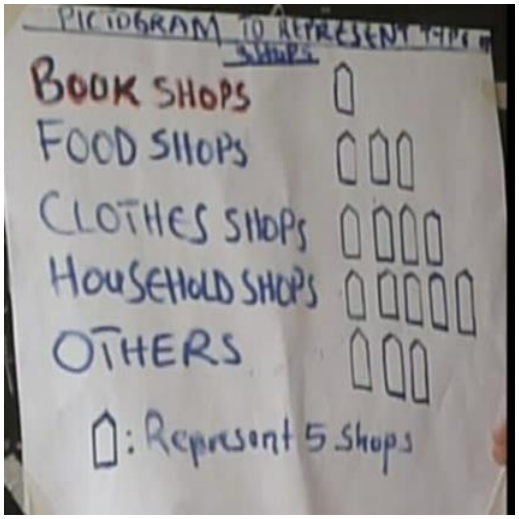

Figure 4.2 A poster with a pictorial representation

Teacher A: "*How many book shops were there?"*

Learners (several): "*Five.*"

Teacher A: *"How many food shops were there?"*

Learners (several): "*Fifteen.*"

Teacher A: *"How many clothes shops were there?"*

Learners (several): "Twenty."

This situation revealed a learning environment in which it was very difficult to determine which of the learners understood the lesson and which of them did not. Teacher A did not assess the learners or situation, but simply proceeded with the lesson.

4.3.1.3 Combination of text and visual media

Teacher A often integrated verbal explanations into still media to ensure that mathematical concepts were delivered successfully. She used graphs, charts, tables, diagrams and symbols, as shown in Table 4.2 below. She believed that the use of these media might enable learners to understand mathematical concepts with ease. She normally started lessons either by explaining the concept first, followed by a visual representation, or vice versa. Particularly, the choice of which concept to start with depended on the nature of the concept. However, she never combined text or verbal explanations with dynamic or technological media. When asked later on during the interview why she neglected those form of media, she explained that the school did not have enough technology-based media, such as computers, to teach mathematics. She also used models when teaching the concept of similarity.

Table 4.2 Visual media used by Teacher A in her mathematics lessons

Teacher's name	Topic	Still media	Dynamic Media	Technological media
Teacher A	Similarity	Models	None	None
		Diagrams (Triangles)		
	Statistics	Symbols		
		Charts (Bar charts)		
		Tables (Frequency distribution)		
		Graphs (Bar graphs)		

4.3.1.4 Learning activities that facilitate the development of learners' visual literacy skills

It is through participation in various practical learning activities, such as drawing, that learners can acquire visual literacy skills. In fact, in none of the three observed lessons did Teacher A provide such an opportunity to the learners, for example, she did not give learners the opportunity to communicate mathematical ideas visually by using graphs, charts, drawings, and other visual representations. She also never gave them the chance to describe the meaning, interpret, and evaluate the visual representations or messages used during the lessons. However, she gave them opportunities to decode visual representations, particularly when they

were answering questions (see Figure 4.3). Many questions in the class activities did not require the learners to use visual illustrations to answer them. This was evident in the question below, which was provided to the learners as the class activity in the first lesson:

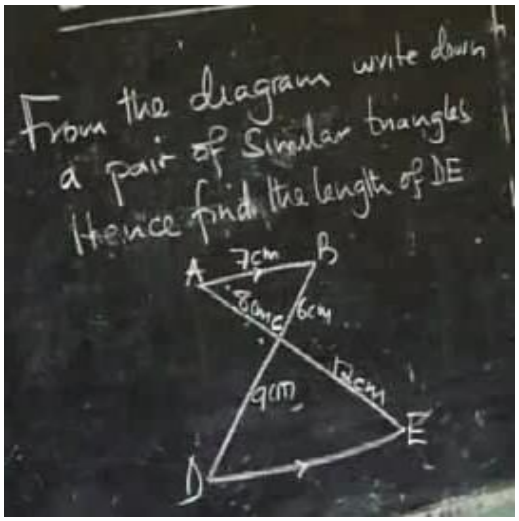

Figure 4.3 An exercise provided to the learners in one of Teacher A's lessons

To summarise, Teacher A used a teacher-centred teaching style, and mainly used traditional teaching as her teaching strategy. In addition, she involved the learners in the learning process through asking low-level questions. She often incorporated textual or verbal explanations with visual media, particularly still media, in order to assist learners to better understand the mathematical concepts. Unfortunately, she did not provide enough opportunity for learners to use visual media, such as visual representations, to communicate mathematical ideas either during the classroom discussion or when performing learning tasks.

4.3.2 Observations of Teacher B

Teacher B was a young man with a sociable attitude, which caused him to smile all the time. He was observed while teaching a class of 41 learners on the topics of sets and trigonometry, in particular, angles of elevation and depression. Teacher B's lessons were characterised by chalk and talk teaching. He stood near the chalkboard the entire time, transferring knowledge to the learners in this manner. During the lessons, he assessed learners' understanding by asking them questions such as, "Did you get the point?", "Are we together?", "Is it right?", and "Is that clear?" to which the learners replied, "Yes." However, he encouraged learners to ask questions after he completed his explanation of a concept. If a learner complained about misunderstanding the concept, he would explain it in the same way until the learner was satisfied.

4.3.2.1 Teacher B's teaching style

Teacher B normally introduced the lesson by informing the learners about the lesson's topic for the day, where after he continued teaching the topic. During all of his lessons, he applied the same procedures as Teacher A, namely, discussing, explaining, and demonstrating mathematical concepts to the learners. Throughout the lessons, learners were seated at their desks listening carefully, copying notes, and answering short questions posed by the teacher. There was no opportunity for them to discuss the subject matter themselves in small groups, as is evident in the following extract from one of his lessons.

> Teacher B: *"Today we are going to discuss about angles of elevation and?"* (While moving around).
>
> Learners (several): "*Depression.*"
>
> Teacher B: *"Say elevation."*
>
> Learners (several): "*Elevation.*"
>
> Teacher B: "*Depression."*
>
> Learners (several): "*Depression.*"
>
> Teacher B: *"This is the application of trigonometric ratios as we discussed in the previous lesson. It is about sin, cos, and tan. Is application of what?*
>
> Learners (several): "*Trigonometric ratios.*"

He then displayed a poster (see Figure 4.4) with a diagram that showed how the angles of elevation and depression are formed from an observer's eye.

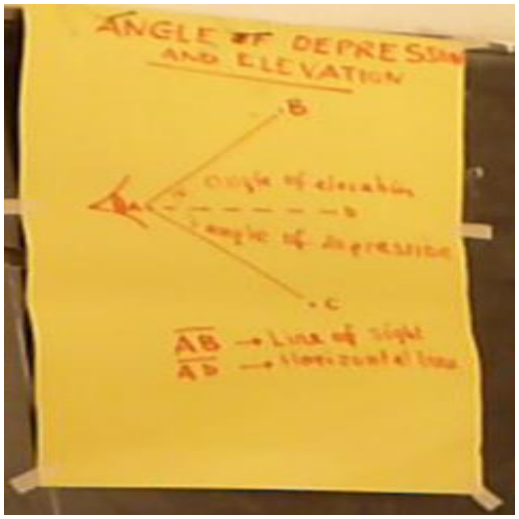

Figure 4.4 A poster illustrating an angle of elevation and depression

He then started to teach the concept using the diagram:

> Teacher B: *"Look at this diagram. Suppose an observer is here (pointed) looking at an object. An object can be anything such as an airplane. Suppose an observer A is looking at object B. So here is an observer's eye directly watching point B. The angle formed here between the horizontal line (AD) and the line of sight AB is called what?"*
>
> Learners (several): *"Angle of elevation."*
>
> Teacher B*: "The angle formed here* (demonstrates using the pen in front of his eye) *between the line of sight and horizontal line is called what?"*
>
> Learners (several): *"Angle of elevation."*

He then proceeded:

> Teacher B: *"Suppose now the person is above the ground looking at the good car passing down the road* (while drawing on the chalkboard). *The line of sight now is downward. The angle formed here between the horizontal line (AD) and the line of sight AC is called the angle of what?"*
>
> Learners (several): *"Depression."*
>
> Teacher B: *"The angle of elevation is between* (pointing to the diagram on the chalkboard) *the horizontal line and the line of sight. The angle formed below the horizontal line is called what?"*
>
> Learners (several): *"The angle of depression."*

Teacher B: *"Did you get the point?"*

Learners (several): *"Yes."*

Teacher B: *"Is it clear?"*

Learners (several): *"Yes."*

After this discussion, he then asked learners if they had any questions before they continued to the next section.

Similar to Teacher A, Teacher B also used a teacher-centred teaching style as he dominated the classroom discussions, and thus learners' participation was minimal.

4.3.2.2 Teacher B's teaching strategies

During the lessons, Teacher B also used a number of examples, similar to Teacher A. The examples were also taken from the learners' textbook. Instead of asking the learners to work out the examples themselves when solving these examples, he, similarly to Teacher A, worked out the examples by himself and the learners then copied the examples into their exercise books. He also provided the steps, formulae, and procedures to the learners. This was evident in solving the following example:

> *From the top of the tower, the angle of depression of a point on a ground 10m away from the base of the tower is 60°. How high is the tower?*

After writing the question, he then drew the following triangle (see Figure 4.5) in order to simplify the learners' understanding.

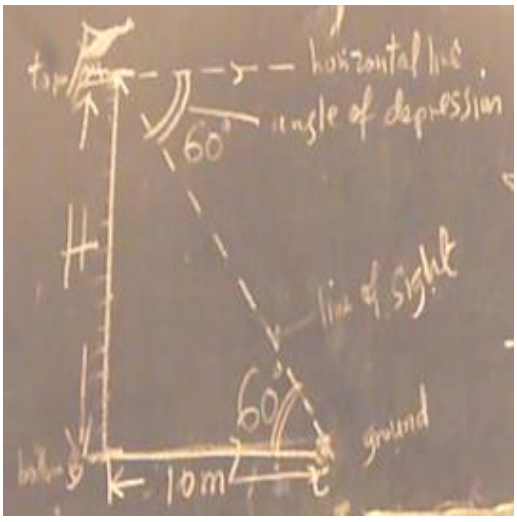

Figure 4.5 The first triangle of a question that Teacher B posed to the learners

To make the concept more clear to the learners, he then reconstructed the triangle, presenting a new triangle, as shown in Figure 4.6 below.

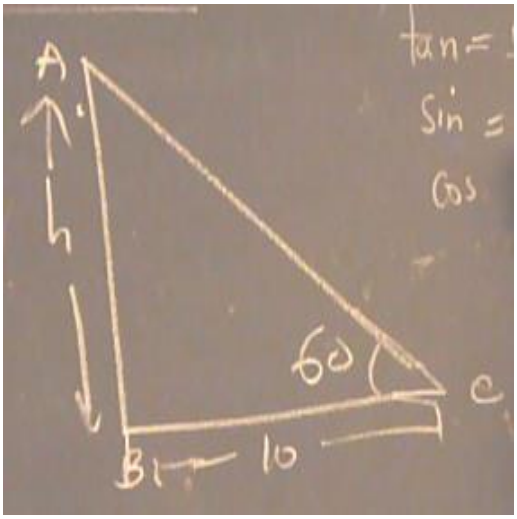

Figure 4.6 The second triangle that Teacher B presented to the learners

He then led the discussion as follows:

Teacher B: "*Therefore, our ratio we are going to use now is tan of which angle*?"

Learners (several): *"Tan of 60°"*

Teacher B: "*What is our opposite?"*

Learners (several): "*h.*"

Teacher B: "*What is our adjacent?"*

Learners (several): *"10."*

Teacher B: "*Right?"*

Learners (several): *"Yes."*

He then solved the question as follows:

$\tan 60° = \frac{opp}{adj} = \frac{h}{10}$

$\tan 60° = \frac{h}{10}$

$h = 10 \times \tan 60°$

When he reached this point, he asked the learners to read the value of tan 60° from the mathematical tables. Later on during the interview, I asked him why the learners used mathematical tables instead of calculators. He then explained that the school had no calculators. After writing the solution, he asked the learners if they understood it; none of the learners expressed any kind of confusion. Thereafter, the learners copied the question and solution into their exercise books. Similar to Teacher A, Teacher B also used a traditional teaching strategy.

Similar to Teacher A's lessons, Teacher B also involved learners in the classroom discussion through questions. However, sometimes he allowed the learners to demonstrate their solutions on the chalkboard. This was done in the first lesson only when one girl, after being assessed already, voluntarily demonstrated how to solve a question based on sets on the chalkboard. Unfortunately, she did not explain to the others how she arrived at the answer. The questions posed by Teacher B were also simple and thus did not require a higher level of thinking, but required only straightforward responses, for example, he asked the learners: "What is h?" The learners replied in chorus, "Opposite". This was again evident in the following trigonometric lesson:

Teacher B: *"What is h?"*

Learners (several): *"Opposite."*

Teacher B: *"What we have?"* (While pointing at the diagram)

Learners (several): *"Adjacent."*

Teacher B: *"Ohooo, now we have opposite and…?"*

Learners (several): *"Adjacent."*

Teacher B: *"Which ratio we are going to use now?"*

Learners (several): *"tan."*

Teacher B: *"tan of which angle?"*

Learners (several): *"35."*

Chorus answers led to some difficulties for the teacher in identifying who was right and who was wrong, for example, when he asked them to mention the sides involved in sine of an angle, one learner answered, "*Opposite over adjacent*." Since the learners gave chorus answers, it was difficult for him to notice this misconception so that he could correct it immediately.

4.3.2.3 Combination of text and visual media

Similar to Teacher A, Teacher B also integrated textual or verbal explanations into his lessons with still media such as diagrams to enhance learners' understanding (see Table 4.3). Whilst teaching the concept of angles of elevations and depression, for example, he used diagrams (triangle) to make concepts clear. The teacher explained that he liked to use still media in his lessons because he believed that by visualising the figures or diagrams, learners could get a better understanding of the subject matter than if they were only reading or listening to him. He normally started by explaining the concept verbally before using a visual representation. Similar to Teacher A, Teacher B also never combined textual or verbal explanations with dynamic or technological media. During the interview, he explained that the school had visual media such as computers, not for teaching, but for office use only.

Table 4.3 Visual media used by Teacher B in the mathematics lessons

Teacher's name	Topic	Still media	Dynamic media	Technological media
Teacher B	Sets	Diagrams (Venn diagram)	None	None
	Angles of elevation and depression	Diagrams (Triangles)		

4.3.2.4 Learning activities that facilitate the development of learners' visual literacy skills

During the lessons, Teacher B did not give learners an opportunity to be involved in the learning activities as they were not given a chance to understand, decode, interpret and evaluate visual representations used in the lessons. However, during the learning tasks, particularly in the first two lessons, he gave the learners exercises that required them to encode visual representations, as is evident in the following question that was posed to them in the second lesson:

> *Find the height of the tower if the angle of elevation of the top of the tower is 34° from a point 20m from the ground level.*

To summarise, similar to Teacher A, Teacher B used a teacher-centred teaching style in combination with a traditional teaching strategy. He also involved learners in the learning process through asking simple oral questions. He regularly combined text-based or verbal explanations with visual media, especially still media, to make mathematical concepts clear to

the learners. He also sometimes gave learners the opportunity to represent mathematical ideas visually, especially during the lesson assessment.

4.3.3 Observations of Teacher C

Teacher C was a young man who was very friendly with the learners. Although his class was over populated (about 95 learners), he knew all of the learners by their names. He was observed when teaching the topic of statistics and revising the previous lessons. His lessons were very interesting because throughout the discussion, he involved learners in the learning process through asking questions and giving demonstrations. The learners seemed very active and happy throughout the lessons. To a large extent, Teacher C's lessons were dominated by questions and he made sure that the learners were following at every step. Some of the questions were closed questions (straightforward), and others were based on recalling facts such as formulae, for example, he asked learners to mention the simple interest formula in one of his lessons. One learner mentioned that, "Simple interest is equal to principal times rate times time divide by hundred (I= $\frac{PRT}{100}$)". Teacher C was the only teacher of the three teachers who assigned group work to the learners during his lessons. The learners seemed to be very interested, particularly when their peers demonstrated how to solve the question on the chalkboard. Teacher C did not encourage questions from the learners in any of the three observed lessons.

4.3.3.1 Teacher C's teaching style

Teacher C introduced the lesson by defining new concepts. He often wrote the definitions on the chalkboard and explained them verbally. It can be said that his lessons were dominated by him asking questions and learners answering. Below is an extract of one of his lessons:

> Teacher C: "*Today we are going to discuss about a frequency polygon. This is another important sub-topic of statistics*".

He then wrote the definition of the frequency polygon on the chalkboard as follows: *"A frequency polygon is a line graph of class frequency plotted against class mark"* which the learners had to copy into their exercise books before he described it verbally. Teacher C then wrote the following example on the chalkboard:

> *"The table below shows the frequency distribution of scores for a history test. Represent the information in a frequency polygon."*

Class interval	Frequency
60-69	2
50-59	4
40-49	6
30-39	3
20-29	2

Thereafter, he led the discussion as follows:

> Teacher C: "*How do we find the class mark of the class interval*?" (Majority of the learners raised their hands)
>
> Learner (one): *"Upper limit plus lower limit divided by two."*
>
> Teacher C: "*Class mark equal to upper limit plus lower limit divided by two. Find the class mark of the class interval 60-69, individually.*" (Each learner was busy finding the class mark) (after a short while) "*yes, stand up.*"
>
> Learner (two): *"60 plus 69 divided by 2 which is equal to 64.5."*

The teacher then wrote the formula and answer on the chalkboard, after which he explained to the class as follows:

> *"By formula class mark is equal to upper limit plus lower limit divided by two, 60, 50. 40, 30 and 20 are lower limits, while 69, 59. 49, 39 and 29 are upper limits. The first class mark is 64.5."*

He then continued:

> Teacher C: "*What is the second class mark of the class interval 50-59*?" (He pointed to the learners) "You stand up."
> Learner (three): *"54.5."*
> Teacher C: "*50 plus 59 divided by 2 is equal to 54.5.*"
> Teacher C: "*Yes, stand up, find the class mark from 30 to 39.*"
> Learner (four): (In a lower voice) *"24 point…"* (She found it difficult to explain the answer).

(Majority of learners raised their hands to answer the question).

Teacher C: "*Yes, stand up.*"

Learner (five): *"34.5."*

Teacher C, with the learners (several): "34.5."

After completing the table, he summarised the lesson by saying:

Teacher C: *"By formula, class mark is equal to upper limit plus lower limit divided by what?"*

Teacher C, with the learners (several): *"2."*

After the discussion, he explained to the learners that the next step was to draw the frequency polygon graph of the given data. He first reminded the learners the definition of the frequency polygon before drawing the following graph:

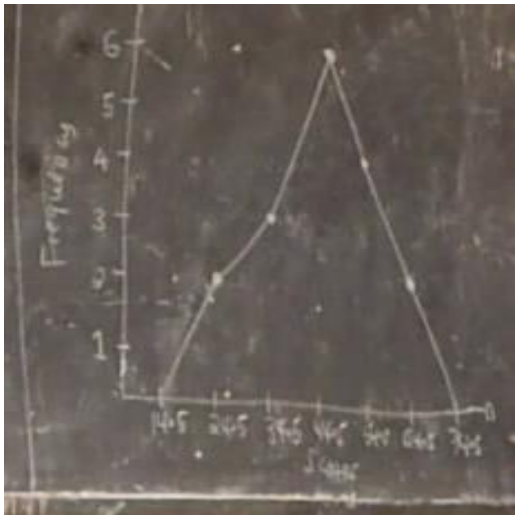

Figure 4.7 A frequency polygon graph

It can be seen from the lesson excerpt that Teacher C's lessons were also characterised by the teacher-centred teaching style, similar to teachers A and B. He dominated the classroom discussion through asking questions, while the learners had no opportunity to discuss the subject matter on their own with their peers.

4.3.3.2 Teacher C's teaching strategies

Similar to Teachers A and B, Teacher C used a number of examples in the lessons. He took some questions from the learners' textbook and some from past National Examination papers. He did not provide the formulae and procedures to the learners, but allowed them to suggest

appropriate formulae or procedures for solving problems. He worked out the examples by himself, rather than giving learners an opportunity to solve them, although he made sure that the learners understood every step of solving the examples by providing a clear explanation of each step. This was evident in the following example:

$$\textit{If } \tan A = \frac{12}{5} \qquad \textit{Evaluate} \quad \frac{sinA+2cosA}{1-sinA}$$

After writing the question, he then drew the following triangle:

Figure 4.8 Δ ABC in a question posed by Teacher C

Thereafter, he asked the learners about the tan of an angle:

Learner: *"tan is equal to opposite side over adjacent side."*

Teacher C: *"What is the opposite of angle A? Yes."*

Learner (six): *"Side BC."*

Teacher C: *"What is adjacent side? Yes."*

Learner (seven): *"Side AC."*

Teacher C: *"Side AB is called?"*

Learners (several): *"Hypotenuse side."*

Teacher C: *"Apply the Pythagoras theorem."*

Learners (several): *"Side $BA^2=AC^2+BC^2$."*

After the discussion, he gave the learners group work to do. The groups were formulated randomly and consisted of five to 12 members. This allowed some learners, especially those in big groups, to have informal discussions with their friends about non-mathematical issues and not participate in the discussion. One or two learners led the discussion in each group while other group members looked on. When the learners were busy with work, their teacher was moving around to provide assistance to those who faced some difficulties in solving the problem. All of the findings were written on the paper sheets that were distributed by the teacher to the groups. Only a few groups (two out of the 10 groups) managed to accomplish the work within the specified time, and presented their findings. This was the case in almost in all of the observed lessons. The time provided for the group work was 20 minutes only, which may have been insufficient time for group work. In general, Teacher C used traditional teaching and group work to conduct his lessons.

Teacher C involved learners in classroom discussions through asking questions and allowing some of the learners to demonstrate their work on the chalkboard. Similar to teachers A and B's lessons, the questions posed to the learners were not difficult and most of them were straight forward, for example, he asked learners the answer to "negative sign times negative sign?" One boy raised his hand and answered, "Positive". The teacher either mentioned the learners by their names or picked learners who raised their hands to answer questions. The learners always stood up when answering questions, and rarely gave chorus answers.

4.3.3.3 Combination of text and visual media

Similar to Teachers A and B, Teacher C frequently combined text-based or verbal explanations with still media to enhance learners' understanding. He used tables, graphs, charts and diagrams, as shown in Table 4.4 below. He believed that by using these media, learners could understand the subject with ease. He often explained the concept verbally and then demonstrated it using still media. However, he never combined textual or verbal explanations with dynamic or technological media during his lessons. During the interview, I asked him why he did not use these in his lessons, he replied that the scarcity of those media at the school was the main reason for this.

Table 4.4 Visual media used by Teacher C in the mathematics lessons

Teacher's name	Topic	Still Media	Dynamic media	Technological media
Teacher C	Statistics	Tables	None	None
		Graphs		
		Charts (Pie charts)		
	Trigonometry	Diagrams (Triangles)		

4.3.3.4 Learning activities that facilitate the development of learners' visual literacy skills

During the lessons, similar to Teachers A and B, Teacher C did not give learners the opportunity to engage in learning activities that could develop visual literacy skills. He did not encourage them to decode, interpret, evaluate and analyse the visual messages or representations used in the lessons. However, all of the learning tasks assigned to the learners for assessment required them to encode visual representations. This was evident in the response to the following question:

Given the frequency distribution for a mathematics test.

Class interval	Frequency
31-40	4
41-50	7
51-60	10
61-70	5
71-80	3
81-90	1

Represent the information in a frequency polygon.

To summarise, Teacher C conducted his lessons by using a teacher-centred teaching style alongside traditional and group work teaching strategies. Alternatively, he involved learners in the learning process through asking simple oral questions and allowing them to demonstrate on the chalkboard. He also combined text-based or verbal explanations with visual media (still media) to simplify the learners' acquisition of mathematical concepts. Nevertheless, he did not give learners the opportunity to engage in learning activities that could develop visual literacy

skills, particularly during the lesson discussion. Unlike Teachers A and B though, the learning tasks required the learners to generate visual representations. The findings of the observations were then confirmed and explored in the follow-up interviews, the results of which are discussed below.

4.4 THE FINDINGS OF THE SEMI-STRUCTURED INTERVIEWS

The researcher conducted one semi-structured interview with each teacher for an average of one hour per teacher after all the classroom observations had been completed. The purpose of the semi-structured interviews with the teachers was to compare their actions in the classrooms with their views and opinions. The interviews focused on the following themes:

- Teachers' understanding of the term visual literacy and its role in teaching mathematics.
- Teachers' teaching styles and strategies.
- The way the teachers combined verbal explanations and visual media during their lessons.
- Learning activities that facilitated the development of visual literacy skills.
- The visual media that the teachers used in classroom instruction.

4.4.1 The teachers' understanding of the term visual literacy and its role in teaching mathematics

During the data collection process, the teachers' understanding of the term visual literacy and its role in teaching mathematics was examined to obtain insight into how familiar they were with this concept. Several definitions provided by the teachers indicated that they were familiar with visual literacy. All three of the teachers viewed the term visual literacy as the use of visual aids that could be detected by the sense of sight. They knew the core meaning of visual literacy and its role in facilitating mathematics instruction, and further explained it as follows:

> Teacher A: "*The use of visual aids in order to foster learners' understanding. Its role in teaching mathematics is that it can facilitate learning. Sometimes if you have a concept to teach, you explain and then demonstrate. Sometimes learners can touch and see, which enables them to retain in memory that material for a long time*".
>
> Teacher B: *"The term visual literacy refers to the kind of learning through pictures or media whereby learners can see the images. In other words, I can say that it is the process whereby learners can get the information about mathematical problems by*

seeing with their eyes. The role of visual literacy in teaching mathematics is that it simplifies learners' learning. When a learner visualises an image or a picture, the information can stick easily in his/her mind rather than reading from a written material or listening to someone. By this matter, the learner can be able to figure out what is going on within a short time."

Teacher C: **"***The term visual literacy refers to the procedures that can make learners to understand the subject by eye contact. Its role in teaching mathematics is that it simplifies learners' understanding. The reason is that visual information can be easily understood by learners.*"

When the teachers were asked about the advantages of developing visual literacy skills in the learners, they said that visual literacy skills enabled learners to easily understand the subject matter. Their responses were as follows:

Teacher A: "*By developing visual literacy skills in the learners, they can be able to get the concept with ease. It also enables the teacher to use a short time in teaching."*

Teacher B: *"It makes easier for learners to understand the subject matter. By developing visual literacy skills in learners, the teacher can explain the topic easily and learners can understand it easily within a short time."*

Teacher C: "*It helps learners to understand the subject matter very easily."*

From these responses, it can be seen that the teachers were familiar with some of the advantages of developing visual literacy skills in their learners. The teachers also appeared to be familiar with some of the advantages of using visual materials during mathematics instruction, as explained by Teachers A and B below:

Teacher A: "*When you teach by showing them the picture or an image or an object they get the concept within a short time rather than by using words alone."*

Teacher B: *"By using real materials, which are available within the environment, the teacher can make the subject clear, for example, when you teach the topic of currency and tell them to collect the currency from the society for the classroom discussion. It will be easily for them to understand the topic."*

Teacher C, however, did not contribute to this, rather, he agreed that it is necessary to teach for understanding while using a teaching strategy that enhances an understanding of the subject matter.

4.4.2 Teachers' teaching styles and strategies

In terms of the teaching style that they used in their lessons, all of the teachers said they liked to use the teacher-centred teaching style. They explained that the length of the syllabus, class size, a lack of teaching and learning resources, and a lack of competence in using other teaching styles were the main factors that led them to use a teacher-centred style in conducting their lessons. Their responses were as follows:

> Teacher A: *"I use the teacher-centred teaching style to conduct my lessons. The reason is that, in teaching mathematics particularly here* [means in our country], *we have the syllabus, which must be covered within the specified time. So if I involve learners effectively in the classroom discussion, it will be difficult for me to accomplish the syllabus."*
>
> Teacher B: *"I use the teacher-centred teaching style. The problem is that the time is very minimal for me to accomplish the syllabus within the limited time, thus why I make sure that, all the time, I do all activities for myself. However, I involve learners effectively in the classroom discussion during the remedial or reviews."*
>
> Teacher C: *"I use the teacher-centred teaching style. The reason is that I have no idea of other teaching styles because from my teacher's training they did not teach us how to teach by using other teaching styles. Also, the school has no teaching and learning resources that can enable us to use other teaching styles to conduct our lessons. Similarly, the syllabus also is too long for us to use other teaching styles."*

The teachers' responses were consistent with their actions in the classroom environment as during the classroom observations, I observed that all of the teachers dominated classroom instruction.

Productive classroom instruction occurs when teachers combine various teaching strategies that involve learners effectively in the learning process. Wandberg and Rohwer (2010) indicate that effective teaching strategies are those that allow learners to participate actively in the learning process. According to Wandberg and Rohwer (2010), many people learn more and

acquire necessary skills through learning practically rather than listening to a teacher, reading from various sources, or watching while others do practical work. Instructional strategies such as traditional teaching, problem-based learning, discovery learning, cooperative learning, and multimedia instruction are key strategies to use in combination when teaching mathematics to develop visual literacy skills. The Tanzanian mathematics teachers were asked about the teaching strategies that they employed in their lessons. All three participating teachers said that they preferred a traditional teaching strategy above the other teaching strategies. They also explained their reasons for using this teaching strategy in their lessons:

> Teacher A: "*I use the traditional teaching strategy because it makes it easier for learners to understand. But sometimes I change to other teaching strategies because I know that not all learners learn the same. I can say that it depends with the class you have. But in reality, I use other teaching strategies not so much."*
>
> Teacher B: "*I usually use the traditional teaching strategy because of the teaching environment. Our system does not allow us to use other teaching strategies such as using new technologies for teaching. In short, the system does not support us to use new technology, thus why we still rely on traditional teaching strategy of using chalk. Most of the time we write on the chalkboard."*

When I asked Teacher B about placing the learners in small groups during the lesson presentation, he said:

> Teacher B*: "I normally put them in small groups but not in every topic. Most of the time, the group have two or three members to ensure that each group member participate fully in the discussion, otherwise they are ending on making the noise."*
>
> Teacher C: *"I normally use the traditional teaching and the problem-solving strategy. Considering the number of learners in my class, other teaching strategies cannot be applied. I have almost 95 learners. So even though I will assign the small groups, it will be difficult for me to assist each group."*

When I asked Teacher C why he used a problem solving strategy and not discovery learning, his answer was:

> Teacher C: "*Because of the nature of the learners. Most of the learners are slow learners. However, apart from that, I have no idea of discovery learning."*

It was noticeable that Teacher C was not familiar with the problem-based learning strategy, which was why he could not differentiate between the problem solving strategy and the basic questioning technique. Actually, most of the time, Teacher C used questioning to lead the classroom discussion. A problem-based learning strategy works successfully when learners learn in small groups, while the strategy of questioning can be applied to the class as a whole. Through the observations, it became clear that this teacher used traditional teaching and group work for classroom instruction. In general, the teachers' responses showed that they did not know about other teaching strategies such as cooperative learning, which does not necessarily require the use of new technology, and could work effectively with a big class.

4.4.3 The way the teachers combined verbal explanations and visual media during their lessons

In terms of teaching new concepts, all three teachers admitted that they usually combined text with still media when explaining concepts:

> Teacher A: "*I normally combine text with still media to teach a new concept. During the presentation, I explain the concept first and then demonstrate still media such as graphs."*
>
> Teacher B: *"I usually use both verbal and visual information to teach a new concept. The problem is the language, because not all learners can be able to figure out what is written. To make them understand easily, I try to draw some figures instead of using words alone."*
>
> Researcher: *"How do you combine?"*
>
> Teacher B: *"I explain first the concept, then a figure or picture follows."*
>
> Teacher C: *"I usually combine verbal explanations with visuals in order to help learners to gain knowledge according to their learning styles. I know that learners learn differently. Thus, some learners acquire knowledge by listening, while others by watching and doing. I start with verbal, after that I display the pictorial representation."*

4.4.4 Learning activities that facilitate the development of learners' visual literacy skills

These teachers were also asked about the activities that they used to develop visual literacy skills in the learners. One of the teachers said that during lessons, there was insufficient time for learners to carry out learning activities to develop visual literacy skills:

> Teacher A: *"During the period it is not easy. But during the subject clubs, normally I involve learners in the learning activities that require them to generate visual representations or make visual aids. Particularly, in the lessons I rarely give them the opportunity of drawing or generating visual information."*
>
> Teacher B: *"I usually assign to learners the learning tasks that require them to generate visual information."*
>
> Teacher C: *"I have no idea of those strategies.*"

All of the teachers agreed that it was necessary to develop visual literacy skills in learners. According to them, by developing learners' visual literacy skills, it became easier for them to deliver mathematical concepts to the learners, thus enabling the learners to understand the concept easier. Teacher B, for example, explained the following:

> Teacher B: *"By developing visual literacy skills it will be easy for the teacher to ask learners to prepare the teaching materials using local resources available within the school premises in advance. This gives them a chance to understand what is going on before the actual class".*

Teachers A and C made further contributions to this as they insisted that it is very important to develop visual literacy skills in learners since many mathematical concepts are well understood when are represented visually.

4.4.5 Visual media that the teachers used during classroom instruction

One of the key requirements of teaching mathematics for visual literacy is that teachers should employ visual media in classroom instruction. The teachers, therefore, are supposed to use various visual media to facilitate mathematics teaching. Taking this into consideration, the three teachers were asked about the visual media that they normally used in teaching the concepts of geometric transformation, similarity, quadratic equations, statistics, and trigonometry. All three teachers claimed that they used still media, but never dynamic or

technological media. They also explained their reasons for only using still media in their lessons:

Teacher A: *"I usually use still media in teaching the mentioned concepts. The reason is, my school has no enough technology media such as computers. The computers which we have are used in teaching other disciplines such as computer literacy."*

Researcher: *"If the government brings the computers, will you be able to use them for teaching?"*

Teacher A:" *Mmmh! Not at all. I don't know how to use the computers for teaching, but I only use them for other activities such as typing."*

Researcher: *"Do you have calculators at your school?"*

Teacher A: "*We have no calculators at all. Actually, learners are not allowed to use calculators during the National Examination. Of course, I also do not believe in calculators."*

Researcher: *"Why?"*

Teacher A: "*The calculator does not make learners to struggle in solving a problem because they provide direct answers. But learners cannot explain how they reach at the answer. Personally, I believe that, by doing calculations themselves, learners can retain and retrieve the information when they need it. But by using calculators, the information can be remembered shortly and then get forgotten."*

Researcher: *"Do you have the geo-board at this school?"*

Teacher A: *"Yes we have few geo-boards which I normally use to teach geometry."*

Teacher B: "*Most of the time, I use still media to instruct those concepts. I am not using any other media because we have scarcity of modern media at this school, for example, we have few computers for academic office use only. The government should see mathematics in another way because for many years mathematics has been ignored by many learners since it is not an interesting subject to them due to the way it is taught. We still teach mathematics using the local or traditional way instead of the participatory method. Myself, I like to teach mathematics using new technology such as using the projector or laptop."*

Researcher: *"If the government brings technology media such as computers at this school will you be able to use them?"*

Teacher B: "*Yes, I will be able to use them because I have some knowledge of ICT. Also, I like to watch from YouTube how teachers from other countries teach mathematics using technology. According to this, I think it is a time now for Tanzanian mathematics teachers to teach mathematics using new technology. However, I am sure that most of the teachers are not knowledgeable enough in using new technologies."*

Researcher: *"Do you have calculators at this school?"*

Teacher B: "*No. We don't have calculators at all. Normally, we use mathematical tables in the lessons rather than calculators. Actually, learners are not allowed to use calculators in the National Examinations."*

Researcher: *"Do you use the geo-board when teaching mathematics?"*

Teacher B: *"No, we don't have the geo-boards."*

Teacher C: "*Usually, I use still media to teach those concepts. We don't have enough technology media at this school, for example, we have only one computer and it is for the school secretary only. Similarly, learners at O-level are not allowed to use calculators when they seat for the National Examinations, therefore it is useless to use them."*

Researcher: "*Do you have the geo-board at this school*?*"*

Teacher C: *"We do not have geo-boards completely."*

To summarise, all three teachers said that they used a teacher-centred teaching style to conduct their lessons. Generally, Teachers A and B used a traditional teaching strategy, while Teacher C employed both traditional and small groups teaching strategies. Alternatively, all of the teachers said that they combined text-based or verbal explanations with visual media when teaching a new concept. In the case of learning activities that could facilitate learners' development of visual literacy skills, the teachers had different points of view. On the one hand, Teacher A, for example, said that it was difficult for her to involve learners in learning activities that could develop visual literacy skills during classroom presentations due to the limitation of time. Teacher B, on the other hand, said he normally assigned learners learning activities that required them to generate visual information, and Teacher C said that he did not know other strategies. In addition, all three teachers confirmed that they employed still media in

mathematics teaching, but not technology or dynamic media due to the scarcity of those media in their schools.

4.5 CHAPTER SUMMARY

This chapter presented the findings of this study, which have shown that these Tanzanian Form 2 mathematics teachers used a teacher-centred teaching style and a traditional teaching strategy in their lessons. The teachers also involved learners in the classroom discussion through asking simple oral questions and doing demonstrations. Alternatively, the findings revealed that, in most cases, these teachers did not involve learners in learning tasks that could develop visual literacy skills. However, the findings revealed that the teachers often combined text-based or verbal explanations with still media, but not dynamic or technology-based media in their lessons. In general, the findings from the classroom observations were confirmed in the interviews. A discussion of the findings of the study follows in the next chapter.

CHAPTER 5 DISCUSSION OF THE FINDINGS

5.1 INTRODUCTION

The aim of this study was to explore how Tanzanian secondary school mathematics teachers teach for visual literacy in Form 2 classrooms. The findings from the classroom observations and semi-structured interviews that were conducted were presented in Chapter 4. In this chapter, I will discuss the findings of the study based on the conceptual framework, and compare it with the findings from the literature that was reviewed.

The discussion includes teachers' understanding of the term visual literacy and the role it plays in teaching mathematics; teachers' teaching styles and strategies that contribute to developing learners' visual literacy skills; the visual media that teachers use to facilitate the development of learners' visual literacy skills; and the learning activities that facilitate the development of learners' visual literacy skills. This discussion will be used to answer the research questions in Chapter 6.

5.2 TEACHERS' UNDERSTANDING OF THE TERM VISUAL LITERACY AND ITS ROLE IN TEACHING MATHEMATICS

Teachers are curriculum implementers. In this regard, their understanding of what has been prescribed in the curriculum is crucial in order for them to fulfil the intended learning goals. According to Vesely, Sklofske and Leschied (2013), teaching professionally is not merely the transfer of knowledge, but also understanding the intended learning objectives. It was evident from the data collected that all three teachers were able to define the term visual literacy and the role it plays in teaching mathematics. Although their definitions were not professional, they seemed to have an idea of the term visual literacy. In their opinion, the term visual literacy referred to the use of visual media, as well as constructing meaning through visual observations. The definitions provided by Teachers A and B were in line with that of Velders et al. (2007), who define the term visual literacy as the ability to learn through images, but also that of Bamford (2003), who views visual literacy as the ability to make meaning through images.

Teacher A, for example, defined the term visual literacy as "*the use of visual aids in order to foster learners' understanding*". According to Teacher A, visual aids facilitate learners' learning because when you explain and then demonstrate, it makes it easier for them to understand the concept. Teacher B viewed the term visual literacy as learning through pictures

or media that allows learners to observe images. To the contrary, Teacher C's definition was different from the other two definitions. Teacher C defined the term visual literacy as "*the procedures which make learners understand the subject matter by eye contact.*" Teacher C further explained that visual information usually facilitates the successful delivery of the lesson's message. His definition was similar to Felten's (2008) ideas about visual literacy, which are that images are no longer a means of communication only, but also serve as essential tools of making meaning.

All three teachers clearly interpreted the role of visual literacy in teaching mathematics. These teachers indicated that visual literacy simplifies the teacher's work and learners' understanding. Teacher A and B, for example, stated that visual literacy in teaching mathematics "*facilitates learners' learning*", while Teacher C precisely stated that visual literacy "*simplifies learners' understanding*". According to Teacher A, on the one hand, "*visual literacy enables the teacher to use a short time to teach since the learners may be able to see the picture or an image or even an object which makes the concept to be clearly understood*". Teacher B, on the other hand, explained that, *"visual literacy simplifies learners' learning since seeing is the part of learning. Thus, through visualising an image or a picture the information can stick easily in the learner's mind rather than listening or reading".* Teacher C explicated that, "*visual literacy in mathematics classrooms simplifies leaners' understanding since visual information can be easily understood by learners compared to other sources of information*."

In conclusion, this study suggests that the concept 'visual literacy' primarily has a simple and singular meaning to teachers, which is that they, as teachers, show or use images or pictures in their lessons. This is the most basic conceptualisation of the term and is, in fact, an indication that teachers do not comprehend the term in its full meaning. The elements of the rich concept of visual literacy, as explained in Chapter 2, notably the ability of the teacher to use and interpret visual material, the variations of still and dynamic visual material, the integration of visual material with regard to specific topics, the ability of learners to interpret the material in terms of mathematical concepts, and the period of training learners to obtain the full value out of visuals (Hattwig et al., 2012; Tillmann, 2012; Felten, 2010; Bleed, 2005; Stoke 2002) are some of the aspects that did not form part of the teachers' understanding of the concept of visual literacy and its role in teaching mathematics.

Similarly, the effect of visual literacy was reported in simple and singular terms; the focus was on understanding, making learning content simple (making complex ideas easier to understand

(Section 2.3.1), and remembering facts. The aspects of accommodating learner needs (Section 2.3.2) and preferences for modalities of learning, especially accommodating the dominant visual learner, that visual literacy promotes critical and logical thinking (Section 2.3.3), and the effect it has on teaching and learning styles (Section 2.5) were not taken into account.

5.3 TEACHERS' TEACHING STYLES AND STRATEGIES AS CONTRIBUTING FACTORS TO THE DEVELOPMENT OF LEARNERS' VISUAL LITERACY SKILLS

Teachers' teaching styles and teaching strategies will be discussed separately below. Teaching styles refer to teachers having a learner-centred, teacher-centred, or combination of learner- and teacher-centred teaching styles. Teaching strategies refer to the teachers' use of traditional teaching, cooperative learning, discovery learning, problem-based learning, and multimedia instruction.

5.3.1 Teachers' teaching styles

Although several measures have been taken to improve the Tanzanian school curriculum to purposely empower learners in their learning, this study's findings have shown that Tanzanian Form 2 mathematics teachers mainly use a teacher-centred teaching style. A similar finding was also made by Zilimu (2014), who found that Tanzanian secondary schools' mathematics teachers use a teacher-centred teaching style during the teaching and learning process. All three teachers who participated in this study dominated classroom instruction, and learners were seldom given a chance to participate or contribute their ideas on the subject matter. One of the drawbacks of limiting learners' full participation in the learning process is that they are unable to generate their own knowledge and understanding based on what they already know (Section 2.5.1.3). This could hinder them in obtaining important knowledge and skills that are useful in conducting their daily lives. This is contrary to the constructivist perspective, which advocates that learners should take responsibility in their learning and that the teacher must act as the facilitator or guide in the learners' learning, and not be the only source of learning (Gilakjani et al., 2013; Azeem & Khalid, 2012; Kunter & Baumert, 2004; Applefield et al., 2001). The main goal of the competence-based curriculum is not the quantity of knowledge that learners may come to possess, but how they use this knowledge in real life situations (Kafyulilo et al., 2012).

The results from the interviews showed that the teachers' teaching styles could be linked to the length and expectations of the syllabus. This study's findings have shown that an overloaded

curriculum is one of the factors in Tanzanian Form 2 mathematics teachers' justification for rushing through the work during lessons in order to finish the work within a specified time. During the interviews, all three teachers said that their teaching styles were highly influenced by the length of the syllabus. They complained that the syllabus was too full and that they had to complete the prescribed work within a specified time (before learners sat for the Form 2 National Examinations in November). Teacher A, for example, said the following during the interview: "*If I allow learners to discuss themselves, I will not be able to accomplish the syllabus because the time will not be enough for me*". While Teacher B added that, "*The authority needs us to accomplish the syllabus within a specified time. Thus why, most of the time, I minimise the activities that consume time which can prevent me from finishing the syllabus.*" The Tanzanian mathematics teachers worked under pressure in order to cover the syllabus provided by the Tanzanian Institute of Education (TIE), which was too long for them. This finding corroborates that of Zilimu (2014), who found that during their classroom instruction, Tanzanian mathematics teachers provided direct information to learners so as to finish the syllabus provided by the Tanzania National Examination Council (NECTA) within the specified time. There is not only pressure to cover the syllabus content in Tanzania, but even in other countries. Henderson and Dancy (2007) find that most of the time, physics teachers in the United States of America use a traditional teaching strategy based on lecturing in order to cover the prescribed syllabus.

The results obtained from the interviews also revealed that the teachers' teaching style was associated with their pedagogical knowledge. Some of the participating teachers explained that they used a teacher–centred teaching style because they were not competent in the use of other teaching styles. Teacher C, for example, stated that he used a teacher-centred teaching style because he lacked the pedagogical knowledge and skills for other teaching styles from the teachers' training programme. According to Teacher C, in most cases, the teachers' training focused on the use of the teacher-centred teaching style rather than a learner-centred teaching style. Inadequate professional training and development, is one of the main challenges that affect the classroom instruction of Tanzanian mathematics teachers. Olfos, Goldrine and Estrella (2014) point out that, it is the teachers' pedagogical knowledge that enables them to make a decision on which teaching style(s) to use and how it can be applied to deepen learners' understanding. The teachers' professional training should equip them with the essential skills and knowledge that are useful in performing their duties. Improving Tanzanian teachers'

training is necessary for the reformation of classroom practices, and in particular, the appropriate use of teaching styles and strategies.

5.3.2 Teachers' teaching strategies

In terms of teaching strategies, Tanzanian mathematics teachers are supposed to use various teaching strategies, including traditional teaching, cooperative learning, problem-based learning, discovery learning, and multimedia instruction, as prescribed by the Tanzanian Mathematics Curriculum Document (MoEVT, 2010). According to Portman and Richardon (1997), learners acquire knowledge more efficiently when different teaching strategies are employed and teachers should therefore employ various teaching strategies in their classroom instruction (Section 2.6). The integration of various teaching strategies in the mathematics classroom not only provides learners the opportunity to develop conceptual understanding, but also to think critically and explore new knowledge for themselves (van der Wal, 2015).

Multimedia instruction is one of the features of teaching mathematics for visual literacy (Section 2.6). The study's findings have shown that all three teachers used multimedia instruction considerably during their lessons. They also integrated still media such as graphs, charts, tables, diagrams, and other visual representations into their verbal explanations while teaching various mathematical concepts, including similarity, statistics, sets, angles of elevation and depression, as well as trigonometry. Teacher A also used mathematical models to make the concept of similarly clear to the learners. It follows from the literature (Naidoo, 2012; Murphy, 2011; Rampersard, 2009) that when mathematics instruction not only consists of verbal explanations, but includes the use of different models, learners' understanding of the subject matter is enhanced. During the interview, all three teachers affirmed that the combination of verbal explanations and visual media not only simplified their work, but also made mathematical concepts clear and understandable for the learners. However, it was a challenge for the teachers who participated in this study to combine verbal explanations with dynamic or technological media due to the shortage of these tools in their schools. This finding correlates with several studies (Mpapalika, 2013; Zalia, 2007; Mafumiko, 2006; Kibga, 2004; Kitta, 2004), indicating that most Tanzanian government secondary schools have a shortage of technological tools, especially computers, for teaching and learning. According to Kafyulilo (2010), some Tanzanian government secondary schools have a single computer for administrative usage only. A lack of technological media for teaching and learning is a big problem, not only in Tanzania, but also in many countries all over the world. Researchers

(Moila, 2006; Brown, Askew, Rhodes, Denvir, Ranson & William, 2002; Eadie, 2001) have found that schools in South Africa, New Zealand, and the United Kingdom lack technological media for the teaching and learning of mathematics, especially in rural areas.

The results from the classroom observations confirmed those of the interviews as all three teachers said that they preferred using a traditional teaching strategy in conducting their lessons as opposed to participatory teaching strategies. Teacher A stated that she preferred traditional teaching because it was easy to conduct, while Teacher B explained that pressure from authorities led him to use traditional teaching, and Teacher C claimed that the class was too overpopulated for him to use other teaching strategies. When Teacher B, for example, was asked about cooperative learning, he said, "*I normally assign learners in small groups in specific topics (did not mention which topics), but not in all topics*". A similar response was given by Teacher A. A traditional teaching strategy was extremely dominant in Teachers A and B's lesson, as compared to Teacher C. Teacher C regularly assigned group work a few minutes before the end of the period. When I asked him why he started group work at the end of period, he clarified that "*the number of learners in my class is too big, so I cannot assist all learners during the presentation*". This finding is corroborated by Zilimu (2014), who found that Tanzanian mathematics teachers preferred classroom discussions with the whole class, most of the time, due to the large number of learners in the classroom. This is contrary to what has been prescribed in the Tanzanian Mathematics Curriculum Document, which indicates that teachers should use participatory teaching strategies such as cooperative learning rather than using those that do not encourage learners' participation (MoEVT, 2010; Wangeleja, 2010). However, according to Jidamva (2012), an overcrowded classroom is the main challenge for Tanzanian teachers in using participatory teaching strategies during classroom instruction.

All three teachers used questioning to involve their learners in discussions. Questioning as a teaching technique plays an important role in instruction and the teacher should include different kinds of questions, but also questions based on different cognitive levels (Section 2.6.1). Questioning as teaching technique could involve learners effectively in the learning process (Molefe & Brodie, 2010), and if teachers use this technique wisely in the mathematics classroom, it could develop learners' in-depth understanding of mathematical concepts. It follows from the literature that higher-order questions not only involve learners effectively in the learning process, but also inculcate critical thinking (Güler & Çiltaş, 2011; Molefe & Brodie, 2010). However, according to this study's findings, none of the teachers used higher-

order questions, but rather used simple, low-level questions that required direct and straightforward answers. The learners frequently gave chorus answers when responding to the questions, particularly in the classes of Teachers A and B. This finding is confirmed by Zilimu (2014), who found that Tanzanian mathematics teachers used simple (short) answer questions (low-level thinking questions) to involve learners in classroom discussions. Higher-order questions, apart from promoting cooperative and collaborative learning in the classroom, may also give learners the opportunity to verify their answers (Molefe & Brodie, 2010). The Tanzanian Mathematics Curriculum Document states that learners should participate effectively in the learning process (MoEVT, 2010). As indicated by Muijs and Reynolds (2011), learners who are given the opportunity to take a central part in their learning have a great opportunity to acquire the intended learning goal. Tanzanian mathematics teachers should improve their questioning skills in order to enhance learners' mathematics knowledge and skills.

5.4 VISUAL MEDIA THAT TEACHERS SHOULD USE TO FACILITATE THE DEVELOPMENT OF LEARNERS' VISUAL LITERACY SKILLS

At the heart of teaching mathematics for developing visual literacy skills is the effective use of visual media. According to the literature, teachers should use various visual media, particularly still media (Section 2.6.5.1), dynamic media (Section 2.6.5.2) and technological media (Section 2.6.5.3) during their mathematics instruction.

5.4.1 Still media

Still media such as graphs, charts, tables and other visual representations play an important role in mathematics instruction. All three teachers thoroughly used still media in their mathematics instruction. Teacher A used diagrams, symbols, charts, tables, and graphs to simplify the communication and derivation of the concepts of similarity and statistics. She also used models to reduce the complexity of the concept of similarity. Teacher B used diagrams in teaching the concept of sets and angles of elevation and depression purposely for learners completely understand those concepts. Teacher C used tables, graphs, charts, and diagrams to make the concepts of statistics and trigonometry clear and understandable for the learners. As indicated by the literature, visual representations have the potential to make mathematical concepts clear and understandable for learners (Naidoo, 2012; Murphy, 2011; Rampersard, 2009).

5.4.2 Dynamic media

The use of dynamic media in mathematical instruction, according to the literature, simplifies the clarification of complex mathematical ideas (Ainsworth, 2008). None of the teachers used dynamic media in their mathematics instruction. All of the teachers had a positive attitude towards the use of dynamic media during mathematics instruction, but admitted that these media were not utilised in their schools. The above is contrary to what has been indicated in the literature as dynamic media is an important tool in teaching mathematical concepts such as transformation, translations, and transitions (Ainsworth, 2008). Transformation and translation are among the main topics taught in the Form 2 Tanzanian mathematics syllabus.

5.4.3 Technological media

Technological media, like calculators and computers, is another source that teachers can use to present ideas in various ways and to develop learner understanding (Gilakjani et al., 2013; Joshi, 2012; Okita & Jamalian, 2011; Niess, 2006; National Council for Teachers of Mathematics, 2000). However, several studies have shown that teaching mathematics by using technological media is still a challenge in many countries all over the world, e.g. South Africa, New Zealand and the United Kingdom, due to various factors, including a lack of this media in schools and a lack of knowledge amongst teachers in using these media (Ndlovu & Lawrence, 2012; Moila, 2006; Brown et al., 2002; Eadie, 2001). These factors also affect Tanzanian Form 2 mathematics teachers. None of the teachers used technological media during their mathematics instruction. All three teachers indicated that their schools did not have technological media that could be used for teaching. According to Teacher A, she would have liked to use computers in her teaching as some private school teachers do. The unavailability of technological media in Tanzanian government secondary schools is therefore a barrier to the dynamic teaching of mathematics for the development of visual literacy.

A lack of knowledge to use technological media among teachers is another reason that prevents Tanzanian Form 2 mathematics teachers from using computers during instruction. Some of the teachers acknowledged that they had no knowledge of how to use a computer to teach. During the interviews, Teacher A stated that she would have loved to use computers for teaching, but she was not knowledgeable enough. Teacher C explained the same. Teacher B was the only one who showed an awareness of using computers to teach, based on his personal experiences, but had no specific training on how to use computers during instruction. A lack of knowledge

amongst teachers in using technological media to teach is a problem in many countries (Ndlovu & Lawrence, 2012; Moila, 2006; Brown et al., 2002; Eadie, 2001). It has been identified that the majority of the participating teachers lacked training on the use of technological tools for teaching mathematics, which should be addressed in teachers training programmes (Ndlovu & Lawrence, 2012; Kafyulilo, 2010). Without specific and proper training, it is difficult for Tanzanian secondary school mathematics teachers to teach using computers.

None of the three teachers used calculators for classroom instruction. Teacher, B for example, used mathematical tables instead of calculators when he taught the concept of angles of elevation and depression. During the interview, all three teachers reported that they experienced difficulties in using calculators during classroom instruction because of the National Examinations rules and regulations. Teacher B stated during the interview, "*It is useless for us to use calculators during the instruction while learners are not allowed to use them during the National examinations.*" Tanzanian O-level learners are not allowed to use calculators when sitting for the National Examinations. There is therefore a need to amend the Tanzanian National Examinations rules and regulations to include the use of calculators.

Teachers' attitude and beliefs play an important role in using technological media in teaching mathematics (Moila, 2006). The results from the interviews show that some of the teachers were negative about the efficacy of technological tools, particularly calculators, in teaching mathematics. When Teacher A was asked if the school had calculators for teaching mathematics, she said, "*We have no calculators at all. However, it is better for learners to learn themselves because when calculators are used they cannot get the concepts. Actually, they cannot follow the steps of doing calculations such as division with calculators. Rather to use the calculators is better to teach them step by step in order to know how to reach at the answer instead of using a shortcut way (calculators). Personally I don't like the use of calculators.*" This finding is corroborated by Salani (2013) and Mason (2010), who find that some mathematics teachers disagree about the efficacy of calculators, particularly in enhancing learners' understanding and developing mathematical competencies.

5.5 LEARNING ACTIVITIES THAT FACILITATE THE DEVELOPMENT OF LEARNERS' VISUAL LITERACY SKILLS

Wandberg and Rohwer (2010) specify that when learners are involved practically in the learning process, it becomes easy for them to acquire important skills. This was found to be true in this study in terms of the acquisition of visual literacy skills, which requires proficient

learner involvement in various learning tasks, such as decoding, interpreting, generating and analysing visual images (Section 2.4.3).

In the class of Teacher A, the learners were given an opportunity to interpret visual information during the lesson as they were asked to answer oral questions based on the information on the posters presented to them. However, many learning activities assigned to the learners heavily relied on the use of numbers only. Teachers B and C differed from Teacher A in that they gave learners an opportunity to solve mathematical problems visually specifically by using graphs, charts, and diagrams during the lesson evaluation. In most cases, Teacher B's learners used diagrams to solve mathematical problems, while Teacher C's learners used charts, diagrams, graphs, and tables. All of the learning activities in Teacher C's class were done in small groups. None of the teachers gave the learners the opportunity to present new mathematical ideas visually, for example, using tables, graphs, diagrams, pictures or other visual representations during the lesson presentation, either individually or in small groups. The literature indicates that providing an opportunity for learners to generate new mathematical ideas visually in small groups plays a crucial role in developing visual literacy skills (Murphy, 2011).

The use of visual media was not only required from the teachers, but also from the learners as they needed to be encouraged to use visual media during the learning process as it enhances the understanding of mathematical concepts, and it develops their visual literacy skills (Bennett & Roblyer, 2014; Naidoo, 2012; Murphy, 2011; Bamford, 2003; Sims et al., 2002). The teachers did not encourage learners to use still media during the lesson presentations, although the study's findings revealed that they thoroughly used still media during their presentations, for example, most of the time, Teachers A and B used posters during their lesson presentations, but neither of them encouraged learners to develop posters by themselves to depict the concepts being taught. Providing learners an opportunity to prepare or produce visual materials themselves makes it possible for them to develop visual literacy skills (Hattwig et al., 2012; Murphy, 2011).

The use of technological and dynamic media is crucial in the visual literacy teaching and learning environment. Findings from both the classroom observations and interviews revealed that none of the teachers gave learners an opportunity to use technological or dynamic media in their learning, both during the lesson presentations and assessment. In all of the classes that I attended, learners had no opportunity to use calculators or computers or animations during teaching and learning, this was either due to the scarcity of these resources or a lack of creativity

on the part of the teachers. Some technological media, for example, a geo-board, can be developed by teachers and learners by using locally available resources. This could affect learners' acquisition of visual skills, as it is indicated in the literature that the effective use of technological media enhances the acquisition of visual literacy skills (Bennett & Roblyer, 2014; Bamford, 2003; Sims et al., 2002). According to Jidamva (2012), a lack of creativity and skills amongst teachers is a challenge for Tanzanian secondary schools teachers in developing their teaching and learning tools by using locally available materials in their community.

The goal of teaching mathematics for visual literacy is to improve learners' learning and understanding. However, this can be achieved if learners participate in several learning activities in the class, such as discussion. The study's findings revealed that all three teachers used a number of examples to conduct classroom instruction. Most of the time, Teachers A and B used the questions from the learners' textbook, while Teacher C used questions from both the learners' textbook and past National Examination questions papers. Many mathematics teachers believe that the questions from learners' textbooks or from examination papers are good practice for learners (Zilimu, 2013). This finding correlates with several studies that indicate that most of the time, mathematics teachers use a number of examples from the prescribed textbook and past papers for their classroom instruction (Zilimu; 2014; Suffiana & Rahman, 2010). This is an important aspect as the provision of examples during the teaching and learning process has been found to enhance learners' understanding (Suffiana & Rahman, 2010).

Although the teachers provided examples during the teaching and learning process by using questions from textbooks and past papers, these questions did not reflect real life problems. One of the goals of teaching mathematics for visual literacy is to engage learners in learning activities that reflect real life or authentic problems so that they can acquire the intended learning outcomes. Real life or authentic problems enable learners to connect new ideas with their prior knowledge, which makes it possible for them to understand the concept being learnt and to recall information easily (Ferguson, 2010). These Tanzanian mathematics teachers were, therefore, expected to use real life or authentic problems during classroom instruction.

5.6 CHAPTER SUMMARY

In this study, Tanzanian Form 2 mathematics teachers' understanding of teaching for the development of visual literacy and the role multimedia plays in teaching mathematics were explored through semi-structured interviews. It was observed that the teachers' instructional

practices determined how their instruction contributed to the development of learners' visual literacy skills. This involved a study of the teachers' teaching styles and the strategies used to contribute to developing learners' visual literacy skills. The study also identified the visual media that the teachers used, as well as how they used it to facilitate the development of learners' visual literacy skills. Finally, learning activities that facilitate the development of learners' visual literacy skills were explored. The next, and final, chapter presents a summary of the study, and culminates in recommendations for future research and a conclusion of the study.

CHAPTER 6 CONCLUSIONS AND IMPLICATIONS

6.1 INTRODUCTION

In Chapter 5, I discussed the findings from the data that were collected to answer the research questions of the study. The analysis was based on the conceptual framework, and the findings were compared to those in the literature. In this chapter, the research questions will be answered, the implications of the findings will be discussed, recommendations are made, the limitations of the study are stated, suggestions are made for further research endeavours, where after the study is brought to a close with final conclusions.

6.2 THE AIM OF THIS STUDY

This study aimed to explore how Tanzanian secondary school mathematics teachers teach for visual literacy, with a focus on teachers' understanding of the term 'visual literacy' and its role in teaching mathematics. Furthermore, the teachers' teaching styles, and strategies contributing to the development of learners' visual literacy skill were investigated, the visual media that they used and how they used it were observed, and the learning activities that were given to the learners to facilitate the development of learners' visual literacy skills were also analysed.

The study was guided by the primary research question:

> *How do Tanzanian secondary school mathematics teachers teach for visual literacy in Form 2 classrooms?*

To answer this primary research question, the following secondary research questions were formulated:

1. What is the teachers' understanding of visual literacy and its role in the teaching of mathematics?
2. How do the teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?
3. How do the teachers combine visual media with the text to facilitate the development of visual literacy to learners?
4. How do the learning activities facilitate the development of learners' visual literacy skills?

The secondary research questions are initially answered in order to answer the primary research question.

6.3 ANSWERING THE RESEARCH QUESTIONS

The main findings were summarised in the previous chapter (Chapter 5). This section therefore synthesises the main findings to answer the secondary research questions and the primary research question.

6.3.1 What is the teachers' understanding of visual literacy and its role in the teaching of mathematics?

Teachers' understanding of what has been prescribed in the curriculum document plays an important role in achieving the intended educational goals and objectives. This research found that all three teachers were able to define the term visual literacy and the role it plays in teaching mathematics. Their definitions, however, had a simple and singular meaning as they understood visual literacy to be the use of pictures or images during classroom instruction, as described below:

> Teacher A: "*What I know about visual literacy, is the use of visual aids in order to foster learners' understanding.*"
>
> Teacher B: *"From my own understanding, I can define the visual literacy as the learning through pictures or media whereby learners can observe the images."*
>
> Teacher C: *"Personally, I define the term visual literacy as the procedures which make learners understand the subject matter by eye contact."*

From these findings, it is clear that these teachers' definitions were not in line with those of the literature that was reviewed. In the literature (Naidoo, 2012; Hattwig et al., 2012; Tillmann, 2012; Felten, 2010; Bleed; 2005; Stokes, 2002), the term visual literacy was viewed, in its broadest meaning, to include the ability of the teacher to use and interpret visual material, to variate between still and dynamic visual material, to integrate visual material with regard to specific topics, and the ability of learners to interpret and understand visual information or images. On the basis of these results, it is therefore concluded that the teachers had a vague idea, but did not understand the term in its full meaning.

All three teachers clearly appreciated the value and the role of visual literacy in teaching mathematics. However, their interpretation focused on the single benefit of the simplification of the teaching and learning process through visual literacy, as described below:

> Teacher A: *"In fact, visual literacy in teaching mathematics facilitates learning, for example, if you have a concept to teach, you explain and then demonstrate. Sometimes learners can touch and see, which enables them to retain in memory that material for a long time.*"
>
> Teacher B: "*Visual literacy in teaching mathematics simplifies learners' learning. In fact, when a learner visualises an image or a picture, the information can stick easily in his/her mind rather than reading from a written material or listening to someone. By this matter, the learner can be able to figure out what is going on within a short time."*
>
> Teacher C: "*What I know, visual literacy in teaching mathematics it simplifies learners' understanding. This is because visual information can be easily understood by learners."*

From these findings, it is clear that the teachers lacked clarity on the important role of visual literacy in teaching mathematics, as described by the literature. In addition to the simplification of mathematical ideas through visual literacy, or the clarification of complex ideas, visual literacy also enhances the recall of information, accommodates learners' learning preferences, provides an opportunity for the teacher to use multiple modes of representation, and enhances critical thinking in learners (Aisami, 2015; Naidoo, 2012; Murphy, 2011; Mudaly, 2010; Bamford, 2003).

On the basis of these results, it can be concluded that the teachers' deficient understanding of the term visual literacy and the role it plays in teaching mathematics could be caused by the pedagogical knowledge that they acquired during their tertiary education at teacher training institutions. From the teachers' responses, it is clear that they used personal experiences and understanding to answer the questions, however, they had no specialised exposure to the use and benefits of visual literacy in mathematics teaching. It is therefore vital to equip teachers with the necessary pedagogical content knowledge to perform their duties proficiently.

6.3.2 How do teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?

As argued previously, teaching mathematics for visual literacy requires both the teacher-centred and learner-centred teaching styles. Teachers should therefore combine direct teaching with other strategies to involve learners in the learning process (Boumová, 2008). In other words, it is required of the teacher to facilitate the learning process, providing learners with opportunities to explore, while guiding the learners in constructing their own understanding of the mathematics being taught.

The empirical findings of this study revealed that all three teachers only used the teacher-centred teaching style to conduct their lessons. The teachers dominated classroom instruction, thus, learners' participation in their learning was minimal. Most of the time, the teachers discussed, explained, and demonstrated mathematical concepts to the learners, while the learners had no chance to contribute anything to their own learning. Such teaching styles may have an impact on the learning that takes place, and could compromise learners' complete understanding of the subject matter.

Several factors were mentioned by the teachers as an explanation for, or in defence of their teaching style, including the length of the syllabus and a lack of pedagogical knowledge. The teachers in this study revealed that the syllabus was too long and they had to complete it within a specified time. Similarly, some teachers said that they used a teacher-centred teaching style because they lacked pedagogical knowledge and skills in terms of other teaching styles as a result of an insufficient teacher training programmes.

As stated in Chapter 2, teaching mathematics for developing visual literacy requires teachers to use a combination of various teaching strategies, including traditional teaching, group work, in particular, cooperative learning, discovery learning, problem-based learning and multimedia instruction. Nonetheless, the fact that the teachers used the traditional teaching strategy combined with the use of multimedia instructions, to a certain extent, to conduct their lessons is a starting point, and creates an optimistic expectation that the use of these strategies can be expanded.

The teachers, however, combined still media such as graphs, charts, tables, diagrams, and other visual representations with verbal explanations during instruction, but did not use technological or dynamic media due to the scarcity of these media in their schools.

Moreover, the study's findings indicate that cooperative learning was not given much attention, particularly in the classes of Teachers A and B. These teachers did not give the learners an opportunity to work cooperatively in small groups, either during the discussion or during the lesson assessment. Teacher C, alternatively, often assigned group work to learners during the assessment. None of the teachers used problem-based or discovery learning during their lessons.

All three participating teachers made extensive use of questions to involve learners in the discussion, however, the questions were too simple, straightforward, and on a low cognitive level, which did not require learners to think critically. Unfortunately, the learners often gave chorus answers, particularly in the classes of Teachers A and B. Several factors have been mentioned by the teachers as reasons for their lack of variation in teaching strategies, including the classroom size and pressure from the authorities to complete the work in a specified time frame.

6.3.3 How do the teachers combine visual media with text to facilitate the development of visual literacy in learners?

The way in which the teachers combined visual media with text also became clear during the classroom observations as all three teachers often explained concepts verbally first before they exposed learners to visual media, for example, I observed that when Teacher B taught the concept of angles of elevation and depression, he wrote the question and explained it verbally first before he drew the diagram based on the question on the board.

It is therefore clear that these teachers valued the combination of visual images and verbal information during their instruction. However, the visual images were most of the time almost an 'add-on' or used as an afterthought, whereas these could have been used more efficiently from the beginning of the explanation in order to make the concept more clear to the learners.

6.3.4 How do the learning activities facilitate the development of learners' visual literacy skills?

Teaching mathematics for visual literacy requires learners' involvement in various learning activities, particularly by giving learners an opportunity to interpret visual information, but also to use visual media effectively, for example, Teacher A gave learners an opportunity to explain why the two triangles were similar, and what the diagram represented. Empirical findings

indicate that the teachers who participated in this study did not give learners much opportunity to be involved in these kinds of activities. The findings further show that in all three classes, the learners were rarely given an opportunity to interpret or use visual information. Similarly, they had no opportunity to use visual media, such as calculators, for learning either during the lesson presentation or in assessments.

6.3.5 Primary research question

How do Tanzanian secondary school mathematics teachers teach for visual literacy in Form 2 classrooms?

In answering the primary research question, it can be said that Tanzanian Form 2 mathematics teachers' classroom instruction does not meet the requirements for teaching mathematics for visual literacy.

As indicated previously, teaching mathematics for visual literacy needs both the teacher-centred and learner-centred teaching styles. However, the study's findings showed that the participating Tanzanian Form 2 mathematics teachers' classroom instructions were based on the teacher-centred teaching style only, which is contrary to the curriculum document prescriptions. They used a traditional teaching strategy to conduct lessons instead of employing various teaching strategies, including cooperative learning, problem-based, and discovery learning, which are explicitly prescribed in the curriculum document. Although, it was found that they often combined visual media with text (verbal explanations) in classroom instruction, opportunities for learners to use those media in their learning was limited.

6.4 IMPLICATIONS AND RECOMMENDATIONS

The findings of this study have implications for Tanzanian secondary schools, especially in terms of teaching mathematics for visual literacy. The results from both the classroom observations and interviews show that these Tanzanian Form 2 mathematics teachers employed a teacher-centred teaching style in mathematics instruction instead of using both teacher-centred and learner-centred teaching styles. This is contrary to what has been prescribed in the Tanzanian Mathematics Curriculum Document, which stipulates that the teacher should be the guide or facilitator of the learning process. To facilitate this, the Tanzanian Mathematics Curriculum recommends that teachers use participatory teaching strategies, including problem-based learning, cooperative learning (small group), multimedia instruction, discovery learning, as well as teachers' direct instruction (traditional teaching). Consequently, there is a need for

Tanzanian secondary school mathematics teachers to be knowledgeable of how to use these teaching strategies in mathematics instruction, which makes training, or re-training, imperative.

Alternatively, this study revealed that although the Tanzanian Mathematics Curriculum proposes the use of technology and dynamic media during classroom instruction, these Tanzanian Form 2 mathematics teachers did not use such media in their instruction. In the interviews, all three participating teachers declared that their schools had no technology and dynamic media that could be used in their mathematics instruction. As a result, some mathematical concepts that could be taught easily and interactively by using technological media, such as calculators, had to be instructed in the traditional way. Based on these findings, there is a need for Tanzanian mathematics teachers to be introduced to the use of technology in mathematics teaching, which should go hand in hand with the provision of such facilities in schools.

The Tanzanian Ministry of Education and Vocational Training and other educational authorities should take the following measures to improve the teaching of mathematics in Tanzanian secondary schools:

1. Improve teachers' training. In this regard, the reformation of teachers' training curriculum is crucial in order to equip teachers with the pedagogical content knowledge necessary to teach mathematics for visual literacy.
2. Revise the National Examination rules and regulations, especially in the O-Level. This should be done in order to produce learners who are capable of facing the challenges of the 21st Century of science and technology.
3. Provide technological and dynamic media in schools, such as computers, in order to simplify learners' learning and teachers' work.
4. Reduce the curriculum content that teachers must teach so that they can complete the syllabus in a fruitful way rather than rushing through it.
5. Organise and conduct thorough in-service training, workshops, seminars, conferences and other forms of training for teachers in order to improve their pedagogical knowledge and skills.
6. Reduce class sizes so that teachers are able to use applicable and efficient teaching strategies. If possible, the ratio should not be more than 1:40 in all levels.

6.5 LIMITATIONS

One of the limitations of this study was that I was the only observer in the process of collecting data, which could weaken the reliability of the collected data. It can therefore not be expected that a similar study would necessarily produce the same findings, or that similar conclusions would be drawn if it was to be repeated again using the same procedures. More reliable observational data could be obtained if the investigation included more than one observer using the same observation and interview schedules at the same time.

The sample size was another limitation of this study. The sample used in this study was not representative as it was too small, as compared to the entire population of the Tanzanian Form 2 mathematics teachers. Only three Form 2 mathematics teachers from three different government secondary schools were selected as a sample for this study. This means that the study's findings and conclusions are not generalisable as the results were restricted and applicable only to those schools in the selected sample, excluding a large part of Tanzania. However, as a researcher, I used three cases to replicate findings across three different secondary schools to reflect what may be happening in Tanzanian mathematics classes. I believe that through the study's findings and conclusions, the majority of Tanzanian secondary school mathematics teachers could get insight into how they conduct their classroom practices with respect to developing learners' visual literacy. This, in turn, could help them to reform their classroom practices.

The third limitation was that the time for data collection was too short (one month only). It was also conducted at the end of the year when all three mathematics teachers had almost completed the syllabus. This could have threatened the validity of the collected data, however, as a researcher, I tried to communicate with the participants (teachers) throughout the data collection process for validation, and I cross checked the validity of the collected data. In addition, I made sure that I attended all of the periods as scheduled in the teachers' timetables.

6.6 SUGGESTIONS FOR FUTURE RESEARCH

The focus of this study was at secondary level only, notably in Form 2 classrooms. Also, there were only three participants in the study. To obtain a broader view of the situation in question, it is suggested that a similar study be conducted with a larger cohort. To get in-depth insight into teachers' teaching of mathematics for visual literacy in Tanzanian schools, more studies are needed at different levels where the following questions could be addressed:

- How do Tanzanian primary school teachers teach mathematics for visual literacy?
- How do Tanzanian primary school teachers involve learners in the learning process?
- Which visual media do Tanzanian primary school teachers use to facilitate learners' understanding and learning?

Greater emphasis should be put on teaching mathematics for visual literacy in Tanzania schools at primary school level, rather than at secondary level, because all levels (primary and secondary) have a great influence in developing learners' mathematical capabilities and skills. Failure to do so could lead to the majority of Tanzanian mathematics learners being left behind in the global world of work.

As mentioned, a study of this nature could be replicated on a larger scale to investigate how pre-service educators prepare teachers to teach mathematics for visual literacy.

6.7 CONCLUSION

Finally, the conclusions and recommendations of this chapter pertain primarily to the need for the Tanzanian Ministry of Education and Vocational Training and other educational authorities to strive for some changes in secondary schools, which are as follows:

- Teaching equipment to effect a move from teacher-centred instruction to a combination of teacher- and learner-centred instruction;
- Teaching equipment presented with subject and pedagogical content knowledge and skills to employ various teaching strategies;
- Classroom equipment to make various forms of media available in order to enable teaching mathematics for visual literacy. The Ministry of Education and Vocational Training as well as other educational authorities should improve the teaching of mathematics in Tanzanian secondary schools by providing technological and dynamic media in schools so that teachers can use these in teaching mathematics, in conducting thorough and purposeful workshops, seminars, and in training teachers to improve their pedagogical knowledge and skills. Moreover, the number of learners in the classroom also needs to be reduced for the sake of efficacy in teaching.
- Another recommendation is a review of the mathematics syllabus content, which would allow teachers to complete it in a fruitful way rather than rushing through it.

- Finally, there is a need for the Tanzanian National Examination Council (NECTA) to amend some of the National Examinations rules and regulations so that learners can have the opportunity to use calculators when sitting for the National Examination.

It is hoped that the findings of this study will add value to mathematics teachers' instructional practices, and that they will be eager to effectively incorporate visual media in the teaching and learning of mathematics.

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APPENDICES

Appendix A: Letter of assent to the learners

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science, Mathematics and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

16 June 2015

Dear student

Letter of assent to the Form 2 learners

You are invited to participate in a research project aimed at investigating the use of visual literacy for teaching of mathematics in Form 2 mathematics classrooms. This research will be reported upon in my Master's dissertation conducted at the University of Pretoria. Your parents will be asked to grant consent for your voluntary participation, but you should also declare yourself willing to participate in this study.

Your participation in this research project is voluntary and confidential. You will remain anonymous and will participate as usual during the lesson. I would like to observe your mathematics teacher during the third term of this year while teaching mathematics to your class. The observations will be done once per week for three consecutive weeks and it will not interrupt your school timetable or your subject progress. The lessons will be video recorded. All data collected with public funding may be made available in an open repository for public and scientific use.

You may decide to withdraw at any stage should you not wish to continue with your participation. Your decision to accept/decline involvement in this research will not affect your studies, nor will your participation be reflected in improving mathematics teaching.

If you are willing to participate in this study, please sign this letter as a declaration of your accent, i.e. that you participate in this project willingly and that you understand that you may withdraw from the research project at any time. For any query or more clarification please contact me on the cell phone number provided above.

Yours sincerely

…… ……..

Researcher: Mrs. I.B.Kundema Date

…… ……..

Supervisor: Dr.J.J. Botha Date

I the undersigned, hereby grant assent to Mrs. I.B. Kundema to conduct research for her Master's degree at schools in and around Ilala.

Learner's name ……..

Learner's signature ……..

Date: ……..

Appendix B: Letter of consent to the parents to allow learners to participate in a research study

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science, Mathematics and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

16 June 2015

Dear parent(s)/Guardian(s)

REQUEST TO ALLOW YOUR CHILD TO PARTICIPATE IN A RESEARCH PROJECT

I am a mathematics teacher at a secondary school and have enrolled for my Master's degree at the University of Pretoria at the Department of Science, Mathematics and Technology Education, under the supervision of Dr JJ Botha and Dr LS van Putten. I hereby request you to grant permission for your child to participate in my research project.

The topic of my research project is: Tanzanian secondary mathematics teachers teaching for visual literacy. The aim of this study is to determine how teachers' teaching styles, strategies and use of multimedia contribute to learners' development of visual literacy. The findings of this study may contribute to an awareness of the importance of learners developing visual literacy in order to contribute and understand the world they are living in.

To collect my data, I have to observe your child's mathematics teacher teaching three different lessons in three consecutive weeks. I want to emphasise that it will not interrupt the school timetable or the mathematics class. I will not have any direct contact with the learners, as the focus is on the teacher's instruction in class. The lesson will however be video-recorded, but the video recordings will only be used by me and should my supervisors want to see that in order to assist with the analysis of the data. All data collected with public funding may be made available in an open repository for public and scientific use.

All learners will remain anonymous and no names will be revealed. Learners' participation in this study is voluntary and they may withdraw from the study at any time without any

consequences. Should your child want to withdraw from the study, I will just position myself in class in such a way that your child will sit behind me and will his or her contributions in class not be considered in any way as part of the data being collected.

Yours sincerely

……..
……

Researcher: Mrs IB Kundema
kundemai@yahoo.com

Supervisor: Dr JJ Botha
hanlie.botha@up.ac.za

I, _____ hereby give permission for my child, _____ to participate in this research study, by allowing the researcher to observe my child's mathematics teacher and to also make video recordings of the three lessons. I am aware that my child will remain anonymous and that the findings of this research will be used to promote teaching and learning.

Signed: _____Date:_____

Appendix C: Letter of consent to the mathematics teachers

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science, Mathematics and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

16 June 2015

Dear Ms. /Mr. ……..……

Letter of consent to the Form Two Mathematics teacher

You are invited to participate in a research project aimed at investigating the use of visual literacy for teaching of mathematics in Form 2 mathematics classrooms. This research will be reported upon in my Masters dissertation conducted at the University of Pretoria.

Your participation in this research project is voluntary and confidential. It is proposed that you form part of this study's data collection phase by being observed three times when teaching your mathematics class (es) and being individually interviewed once after the last observation. The lessons will be video recorded and the interviews will be audio-taped by me in order to have a clear and accurate record of all the activities and communication that took place.

The process will be as follows: during the third term of this year I would like to observe you once per week for three weeks while teaching Form 2 Mathematics lessons during school hours. If possible I want to observe different mathematics topics, but will not interfere with your planning. I would like to conduct an interview with you after the third observation. The duration for the interview will take a maximum of an hour and will be scheduled at a time and place convenient to you. The focus of the questions in the interview is based on your understanding of visual literacy and the role of visual literacy in the teaching of mathematics. The observations will focus on the teaching styles, strategies and multimedia that you use in conducting your mathematics lessons. All data collected with public funding may be made available in an open repository for public and scientific use.

Should you declare yourself willing to participate in this study, confidentiality and anonymity will be guaranteed at all times. You may decide to withdraw at any stage should you not wish to continue with your participation. Your decision to accept/decline involvement in this

research will not influence your teaching career in any way, nor will your participation be reflected in your performance appraisal.

If you are willing to participate in this study, please sign this letter as a declaration of your consent, i.e. that you participate in this project willingly and that you understand that you may withdraw from the research project at any time. For any query or more clarification please contact me using the cell phone number provided above.

Yours sincerely

…… ……..

Researcher: Mrs. I.B.Kundema Date

…… ……

Supervisor: Dr.J.J. Botha Date

Teacher's name …….....

Teacher's signature ……..

E-mail address ……..…….

Contact number ……..…….

Date: ……..…….

Appendix D: Letter of consent to the principals

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science,
Mathematics
and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

16 June 2015

Dear Dr/Ms/Mr. ……..……

Letter of consent to the Principal

I hereby request permission to use your school for my research project. I would like to invite a Form2 Mathematics teacher to participate in this research project aimed at investigating theuse of visual literacy for teaching of mathematics in Form 2 mathematics classrooms. This research will be reported upon in my Masters dissertation conducted at the University of Pretoria.

Your participation in this research project is voluntary and confidential. It is proposed that the teacher forms part of this study's data collection phase by being observed three times when teaching Mathematics class(es) and being individually interviewed once soon after the last observation. The lessons will be video recorded and the interviews will be audio-taped by me in order to have a clear and accurate record of all the activities and communication during the lesson.

The process will be as follows: during the second term of this year, should you look favourably upon my request, I would like to observe the teacher teaching three Form Two mathematics lessons, preferably to different mathematics classes as well as different topics during normal school hours. I would like to conduct the interview with the teacher soon after the last (third) observation, but will not interfere with teachers planning. The duration of the interview will take a maximum of an hour and will be scheduled at a time convenient to the teacher. The focus of the questions is on the teachers' understanding regarding visual literacy and the role of visual literacy in the teaching of mathematics. Moreover, it will focus on the teaching styles and strategies that teachers use in conducting mathematics lessons. In addition, it will focus on visual media that mathematics teachers' use in conducting mathematics instruction. The

interviews will be scheduled at a time and place convenient to the teacher. All data collected with public funding may be made available in an open repository for public and scientific use. Confidentiality and anonymity will be guaranteed at all times. Your decision to accept involvement in this research will hopefully contribute to the improvement of teaching of mathematics in Tanzanian classrooms. If you are willing to allow a member of your staff to participate in this study, please sign this letter as a declaration of your consent. For any query or more clarification please contact me using the cell phone number provided above.

Yours sincerely

…… ……

Researcher: Mrs. I.B. Kundema Date

…… ……

Supervisor: Dr.J.J. Botha Date

I the undersigned, hereby grant consent to Mrs. I.B.Kundema to conduct her research in this school for her Masters research.

School principal's name .....

School principal's signature.....

E-mail address .....

Contact number .....

Date:……

Appendix E: Letter of permission to the Ilala District Education Office to conduct research

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science,
Mathematics
and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

ILALA DISTRICT EDUCATION OFFICE
P.O.BOX 20950
DAR-ES-SALAAM
TANZANIA

16 June 2015

Dear Sir/ Madam

Request from IDEO for permission to do classroom observations and to conduct interviews

I am currently enrolled as a master's student at the University of Pretoria. I am also a secondary school teacher at Benjamin William Mkapa High School in Ilala District. The title of my study is: **Tanzanian secondary school Mathematics teachers' teaching for visual literacy**. Visual literacy is an essential skill for learners in learning mathematics especially in developing conceptual understanding of mathematical concepts. It is therefore crucial to investigate how Form 2 Mathematics teachers teach for the development of learners' visual literacy skills. It is important to observe the teaching strategies and styles that mathematics teachers use to contribute to developing learners visual literacy skills. Furthermore, I want to explore what visual media mathematics teachers use for conducting mathematics instruction. I hope that the findings of my research will make a contribution to the improvement of teaching mathematics for the development of learners' visual literacy.

In order to collect data for this project, I would like to observe and interview a purposive sample of Mathematics teachers, preferably one Form 2 Mathematics teachers at approximately three secondary schools in and around Ilala District. Each teacher will be observed three times and

interviewed only once, but will not interfere with the teachers' planning. My observations will be unobtrusive. All data collected with public funding may be made available in an open repository for public and scientific use.

I therefore formally request your permission to observe and interview Mathematics teachers at schools in and around Ilala District in the third term of this year. I trust that my request will meet with a favourable response.

Yours faithfully

…… ……

Researcher: Mrs. I.B. Kundema Date

…… ……

Supervisor: Dr. J.J. Botha Date

I the undersigned, hereby grant consent to Mrs. I.B. Kundema to conduct research for her Master's degree at schools in and around Ilala.

Departmental officer's name and surname: ……

Departmental officer's signature: ……

Date: ……

Appendix F: Letter of permission to the Ministry of Education and Vocational Training to conduct research

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION

Mrs. I.B.Kundema,
Faculty of Education,
Department of Science, Mathematics and Technology Education,
Groenkloof Campus, UP,
Leyds Street 0001 Pretoria
kundemai@yahoo.com
Cell phone: 0659 143 333

PERMANENT SECTRETARY
MINISTRY OF EDUCATION AND VOCATIONAL TRAINING
P.O.BOX 9121
DAR-ES-SALAAM
TANZANIA

16 June 2015

Dear Sir/ Madam

Request from MoEVT for permission to conduct research in Tanzania secondary schools

I am currently enrolled as a Master's student at the University of Pretoria. I am also a secondary school teacher at Benjamin William Mkapa High School in Ilala District. My research topic is: **Tanzanian secondary school Mathematics teachers' teaching for visual literacy.** The aim of this study is to investigate how Tanzanian Mathematics teachers teach for visual literacy at secondary school level. Through the study, I hope to gain insight into how Tanzanian secondary school teachers teach for visual literacy, specifically which teaching strategies and styles they use for classroom instruction that contribute to developing learners' visual literacy skills. The study will furthermore give me insight of teachers' use of visual media during their classroom instruction, which also contribute to developing learners' visual literacy skills. Visual literacy is an essential skill in learners' learning of mathematics. The Ministry will benefit from this study in the following ways:

- The findings of the study will provide better insight on how Tanzanian mathematics teachers conduct their classroom practices as prescribe in the curriculum document.
- It will also allow educational practitioners and policy-makers to gain a better understanding of areas in mathematics teaching that need intervention and additional support.

I would like to assure you that my study will adhere to research ethics and will be in line with the University of Pretoria's ethics requirements. All data collected with public funding may be made available in an open repository for public and scientific use.Attached is the copy of the research proposal.

I therefore formally request your permission to conduct the study in Tanzania secondary schools. I trust that my request will meet with a favourable response.

Yours faithfully

……. …….

Researcher: Mrs. I.B.Kundema Date

……. ……

Supervisor: Dr. J.J. Botha Date

I the undersigned, hereby grant consent to Mrs. I.B.Kundema to conduct research for her Master's degree at Tanzanian secondary schools.

Departmental officer's name and surname: ……

Departmental officer's signature: ……

Date: …….....

Appendix G: Observation schedule for observing Mathematic teachers teaching for visual literacy

OBSERVATION SCHEDULE

To answer Sub-questions 2 and 3:

2. How do teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?

3. How do teachers integrate visual media with the text to facilitate the development of visual literacy to learners?

(To be used for all three observations per teacher)

(Lessons will be video recorded)

Name of school	
Name of researcher	Mrs. I.B. Kundema
Subject observed	Mathematics
Grade observed	Form 2
Number of learners in class list (present in class)	
Topic of the lesson	
Name of teacher	
Date of observation	
Observation number	
Observation Time	± 1 hour

Table A is based on the teaching styles and strategies that teachers use for mathematics instruction.

Table B is based on the visual media that teachers use for mathematics lessons.

Table A: ASSESSING TEACHERS' TEACHING STYLES AND STRATEGIES

No	Question	Yes	No	Comments
1.	The teacher is the source of information.			
2.	The teacher involves learners in the classroom activities.			
3.	The teacher provides opportunities for learners to work independently either in small groups or individually.			
4.	The teacher guides/assists learners while working independently.			
5.	The teacher involves learners in the classroom discussion.			
6.	The teacher puts learners in small groups during the classroom instruction.			
7.	The teacher uses verbal explanations alone for the classroom instruction.			
8.	The teacher uses visuals (such as charts, tables, diagrams, graphs, symbols, and other visual illustrations) for mathematics instruction.			
9.	Teaching style(s) used			
10	Teaching strategy(ies) used			

Evaluation scale: Table A: Only tick the appropriate block and write comments.

Table B. ASSESSING THE USAGE OF VISUAL MEDIA DURING CLASSROOM INSTRUCTION

No	Question	Yes	No	Comments
1.	The teacher uses verbal explanations alone for the classroom instruction.			
2.	The teacher combines words and pictures for the classroom instruction. If yes, how?			
3.	**The teacher combines text (printed / narration) with the following visual media:**			
	Still media (charts, graphs, tables or illustrations). If yes, how is it used?			
	Dynamic media (models, animations or video) If yes, how is it used?			
	Technology (computers, calculators, geo-boards) If yes, how is it used?			
4.	**During the classroom instruction, opportunities are provided by the teacher for learners to:**			
	Use visual messages for communication			
	Understand meaning of a concept			
	Interpret and evaluate visual messages			
	Generate visual messages			
	Explain meaning of visual messages			

Evaluation scale: Table B: Tick the appropriate block and write comment

Appendix H: Interview schedule

INTERVIEW SCHEDULE

Semi-structured interview
To answer Sub-questions 1, 2, and 3 which are:

1. What is the teachers' understanding of visual literacy and its role in the teaching of mathematics?
2. How do teachers' teaching styles and strategies contribute to developing learners' visual literacy skills?
3. How do teachers integrate visual media with the text to facilitate the development ofvisual literacy to learners?

(Audiotape recording)

Name of school	
Name of researcher	Mrs. I.B.Kundema
Name of teacher	
Gender	
Age	
Date of interview	
Teacher's qualification	
Number of years teaching Mathematics	

SECTION A
Questions based on teachers' understanding of visual literacy and its role in teaching mathematics

1) What is visual literacy?

_____
_____
_____
_____
_____

2) What is the role of visual literacy in mathematics teaching?

_____
_____
_____
_____
_____

3) What are the advantages of learners developing visual literacy skills?

_____
_____
_____
_____
_____

SECTION B

Questions based on the teachers' teaching styles and strategies used in the lessons observed

Questions will be compiled once the observations have been done and will most probably vary from teacher to teacher.

1) I observed you used a Teacher centred (TC) or Learner centred (LC) or using both TC and LC style in your lessons.

Why did you choose this teaching style(s)?

_____
_____
_____
_____
_____

2) Why did you choose to use ……. teaching strategies? (Iwill explain to them if they are not familiar with the term).

3) Of which other teaching strategies are you aware which would also have been effective in your teaching this topic?

4) How do you prefer to teach learners new concepts?

a) Verbal explanation alone

b) Verbal explanation with pictures (visuals)

Why do you choose this teaching strategy?

5) How do you combine words and pictures (visuals) for classroom instruction?

6) How can you teach to develop learners' visual literacy skills?

SECTION C

Questions based on the visual media

1) Which visual media do you normally use in your classroom instruction?

_____
_____
_____
_____

2) Which visual media do you use when teaching the following topics?

a) Geometrical Transformation

_____

b) Similarity

_____

c) Quadratic Equations

_____

d) Statistics

_____

e) Trigonometry

_____

END OF INTERVIEW

Appendix I: Ilala District Education office permission letter

ILALA MUNICIPALITY

P. O. BOX 20950
PHONE NO. 2128800
2128805
FAX NO. 2121486

OFFICE OF DIRECTOR
ILALA MUNICIPALITY
1 MISSSION STREET
11883- DAR ES SALAA

Ref no. IMC/LK.6/1/119

The Head Masters/Mistresses,
Jangwani, Ari and Mchanganyiko Secondary Schools,
Dar es Salaam, Tanzania.

20th September 2015

Dear sir/madam,

Ref. Intoducing Ms. Imani Bakari Kundema

Kindly refere to the caption above.

The Ilala Municipality has confirmed that **Imani Bakari Kundema** is a registered student in the **University of Pretoria** and thus, permitted to collect data for her Masters (MSc.) programme in your school.
Her approved research is entittled ***Tanzania Secondary Schools Mathematics Teachers 'Teaching for visual literacy'.*** The data collection will commence on 28/09/2015 to 22/10/2015.

Please, give her your kindly support.

Regards,

V.P. MLOWOSA
On behalf of, DIRECTOR OF ILALA MUNICIPALITY

Copy: DIRECTOR OF ILALA MUNICIPALITY (on file)

Appendix H: Ministry of Education and Vocational Training permission letter

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION AND VOCATIONAL TRAINING

Cable: ELIMU DAR ES SALAAM.
Telephone: 2120403/2120412/17
Fax: 022-2113271.
Email: edmis@cats-net.com
Reply please quote:
Ref: ED/OKE 193/292/02/268

7 Magogoni Street,
Post Code 9121,
11479 DAR ES SALAAM.

Date: 26 January 2015

The Director,
Regional Administration and Local Government
P.O. Box
DAR ES SALAAM.

RE: RESEARCH CLEARANCE FOR M/S IMANI B. KUNDEMA

The above mentioned is a bonafide student of University of Pretoria, faculty of Education Department of Science, Mathematics and Technology Education (SMTE). She is conducting a research on topic titled "***How do Tanzania Secondary School Teachers Teaching for Visual Literacy in form 2 Mathematics Classrooms***" as part [her course programme for the award Masters in Education.

For the purpose of accomplishing this study, a researcher will therefore need to collet data and necessary information related to the research topic from your schools.

In line with the above information you are being requested to provide the needed assistance that will enable him to complete the research successfully.

The period by which this permission has been granted is from **February 2015 to September, 2015.**

By copy of this letter M/S Imani B. Kundema is required to submit a copy of her proposal and the report (or part of it) to the Permanent Secretary Ministry of Education and Vocational Training.

Yours Truly,

Prof. Eustella P. Bhalalusesa
For: PERMANENT SECRETARY

Copy: M/S Imani B. Kunduma