# AN INVESTIGATION ON THE EFFECTS OF TEACHER-DESIGNED EDUCATIONAL VIDEOS ON GRADE 11 LEARNERS' GEOMETRY PERFORMANCE IN OSHIKOTO EDUCATION REGION, NAMIBIA

A RESEARCH SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF EDUCATION (MATHEMATICS EDUCATION)

OF

THE UNIVERSITY OF NAMIBIA

BY

LINDA UGULU

SEPTEMBER 2019

Main Supervisor: Dr E. N. Ngololo

Co-supervisor: Dr F. Vatileni

**ABSTRACT**

Over a decade, Mathematics performance has been reportedly poor, of which Geometry has been identified as one of the difficult topics for learners in Namibia. Non-experimental and experimental studies revealed a need for teachers to develop classroom related ICT resources for subject teaching, more especially for conceptually demanding topics in like Geometry. An embedded mixed method research design was applied, using a non-equivalent pre-test-post-test quasi experimental design and a survey to sought learners' views on the use of the videos. Seventy-six (76) learners participated in the study and were divided into the experimental group; and the control group. A T-test was used to compare the mean scores of the two groups after the intervention. The independent T-test results for the post-test on p-value = 0.027, indicates that the variances are unequal in both groups. Since the p-value = 0.026, $p < 0.05$, the null hypothesis was not accepted. Hence there is a significance performance between the two groups. The experimental group showed an improved performance. Furthermore, a perception survey was used to determine the views of the learners towards the videos and to assess if learners perceived videos use as useful. The study revealed that learners had a positive attitude towards video use (91.3%), a good learning environment (84.6%) and relevant and enjoyable learning experiences (83.9%). Lastly, results from $X^2$ test to assess the significant association between learners' post-test and their views towards videos use, indicated that there was no statistically significant relationship as $p > 0.05$. This study recommends the use of teacher-designed videos in teaching Angle properties to arouse interest and consequently improve learners' performance.

## Table of Contents

**LIST OF TABLES**

**TABLE OF FIGURES**

## LIST OF ACRONYMS

| | |
|---|---|
| CAI | Computer Assisted Instruction |
| DNEA | Directorate of National Examination and Assessment |
| GTML | Generative Theory of Multimedia Learning |
| ICT | Information Communication and Technology |
| MoEAC | Ministry of Education, Arts and Culture |
| NCTM | National Council of Teachers of Mathematics |
| NIED | National Institute of Educational Development |
| NSSC | National Senior Secondary Certificate |
| OER | Oshikoto Education Region |
| SADC | Southern African Development Community |
| SEO | Senior Education Officer |
| TRAT | Trigonometry Achievement Test |
| UNAM | University of Namibia |
| UNICEF | United Nations Children’s Fund |
| UPP | Upper Primary Phase |

## ACKNOWLEDGEMENTS

First and foremost, I would like to thank the almighty God who is the source of knowledge and wisdom for being with me as from the beginning of this journey, till the very end. For never failing me, till I persevere. I thank the almighty for waking me daily in good health and with a sound mind; and most importantly, for continuously blessing me with what I need to pursue and fulfil my dreams.

My utmost profound gratitude goes to my supervisor Dr E. N. Ngololo for her tirelessly effort, and for never giving up on me. I am thankful to the support and guidance provided regarding writing of this thesis. My undoubted thanks go to Dr F. Vatileni, for successfully accomplishing her duties as a co-supervisor. A very special thank you is extended to the Visiting Professor to Namibia, Prof E. Hamilton from Pepperdine University, United States, who did introduced me to a Mathematics software (Camtasia) and for training me how the software functions in a very friendly way; and most importantly for donating to me one of the Pen-based tablet that was used during the production of educational videos used in this study.

I would like to express my appreciation to Dr D. Ntirampeba from the Namibia University of Science and Technology (NUST), who helped with data analysis and who helped me all along the journey. Warmest appreciation goes to the Editor of this thesis, Dr Nelson Mlambo. To all my lecturers (Prof C Kasanda, Dr H. Kapenda and Mr N. !Gaoseb) from the department of Mathematics, Science and Sport Education who assisted me during coursework and proposal development, I thank you all. Thank you for being so kind enough and understanding.

My deepest gratitude goes to my former school principal, Mr E. Iimene for doing all possible and making sure that I was given a one-year special study leave, I am all indebted to you. I would like to further express my deepest gratitude and thank all my colleagues, more especially Mr Mvula, Mr Jeremy, Mr Angolo Mrs Haufiku and my former HoD Mr Nakanyala, who made sure that my learners were attended to when I was away. Your moral support during the learning sessions all appreciated. Further, I would like to say thank you to all the learners that participated in this study, without you this study has no purpose. You allowed me to take a closer look at my teaching so I could become a better teacher.

Profound gratitude goes to the main sponsor of this study, Carl Schlettwein Foundation, for successful funding this study, it was a walk in a park; as well as Oshikoto Education Directorate, Professional Development sub-division for availing funds to subsidise my study. To my friends, Aili, Hanna, Kefo and Tangy, thanks for always believing in me that I can do it. Of course, I did it. Benita and Teopo who would not let me give up when things got tough. What a wonderful group of people. Thank you, Albin, for all positive words of encouragement. I do not want to forget a special friend, P. Nampala, for always making sure I keep up with my school work, I thank you. To all who contributed positively to the success of my studies, I say God bless you abundantly.

Finally, my greatest appreciation goes, as always, to my parents who have always encouraged me, and with whom I have the understanding to spend far more time in pursuing my dreams. Special praise needs to be given to my dearest nieces and nephew, Dhiginina, Blessing and Given, for their patience to my studies and not playing with them.

Finally, to my sisters, Aily and Anna, you have all made me the person I am today. I love you all.

## DEDICATIONS

This thesis is dedicated to my late and only brother, Jason Mekondjo Ugulu, who only enjoyed the fruits of being on this planet earth for one and a half years only, you are dearly missed brother. To my nieces and nephew, Dhiginia, Blessing and Given, this is for you!

**DECLARATIONS**

I, Linda Ugulu, hereby declare that this study **"AN INVESTIGATION ON THE EFFECTS OF TEACHER-DESIGNED EDUCATIONAL VIDEOS ON GRADE 11 LEARNERS' GEOMETRY PERFORMANCE IN OSHIKOTO EDUCATION REGION, NAMIBIA"** is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution.



I, Linda Ugulu, grant The University of Namibia the right to reproduce this thesis in whole or in part, in any manner or format, which The University of Namibia may deem fit.

……………………………...… ……………………………… ….……………

Name Signature Date

## CHAPTER 1: INTRODUCTION

This chapter introduces a study on the effects of teacher-designed educational videos on Geometry performance of Grade 11 Geometry Ordinary level learners in the Oshikoto Education region, Namibia. This chapter begins with presenting the orientation of the study, the research problem, and aims of the study. It further, presents the research questions, hypothesis and the significance of the study. The limitations of the study and delimitation are further discussed, followed by the definition of terms used in the study.

### 1.1 Orientation of the study

Geometry as one of the branches of Mathematics has an important role in the study of Mathematics. The United States based National Council of Teachers of Mathematics [NCTM] (2000) as the global leader in Mathematics education, stresses the prominence of geometry by stating that “Geometry offers an aspect of mathematical thinking that is different from, but connected to, the world of numbers” (p. 97). With Geometry, one can describe, analyse and understand the world in which we live. Therefore, Geometry is considered as a tool that facilitates the interpretation and reflection of the physical environment (Clements & Battista, 1992). Furthermore, Geometry allows learners to be equipped with the skills they can apply in other areas of Mathematics like Engineering (Hwang, Lin, Ochirbat, Shih & Kumara, 2015). The understanding of the environment we live in and the ability to do well in other areas of Mathematics rest on our understanding of Geometry.

Midgett and Eddins (2001, p. 38) highlight the goals of NCTM standards 2000 which provide that instructional programmes should enable learners to do the following goals in Geometry as from pre-grade to Grade 12:

- Analyse characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Locations and describe spatial relationships using coordinate Geometry and other representational systems.
- Apply transformations and use symmetry to analyse mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

The reasons for including Geometry in the school's Mathematics curriculum are myriad and they encompass providing opportunities for learners, not only to develop spatial awareness, geometrical intuition and the ability to visualise, but also to develop knowledge and understanding of, and the ability to use geometrical properties and theorems (Jones, 2002). This being the case, it can be argued that teaching approaches need to encompass the encouragement of the development and use of conjecturing, deductive reasoning and proof, as well as developing skills of applying Geometry through modelling and problem-solving in a range of contexts (including real world ones), and an awareness of the historical as well as the contemporary applications of Geometry. Understanding of these goals is needed by all teachers, including those in Namibia, as they provide the teacher with guidance on how to design and structure their lesson. All these considerations tend to make Geometry a demanding element of Mathematics and they require a teacher to teach it effectively.

Geometry is regarded as one of the most difficult and abstract topics in Mathematics for the learners (Gutierrez, 2006; Jones, 2008), and Namibia is no exception (Directorate of National Examination and Assessment [DNEA], 2013, 2014, 2015, 2016 & 2017; Muyeghu, 2008). It is argued that when learners learn Geometry, their minds are accustomed to concrete content only (Jones, 2002; Ramdhani, Usodo & Subanti, 2017). Due to this reason, many learners fail to develop an adequate understanding of Geometry concepts, Geometry reasoning and Geometry problem solving skills (Batista & Idris, 2010; Khoo & Clements, 2001). Furthermore, lack of understanding in learning Geometry often causes discouragement among learners, which inevitably leads to poor performance in Mathematics (Hwang et al., 2015; Saha, Ayubb & Tarmizic, 2010).

In Namibia, the problem of lack of understanding of Geometry concepts is identified from as far as lower schooling phases. Nambira, Kapenda, Tjipueja and Sichombe (2009) observed that more than half of the learners (53%) at Upper Primary Phase (UPP) (Grades 5, 6 and 7) cannot distinguish between different kinds of triangles and quadrilaterals. Nambira et al. (2009) further state that teachers also confirmed that learners faced difficulties in competencies attached to the topic (Geometry) such as fractions and measurements. Despite efforts made to improve performance in Mathematics, Namibia's mean Mathematics score remains the lowest at 471.0 in 2007 and at 558 in 2013 in SADC (Southern African Development Community), as compared to its neighboring countries like Lesotho, Botswana, Mozambique and Zambia (SACMEQ, 2013; South Africa Review, 2016). Like Namibia, in 2007, South Africa (495), Lesotho (477), Mozambique (484) and Zambia (435) obtained mean below the SACMEQ average score of 507.

However, in 2013, some countries showed improved mean scores above the SACMEQ average mean score of (584), except Namibia (558) and Lesotho (559), meaning that these two countries continue to lag with Mathematics competencies at primary school level. Table 1 illustrates SACMEQ scores results of 2007 and 2013.

**Table 1: SACMEQ scores of some SADC countries**

| Learners' Mathematics scores | | |
|---|---|---|
| SACMEQ countries | SACMEQ III 2007 | SACMEQ IV 2013 |
| Namibia | 471 | 558 |
| Botswana | 521 | 598 |
| South Africa | 495 | 587 |
| Lesotho | 477 | 559 |
| Zimbabwe | 520 | 566 |
| Mozambique | 484 | 558 |
| Swaziland | 541 | 601 |
| Zambia | 435 | 522 |
| SACMEQ average | **507** | **584** |

*Source: South Africa Review (2016)*

A poor Mathematics foundation laid at the lower primary school phase has a serious negative impact on academic performance at Grade 12 level. Kgabi and Tyobeka (2013) opine that there is an increase in demand for Mathematics-based professions yet there is a decrease in supply in Namibia. This is since more learners cannot further their studies in Mathematics related fields at higher institutions of learning, like becoming Mathematics teachers, mathematicians, engineers, and doctors if they do not perform well in Grade 12

Mathematics. Dobbins, Gagnon and Ulrich (2014), stress that Geometry is increasingly required for learners to graduate from high school. Failure to improve in Mathematics has a serious impact on the labour force system as it results in the shortage of skills (Kgabi & Tyobeka, 2013), whilst on the other hand teaching Geometry well means enabling more learners to find success in Mathematics (Jones, 2008).

The learning of Geometry can be made less difficult by employing multiple representations in the classroom (Wong, Yin, Yang & Cheng, 2011). Previous studies have also supported the idea that visual media along with traditional methods of teaching can increase learner performance, indicating that learners learn more with the visual media (Eick & King, 2012; Kay & Kletskin, 2012). Hence, the process of teaching Mathematics using traditional educational resources such as chalk and blackboards needs to be modified when teaching Geometry using ICTs (Krishnasamy, Veloo & Hooi, 2013) to enhance deep learning. As such, governments globally invest vast amounts of money in ICT for education to improve teaching and learning (Inan & Lowther, 2010; Ng & Gunsten, 2003). However, there is growing evidence that the pedagogical use of ICT at schools is decreasing (Howie & Blignaut, 2009; Ngololo, 2010; Ngololo, Howie & Plomp, 2012). For example, Finland, which is a developed country, the level of ICT use is not at the level where it is supposed to be, given that access to computers and the internet is almost 100% (Kankaanranta, 2009).

Several teachers try to use digital technologies in the classroom (Gambari, Yaki, Gana & Ughovwa, 2014; Harwood & McMahon, 1997; Kay & Kletskin, 2012; Perry, 2013). The pedagogical argument for using educational technology is based on the belief that using

ICT in schools will improve the quality of teaching and learning and should be used to promote meaningful learning (Kozma, 1991; Robertson, 2011). However, the way teachers present their lessons still lacks modern technology, yet the only significant difference is the presence of the projector instead of the blackboard (Esperanza, Medina & Valdes, 2014; Hooper & Reiber, 1995). The Namibian National Policy for ICT (MoE, 2006) states that teachers should be involved in designing their own tools and activities that best fit the needs of the learners. Hamilton et al. (2016) observed that in most African country's learners are subjected to digital materials in English that are enjoyed somewhere in the United States, but they are not necessarily localised to suit the needs of learners in Sub-Saharan Africa. This can negatively affect learning and therefore, there is a need for teachers to adopt and adapt or develop the most appropriate digital teaching materials for their learners. Teachers should therefore be encouraged to use visual media in teaching since visual media strengthens understanding by simplifying abstract concepts like Geometry (George & Sanders, 2017; Kanandjebo, 2017; Mudaly, 2014).

Hamilton et al. (2016) revealed that teachers are ready to seek and implement effective alternatives to the 'chalk and talk' method. These approaches rely heavily on the affordance of technology to promote collaboration. Although there is a seemingly universally shared aspiration to implement technology to improve classroom instruction, the associated costs and infrastructure required present obstacles that are especially daunting in low income nations such as those in Sub-Saharan Africa (Hamilton et al., 2016). Lack of time to implement technology-based tasks has proven to be a barrier to

ICT use in education (George & Sanders, 2017). Likewise, in Namibia, teachers want already prepared materials and they do not want to come up with their own.

Nikopoulu-Smyrni and Nikopoulus (2010) revealed that the use of videos in education may hold great promises. Video being a form of multimedia uses multiple presentations that convey information through both aural and visual channels (Woolfitt, 2015). Furthermore, Woolfitt (2015) commented that a combination of audios and visuals together make a powerful tool that provides multisensory experience for the learners. Audios and visuals used together make a rich experience for the viewer (Clarine, 2016), hence, these can help learners to understand the meaning of geometric formulas better.

Presenting Geometry in a way that stimulates curiosity and encourages exploration can enhance learners' learning. Improving learning using videos becomes more and more important because a video, in contrast to a teacher, can be accessed anytime and anywhere (De Boer, 2013). For example, statistical results in a study carried out in California revealed that learners who received the video enhanced instruction in high school Chemistry scored significantly higher than those who were exposed to a traditional way of teaching (Harwood & McMahon, 1997). The results indicated that the significance level was at $F = 24.04$, $p < .01$, meaning that the two groups were significantly different. Research has found videos to be effective for learners' learning (Hiebert & Grouws 2007). However, some researchers contend that whether the instruction using video technology is successful depends on how it is designed and used (Choi & Johnson, 2005; George &

Sanders, 2017; Woolfitt, 2015). On top of that, most studies (Choi & Johnson, 2005; De Boer, 2013; Nikopoulou & Nikopoulos, 2010) were conducted in higher education, leaving little literature on teaching Geometry and the use of ICTs at secondary level (Ali, Baghawati & Sarmah, 2014). In Africa, the use of videos in schools is still in its infancy stage, hence there is a need for more studies.

Kapenda (2008); Ngololo, Howie and Plomp (2012); and Ploesser (2016), recommends that there is a need for developing classroom related ICT resources such as specific software for Science subject teaching, assessment tools and mounting a portal with specific-based activities. However, Midgett and Eddins (2001) urged that technology should not replace basic skills but it must be used as an important tool for enhancing learners' learning. Geometry requires innovative approaches on how it is being taught, as there is no single best practice and no simple formula for teaching conceptually demanding Mathematics like Geometry. It is against this background that this present study looked at 'An investigation on the effects of Teacher-Designed educational videos on Grade 11 learners' Geometry performance in Oshikoto Education Region, Namibia'.

## 1.2 Statement of the problem

Learners in Namibia have been failing Geometry due to partly lack of alternatives teaching strategies to the 'chalk and talk' method used in Namibian secondary schools. This has been indicated in the Namibian MoEAC Examiner's reports dating back as 2008 to date (DNEA, 2008 - 2017). Approximately about a third of Grade 12 learners in Oshikoto

Education Region (OER) obtained A*- C symbols in the NSSC (National Senior Secondary Certificate) Mathematics examination (MoE, 2014; 2015; 2016; 2017). In 2015, the OER had pronounced its regional performance target of 70%, aiming to obtain A* – C symbols in Mathematics Ordinary Level (OER, 2015). However, this target was not met. In 2015, the performance in Mathematics in general was 27.50% while in 2014, 29.11% was obtained, and a decline in performance was noted from 2014 to 2015 by 1.61%. In 2017, 21.1% of the learners scored A* - C symbol compared to 27.5% in 2016 (OER, 2017), similarly a drop-in performance of 6.3% was reported.

The Examiner's Report commented on question 17 which was targeting Geometry by stating that "this question was moderately answered as it seems some learners were unaware of Circle Geometry" (DNEA, 2014, p. 316). Furthermore, DNEA (2016, 2017) revealed that one of the topics that need more attention is Circle Geometry. To exacerbate the problem, the Examiner's Report stated that "teachers must concentrate on the topics that proved to be difficult for the learners" (DNEA, 2016, p. 364) of which Geometry was one of the topics. This implies that Geometry is one of the topics that lead to the poor performance of the learners in NSSC results, as it covers about 20% of the NSSC end of the year examination Mathematics question paper. In order to address the high failure rate, NIED (2010) suggested that teachers should design instructions that involve the active participation of learners in the learning process. In addressing this call, video use aids learners' retention of knowledge, motivates interest in the subject matter and illustrates the relevance of many concepts (Mateer, Ghent, Poter & Purdom, 2014; George & Sanders, 2017). When used appropriately, videos can increase learning achievement

(Krishnasamy et al., 2013) and they encourage the active participation of learners (Mateer et al., 2014). However, with lack of literature on video use in Geometry, it is not evident how learners react to the teacher-designed video-based teaching approach. Given this background, studies that seek interventions in which Geometry learning can be enhanced to improve Mathematics results can be useful (Jones, 2008).

### 1.3 Research question

1. What is the effect of teacher-designed educational videos on Grade 11 learners' Geometry performance?
2. What are the views of learners in the experimental group on the use of videos?

#### 1.3.1 Research hypothesis

*$H_0$: There is no significant difference in Grade 11 Geometry performance of learners taught using videos and those who are not.*

*$H_1$: There is a significant difference in Grade 11 Geometry performance of learners taught using videos and those who are not.*

### 1.4 Significance of the study

This study contributes to the knowledge of the use of educational videos in the Mathematics classroom when teaching Geometry. Mathematics teachers may learn about the effects of educational videos in the Mathematics classroom as they enhance visualization. Moreover, the study might help promote the use of videos in the teaching of Mathematics in Namibian schools. Furthermore, this study may help in the production of educational video banks that can be used at the schools by the learners. In the absence of the subject (Mathematics) teachers, these videos can be helpful as the learners can still learn the Mathematics content even in the teacher's absence by watching the videos. Therefore, in this way the learners will not miss out on the lesson on such a day. Besides, this work would be very useful to the education policy makers since it exposes some problems associated with the use of educational videos in the classrooms and the solutions provided can go a long way to help them in the formulation of policies. Lastly, this work is another contribution to knowledge as this study is the first of its kind in Namibia.

## 1.5 Limitations of the study

The findings of this study cannot be generalized to other regions of the country because it is only one region that this study focused on. Furthermore, the learners' learning styles were not considered in this research when developing the educational videos. Boer (2014) states that learners have different learning styles when learning from videos as they have different ways of viewing the videos to catch up. As a result, this might have an influence on the Geometry performance of the learners in the experimental group. Learners' unusual use of the Personal Computers (PC) which were used by the experimental group learners in this study may be a limiting factor for the learners. Generally, learners use computers minimally during school hours (Howie, Muller & Paterson, 2005). The researcher was the instructor for both groups; as a result, she could have been biased towards one group. Furthermore, as attitude questionnaires were personal and subjective, it was difficult to determine how honestly the learners reported. Perhaps some learners inflated the responses while others deflated them. Moreover, there was a loss of five learners from the control group and three from the treatment group.

## 1.6 Delimitations of the study

This study was strictly limited to Grade 12 Mathematics learners of two selected secondary schools in the Oshikoto Education Region at the Senior Phase (SP) of the Basic Education, Grade 11 - 12.

## 1.7 Definition of terms

**Educational videos** – These are technological-based tools which can be used to enhance teaching and learning in the classroom. The learners will view, listen, read and watch the video to enhance the learning process. The teacher is there to facilitate the learning process. This instruction can be used to teach a variety of skills including social communication and behavioral skills. In this study, the learners in the experimental group were taught using (educational) videos.

**Videos** - Woolfitt (2015, p. 4) defines videos as "digitally recorded content that has sound and motion that can be stored or delivered live and can be streamed to a variety of devices. It may or may not have the teacher visible and can include an animated film". In this study, videos are pre-recorded files which are stored with texts, diagrams, symbols, animations and sound.

**Geometry** - is a “branch of Mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids. Broadly, it is the study of properties of given elements that remain invariant under specified transformations” (NCTM, 2000, p. 30). In this study, Geometry is the branch of Mathematics concerned with the properties and relations surface and solid or the shape, including circle Geometry.

**Geometry performance** – Creswell (2014) defines performance as an individual’s ability to perform on an achievement test. In this study, Geometry performance refers to an ability of learners to perform in a Geometry test.

**Meaningful learning** – Meaningful learning involves understanding how all the pieces of an entire concept fit together. In this study, meaningful learning refers to the knowledge gained through videos and is applied to new learning environments. This is an active, constructive, and long-lasting phenomenon, and it allows learners to be fully active and engaged (Meaningful vs Rote learning, 2017).

**Rote learning** - This is a memorisation technique whereby the material is learned by repetition. The extent to which the learners recall the materials is dependent on how often it is repeated.

## 1.8 Conclusion

The study argues that learners are performing poorly in Mathematics, not only in Namibia but globally. Specifically, Geometry has been identified as one of the difficult topics for Grade 11 learners in Namibia. In order to address this deficiency, researchers call for innovative approaches, such as the teacher-designed educational videos to enhance performance in Geometry.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter presents the literature review on investigating the effects of educational videos on learners' performance in Geometry at secondary schools. The review of the literature includes a discussion on the traditional ways of teaching Geometry, the usefulness of multimedia, specifically videos and their effects on learners' performance, teacher-designed technology-based tasks, features guiding the designing of educational videos, as well as the discussion on the Generative Model of Multimedia Learning. In addition, the teacher-designed based tasks and guidance on the production of videos is presented. Lastly, the Generative Theory of Multimedia Learning is explained and how it influenced the conceptual framework guiding this study.

## 2.2 Traditional ways of teaching Geometry

Learning of geometric concepts has been taught through the 'Chalk and talk' method and this has often resulted in rote learning (Mayberry, 1983; Mamali, 2015). Due to this, in most cases learners do not properly understand the properties of shapes, their relationships and the implications thereof. Mayberry (1983) blames the school's Geometry curriculum as a primary cause of poor performance because of how topics are developed and how they are delivered to learners. In addition, Ali, Bhagawati and Sarmah (2014) argue that the failure in Geometry is due to the non-existence of a conducive learning environment and inappropriate teaching methods that lack the importance and immediate application of Mathematics, Geometry. As a matter of fact, Ali et al. (2014) stress that learners memorise the geometrical theorem or problem without knowing about its application. Furthermore, secondary school level learners have deplorable geometrical concepts due to the anxiety that stems from unpleasant experiences in Geometry. This is also due to a poor foundation of basic knowledge from their primary stage (Ali et al., 2014; Nambira et al., 2009). According to Ali et al. (2014), learners lack the willingness and readiness to learn and often fail to do the given tasks. Instead, learners have the tendency to copy the solution of sums from other learners whenever the problems are given to them in class.

Learners in a Geometry class are also being provided with theories and they are referred to textbooks which are filled with facts that learners are expected to memorise, and most tests assess learners' abilities to remember the facts (Bransford, Brown & Cocking, 2000), and this makes it difficult for the learners to do well in Geometry tests. Moreover, the abstraction of content in Geometry has also made Mathematics a difficult subject to teach and study (Kok, n.d.). One challenge the learners face when confronted with abstract ideas is that they are required to make sense of what they are learning. This is because most learners who are trying to understand a mathematical concept lose their motivation easily when they cannot see, touch or try what they are studying. Hence, the concretisation of ideas becomes crucial when it comes to the process of learning mathematics, through the visualisation of mathematical ideas. To tackle this problem, several researchers recommend the use of multimedia instruction to improve teaching and thereby yield good results (Clarine, 2016; De Boer, 2013; Marshall, 2002). As stated in Chapter 1, Namibian learners have shown poor performance in Geometry over the past 10 years (DNEA, 2008

– 2017). To date, studies based in Namibia about how Geometry is taught is very limited (Muyeghu, 2008). It is therefore important to introduce innovative ways of teaching Geometry meaningfully at secondary school level and enhance performance. All these factors lead to rote learning and consequently to failure in Geometry. To improve the knowledge and ability of learners about geometrical education at secondary school level, it is felt imperative to study the performance of geometry among the secondary school learners (Mejia-Ramos, Fuller, Weber, Rhoads & Samkoff, 2012). This information was useful as in this study learners in the control group were taught using a traditional way of teaching, that is, ‘chalk and talk’.

## 2.3 Usefulness of multimedia

An appropriate instructional strategy used in a classroom should portray successful learning (Akerele & Afolabi, 2012). Accordingly, a lesson should employ an appropriate instructional strategy to enable learners to enjoy and easily understand lessons. Furthermore, Akerele and Afolabi opine that the use of instructional materials in the teaching process should provide the basis for improved teaching and learning of a subject. Therefore, the lessons should be designed, produced and used to achieve specific instructional goals. In order to achieve meaningful learning, some researchers stress the importance of multimedia technology use in the classroom to provide strategies for teaching Mathematics critically and creatively (Prieto, Juanena & Star, 2013; Pudi, 2007). Furthermore, Pudi (2007) highlights that learners’ thinking and reasoning abilities are sharpened as they solve mathematical problems through mind-involving activities to solve every day problems, including Geometry. This can be achieved through an interdisciplinary setting by implementing a technology-based approach in the Mathematics educational framework. Thus, multimedia technology allows for mathematical learning difficulties to be overcome. However, the challenge is more complex in instances where teachers must balance their time such that they can develop digital tools for teaching abstract geometrical concepts that are viewed as difficult to be understood by learners (Prieto et al., 2013).

In Namibia, Hamilton et al. (2016) have run several workshops on Media-Making using Pen-based tablets. This project focused on producing videos in line with the secondary school Mathematics and Science curriculum to improve teaching and learning. The project yielded positive outcomes in that teachers and learners showed an effective alternative approach to the conventional ways of teaching such as ‘chalk and talk’. However, much still needs to be explored on the affordability and adaptability of the new approaches in Namibian schools, and possibly elsewhere (Hamilton, Kapenda, Miranda & Ngololo, in press).

### 2.4 The use of educational videos

The use of videos is believed to be efficient as it illustrates visual examples to help develop understanding. Videos are filling the gap between real life and school life, particularly in developing countries where English is used as a second language in schools (Bal-Gezegin, 2014; Ploesser, 2016). Quite often, these schools have relatively limited access to authentic and other multimedia instructional materials (Hamilton et al., 2016; Howie, Muller & Paterson, 2005; Howie & Blignaut, 2009).

In a study conducted in Turkey, Anston (n.d.) claims that using representations such as educational video clips in teaching and learning has led to higher standards of performance in Mathematics. Videos increase learners' motivation, their desire to learn more about the subject being taught and their enthusiasm. Kemp and Smellie's (2000, as cited by Krishnamy et al., 2013) study indicated that motivation and the desire to learn makes learning more interesting and effective, and it minimises the chances of learners memorising the subject matter blindly without understanding.

Furthermore, Blackmore et al. (2003, as cited in Krishnasamy et al., 2013) also indicated that teachers who use ICT in teaching Mathematics encourage creative thinking and facilitate learners' understanding. Ayinde (1997) opines that an intelligent use of audio-visual aids will save time and stimulate learners' interest. It increases the retention of knowledge and stimulates understanding and the fostering of a positive attitude. The videos help the learners in recognising a problem, providing a solution and summarising the discussions. Moreover, they facilitate independent study, aid communication, create a variety of sensory and makes instructions more powerful and immediate. Akpabio (2004) views video usage as a potential window that can expose the minds and heart of many learners to modern practices and environmental concepts, far more than what traditional classroom teaching can achieve. Akpabio (2004) further states that the youth and children are enthralled with home video films. This interest can therefore be exploited in the formal school system for teaching and learning in a rich and entertaining manner. The teacher, who is an active constructor of learning, transmits knowledge and to do this effectively, the teacher must be innovative in selecting a teaching method which makes it interesting (Duruji, Azuh, Segun, Olanrewaju & Okorie, 2014).

Bransford, Brown and Cocking (2000) proffer that video use in the classroom help learners to learn by being able to re-visit and review the material as many times as possible. However, the videos have a potential of helping the learners only if used properly. The videos which are in the form of pre-recorded files and which have publicly available content can be made available at any time to the learners hence they can be viewed multiple times and at a speed and time that is convenient to the learners (De Boer, 2013). Moreover, videos are said to have the potential of stimulating the interest of the learners in the classroom, aid in the retention of knowledge as well as in the development of the common base of knowledge among the learners and provide greater accommodation of diverse learning styles (Eady & Lockyer, 2013).

According to Apostol (as cited in Kok, n.d.), people tend to forget the works they hear or read, but images are retained for a long time because they have emotional as well as intellectual appeal. First, information is received by sensory registers (e.g., eye, ear), and they store it in the sensory store that briefly holds raw and unprocessed information until the stimulus pattern is recognised or lost. Mayer (2002) as well as Mayer and Moreno (2003) on the other hand argue that multimedia learning happens when a learner is exposed to pictures and verbal forms at the same time, and a learner makes a mental representation of the material which has been presented. They are exposed to learning materials in two ways, namely verbal and pictorial modes, which are both useful for learning outcomes. Moreover, Berk (2009) argues that the presentation of learning materials in the form of videos as a mixture of verbal and visual materials is vital for learners to grasp the information. The video form as a visualisation tool may add value for learner preparation in a Mathematics classroom because learners may find it more engaging (Stockwell et al., 2015). Furthermore, Brame (2016) believes that videos are well-known to illuminate abstract content like Geometry. Bransford, Brown, and Cocking (2000) urge teachers to pay close attention to the knowledge, skills, and attitudes that learners bring into the classroom as these contribute immensely to learners' performance. The next subsection presents the effects of educational videos on learners' performance.

## 2.5 Effects of video-based instruction on learners' performance

Studies on using videos as a mode of instruction reported a significant gain in learning. Studies on the use of video-based instruction for the teaching of Mathematics reveal that the use of video-based instruction has positive influences on the learners in terms of performances (Harwood & McMahon, 1997; Kok, n.d.). Statistical results in a study carried in California revealed that learners who received video enhanced instruction scored significantly higher than those who were not exposed to any intervention (Harwood & McMahon, 1997). The significance level was at $F = 24.04$, $p < .01$, meaning that the two groups were significantly different.

A study conducted in Nigeria on the effects of video-taped instruction in History revealed that learners taught with the video-taped instruction scored significantly higher than learners taught with the conventional/traditional method of teaching (Osokoya, 2007). The study adopted the quasi-experimental research design using video-taped instruction and conventional strategies. The result showed that learners taught with the video-taped instruction performed better than those taught with the conventional method. The experimental group learners obtained a mean score of ($\bar{x}$ = 5.30) whereas, the control group learners obtained a mean score of ($\bar{x}$ = 20.12). This great achievement was reportedly due to the use of the video-taped approach. This study was done in History and the resultant findings can be generalized to other subjects like Mathematics.

In another study conducted in Nigeria, the researchers investigated the effects of video type instructional packages on the achievement of learners in Mathematics among senior secondary schools in Minna, Nigeria. Learners taught using videos performed better than their peers taught using the conventional teaching method (Gambari, Tajudeen, Olutunu & Adeyi, 2016). The study adopted quasi-experimental design. The treatment instrument for the study was researchers' developed video type instructional package on the Trigonometry concept in Mathematics which was used as treatment. A validated Trigonometry Achievement Test (TRAT) was used for data collection. TRAT was administered as pre-test and post-test and data obtained were analysed using ANCOVA and Sidak Post-hoc test. The results revealed that there is a significant difference in the mean achievement score of students taught Mathematics using video type instructional packages. The video type instructional packages had an average mean gain scores of ($\bar{x}$ =

37.43), while the traditional method had the least mean gain scores of ($\bar{x}$ = 21.67). This shows that all the groups benefited from the video type package as they had the highest post-test performance mean. This information was relevant as the experimental group learners in Gambari et al. (2016) used researcher designed videos. All these studies indeed prove the effectiveness of videos; hence, the present researcher strongly believes that what can be done in other African countries like Nigeria can as well be perfectly achieved in Namibia.

Bottge and Hasselbring (1993) compared two methods of problem-solving instruction. Thirty-six ninth-grade learners in two remedial math classes participated in the study and they received either traditional instruction with standard fraction word problems or videodisc instruction with contextualized fraction word problems. Both groups of learners improved their performance on solving word problems, but learners who received videodisc instruction did significantly better on the contextualized problem post-test, and they were able to use their skills in two transfer tasks after an instruction. Similarly, Choi and Yang (2011) conducted a study about the effects of the problem-based video instruction on learner satisfaction, empathy, and learning achievement in the Korean teacher education context. The purpose of this study was to investigate whether the use of videos can have a positive effect on satisfaction, empathy, and learning achievement in problem-based instruction among Korean college learners majoring in education. For the purpose to be achieved, the study compared the findings from three dependent variables in problem-based video instruction with those in problem-based text instruction. The results indicated that there were statistically significant differences in learner satisfaction, empathy, and learning achievement between learners who received problem-based video instruction and learners who received problem-based text instruction. Consequently, the findings of this study imply that video usage can be an effective medium to present authentic situations in order to enhance learner satisfaction, empathy, and learning achievement in problem-based instruction. The study was significant in expanding the potential use of problem based-video instruction in college learners majoring in education. The mean scores of the experimental group learners' results was ($\bar{x}$ = 4.43) and the control group was ($\bar{x}$ = 3.62), hence the scores have shown that learners of video-based instruction learned well as compared to learners attending traditional classrooms teaching. The standard deviation of the experimental group was 1.25, and that of the control group was 1.15.

In general, indeed the use of videos in the form of Computer-Assisted Instruction (CAI) has demonstrable tremendous gains in learning. Shirvani (2010) examined whether CAI was as effective as traditional instruction for teaching lower-achieving learners in Mathematics. One hundred and twenty-seven ninth-grade algebra learners participated in the study. Out of a total of six classes, three classes consisting of 63 learners were placed in the experimental group and the other three classes in the control group consisted of 62 learners. The lower-achieving learners in the CAI condition significantly outperformed the lower-achieving learners in the traditional instruction condition. Despite these results, there were no overall significant differences in learning Mathematics between learners in the two groups, but results indicate that CAI increased learner attitudes towards Mathematics.

Videos do not only report a positive impact on learning as there are also shortcomings in the use of educational videos. Perry (2013) indicates that showing videos with direct instruction may not necessarily produce significant gains in achievement for learners in secondary school level science (Biology) classrooms. An independent t-test was used to test for significance of the data, comparing the post assessment scores $p = 0.791$, with a significance level of 0.05. Since $p > 0.05$, the null hypothesis was not rejected, and there was no significant difference. Moreover, several researchers such as Bal-Gezegina (2014), as well as Herron, Morris, Secules and Curtis (1995) have indicated that the use of videos can cause the passivity of the learners when learning. The fear is that learners using a video-based curriculum will not learn to read or write since a significant portion of classroom time is spent watching videos and, seemingly, concentrating on only the listening skill (Herron et al., 1995). However, Woolfitt (2015) caution that videos must be well organised to measure what they are supposed to measure.

Contrary to what is stated above, there is no extensive research that has been done specifically on the use of educational videos in neither primary nor secondary classrooms in Namibia, specifically on Geometry performance. International studies (Choi & Yang, 2010; Lee, Cheon & Key, 2008; Wong, et al., 2011) focused on computer games, computer-assisted instruction, and interactive videos which are more common in higher learning of institutions. Due to the aforesaid, this study aims to discover whether there is evidence, or not, in using educational videos as a useful teaching tool in a Mathematics classroom to improve Geometry performance.

### 2.6 Learners' views on the use of educational videos

Currently videos are widely used as a learning resource and many researchers have paid attention to the use of this pedagogical tool (Yang, Huang, Tsai, Chung & Wu, 2009). According to Yang et al. (2009), among multimedia learning materials, video is the most favourite and illustrative because it blends many multimedia resources, like text, images, sound, and speech. In a study carried by So, Pow and Hung (2009) on student teachers' view on video database, all student teachers responded positively about the video database that they could use to share the videos. Furthermore, student teachers stated that the database where they shared their videos was useful for them to learn and to improve and reflect upon their teaching. Similar findings were found by Kay and Kletskin (2012, p. 625) who maintained that "learners used video podcasts frequently and rated them as useful or very useful effective learning tools". Furthermore, in Perry's (2013) study, it was observed that learners felt positive about the use of videos with direct instruction, although watching the videos did not improve any performance. The findings of another study revealed that the use of ICT-driven pedagogy improved learners' performance (Kanandjebo, 2017). From the analysis of constructs, the study found that 70.8% of the experimental group held positive perceptions towards ICT-driven pedagogy (Kanandjebo, 2017). The positive attitude towards ICT-driven pedagogy by learners translated into learners encouraging for the adoption of ICT-driven pedagogy.

Furthermore, Kok (n.d.) did a research case study on the use of video-based instruction for the teaching and learning of Mathematics. The purpose of the study was to give an overview on the issues pertaining to the use of video-based instruction for the teaching and learning of Mathematics. The study examined the existing literature and several projects to highlight the reasons and potential for the use of videos in Mathematics and the important issues when designing such instruction for use in the classroom. The findings of the study indicate that the use of video-based instruction has positive influences on the learners in terms of performance and attitude as well as motivation (Kok, n.d.). It is, however, worth noting that this part of literature is relevant to the current study as the researcher investigated if there is any improvement in performance using teacher-designed interventions. Moreover, the evaluation study by Kok (n.d.) revealed that learners who received videodisc instruction clearly showed that they felt the provision of real-world examples of mathematical concepts, and that the videos helped the learners to understand the ideas being taught to them in the classroom (Kok, n.d.). The interpretation of these responses from the learners is that video usage has made it possible to contextualize mathematical concepts in ways that would be very difficult to achieve without the use of technology, like videos.

In a study conducted in Taiwan on the perceptions of playing video games towards second / foreign language learning among undergraduate learners, the results revealed that learners' perceptions of playing video games towards second/foreign language learning were positive. The results indicated that gender and years of playing games have a significant influence on learners' perceptions; whereas the types of games and English proficiency were not significant factors to their perceptions (Lee, Cheon & Key, 2008). Furthermore, a cross-sectional survey was conducted among 320 final year undergraduate students of the University of Professional Studies, Accra, Ghana (in Sub-Saharan Africa), on the views of the student teachers at the college (Nketiah-Amponsah, Asamoah, Allassani & Aziale, 2017). The study employed an ordinary least square to estimate the effects of ICT on academic performance. Overall, the study showed a positive and statistically significant relationship between some selected ICT tools and applications for learning and academic performance. The use of e-mails was found to exert a positive effect on academic performance, while the use of iPads had a negative impact on academic performance. The paper suggests that ICT can be harnessed to improve students' academic performance at the university level. It is recommended that the use of e-mail interface for academic-related activities be intensified among students in order to harness its full potential in improving academic performance.

The graphics and sounds used in videos can keep learners more engaged than they would be in a typical lecture (Perry, 2013). The present study therefore sought to determine if these learners are more engaged and more interested in the content when they are shown videos. Bransford, Brown, and Cocking (2000) urge teachers to pay close attention to the knowledge, skills, and attitudes that learners bring into the classroom, as this would contribute immensely for successful learning. If learners indicate that their interest or attitude is improved, and their test scores are significantly higher than those in the traditional classroom, then this study would support using videos as a teaching tool. The next subtopic discusses advantages of teacher-designed technology-based tasks in teaching Mathematics.

## 2.7 Teacher-designed Technology-based tasks

Teaching is increasingly referred to as a design (in Science and Mathematics classrooms) (McKenney, Kali, Markauskaite, & Voogt, 2015). Today's teachers are not only required to plan lessons that incorporate existing classroom activities and instructional resources, but they are also required to design new learning activities and create their own (technology enhanced) learning materials for the learners (McKenney et al., 2015). Teacher education programmes devote relatively little time to develop expertise in the design of instruction beyond lesson planning.

The fundamental educational advantage of multimedia learning using, for example, videos, is that these resources provide integrated visually and linguistically rich sensory input that enhances the users' learning experiences (Mayer, 1997). Additionally, they improve access to content materials, are cost effective to reproduce, and can be updated easily. However, there are scant appropriate resources available in some areas of teacher education preparation, such as Mathematics education (Diezmann & Watters, 2002). Thus, the researcher capitalises on the educational benefits of technologically-based resources may need to develop their own resource materials. Instruction should be planned through activities that can allow the learners to reveal their foreknowledge and make sense of the presented materials. Ploesser (2016) saw this as motivating to the learners and perceived it as a connection between the classroom and the real world.

Technology is essential in teaching and learning Mathematics as it influences the mathematics that is taught, and it enhances learners' learning (Midgett & Eddins, 2001). The need to keep pace with society and prepare learners for their roles in society is the reason to use technology in education. Educators and researchers point to the potential of technology to increase motivation and the engagement of learners, cater for different learning styles and improve learning outcomes (Eady & Lockyer, 2013). Hamilton et al. (2016) argue that locally developed and owned materials by teachers can produce contextually relevant curricular materials for the learners than conventionally produced materials.

George and Sanders (2017) strongly advise teachers to be involved in the designing of their learners' materials. Digital technologies appear to have the potential to promote deep learning when used purposively and appropriately (George & Sanders, 2017). Thus, for these reasons, the researcher used teacher-designed instruction tools to fill the gaps in Mathematics. Ten educational videos (10-16 minutes long) for this study were designed to enhance the teaching of geometry concepts. George and Sanders (2017) highlight the following attributes that are necessary for technology-based tasks for them to engage the learners in a meaningful learning.

**Table 2: Task attributes for technology-based tasks to engage learners in meaningful learning**

| Task attribute | Explanation | Theoretical or empirical basis | Examples of ICT tasks or tools |
|---|---|---|---|
| Active | Task is interactive, requiring leaners to manipulate objects or ideas in their learning environment, and to observe what happens | Interaction with the learning environment provides the basis for thinking about what is observed (Dewey, 1938; Piaget, 1954). Active engagement results in more effective learning (Smith et al., 2005) | spreadsheets to investigate and graph manipulated variables, simulations, educational games, visualisation tasks (e.g. using Geometer's Sketchpad) |
| Constructive | Task ensures reflection on what has been observed, and articulation of what occurred, so information can be structured into a simple mental model | Personal construction of knowledge by assimilation of new knowledge into existing schemata, which may need to change to accommodate the new ideas (Piaget, 1954; Ausubel, 1968) or social constructivism (Vygotsky, 1978). Significantly correlates with deep processing (Nie & Lau, 2010) | modelling, mind mapping, creating tables for comparisons, using publishing software, emails, chat rooms, discussion forums |
| Intentional | Task necessitates that learners be willfully engaged to achieve some purpose | Motivation (Greene et al., 2004; Lee & Hannafin, 2016) and self-regulation affect the type of cognitive engagement and performance (Pintrich & De Groot, 1990) | problem-solving activities, goal-targeted tasks |

*Source: George and Sanders (2017)*

For meaningful learning to occur, there are five requirements that the learners should possess. However, for the purpose of this study, only three task attributes were considered, as George and Sanders (2017) indicate that without them, learning cannot be meaningful.

Not all information presented in multimedia form supports learning. For meaningful learning to occur, the resources themselves need to be designed purposefully and integrated into the learning experience by the teacher (Eady & Lockyer, 2013). Some educational theories provide direction for the designing of the resources and how a teacher can best use those resources with the learners. The cognitive load theory developed by Sweller (1988), tells us how learning resources must be designed to reduce the load on our working memory for us to be able to construct schema. The following section outlines how best these tasks can be designed.

## 2.8 Features guiding the designing of educational videos

Designing instructional materials for the learners builds on the cognitive load theory. The cognitive load theory states that the working memory has two channels for information acquisition and processing (Mayer, 2002). They are the visual or pictorial channel and an auditory or verbal-processing channel (Mayer, 2002; Mayer & Moreno, 2003). Although each channel has limited capacity, the use of the two channels can facilitate the integration of new information into existing cognitive structures. Using both channels maximises the working memory's capacity, but either channel can be overwhelmed by high cognitive load. Thus, designing the strategies that manage the cognitive load for both channels in multimedia learning materials could enhance learning.

To maximize the benefits of learning from educational videos, Brame (2016, p. 5) identified five key components of cognitive load to take into consideration as they are the elements that impact the engagement of the learners and promote active learning. The videos should be:

- Kept brief and targeted on learning goals (10 – 18 minutes long)
- Audio and visual elements will be used to convey appropriate parts of an explanation
- Use signaling or cueing to highlight important ideas or concepts
- Use segmenting and weeding
- Embed videos in a context of active learning by using guiding questions, interactive elements, or associated homework assignments.

The following features guided the design of educational videos:

### 2.8.1 Signaling

Signaling, which is also known as cueing, is the use of on-screen text or symbols to highlight important information. For example, signaling may be provided by the appearance of two or three key words (Mayer & Johnson, 2008; Ibrahim et al., 2012), a change in color or contrast (deKoning et al., 2009), or a symbol that draws attention to a region of a screen (e.g., an arrow; deKoning et al., 2009). By highlighting the key information, signaling helps direct learner attention, thus targeting elements of the video for processing in the working memory. This can reduce extra load on the learners by helping them with the task of determining which elements within a complex tool are important. Mayer and Moreno (2003) and deKoning et al. (2009) have shown that this approach improves learners' ability to retain and transfer new knowledge from animations, and Ibrahim et al. (2012) have shown that these effects extend to video.

### 2.8.2 Segmenting

The benefits of signaling are complemented by segmenting, or the chunking of information in a video lesson. Segmenting allows the learners to engage with small pieces of new information and it gives them control over the flow of new information. As such, it manages intrinsic load and can also increase germane load by emphasizing the structure of the information. Segmenting can be accomplished both by making shorter videos and by including "click forward" pauses within a video, such as using YouTube Annotate to provide learners with a question and prompting them to click forward after completion. This type of segmenting has been shown to be important for learner engagement with videos (Zhang et al., 2006; Guo et al., 2014), and learning from video (Zhang et al., 2006; Ibrahim et al., 2012). In this study, segmenting will be shown using pause buttons and forwarding of text in a video.

### 2.8.3 Weeding

Interesting but extraneous information that does not contribute to the learning goal but can provide further benefits will be eliminated. This is for instance, music, on-screen photo, complex backgrounds, or extra features within an animation that may require the learner to judge whether to pay attention to them or not, as this can reduce learning. That is, information that may be extraneous for a novice learner may be helpful for a more expertlike learner, while information that is essential for a novice may serve as an already known distraction for the learners. Ibrahim et al. (2012) confirm that treating the learners in this way can improve the retention and transfer of new information from video. The layout should be visually appealing and intuitive, but the activities should remain focused on the concepts to be learned, rather than trying too much to entertain. This is because the working memory can be overloaded by the entertainment or activity before the learner gets to the concept or skill to be learned.

A constructivist classroom may contain the following four characteristics: cognitive exploration to encourage inquiry and direct hands-on minds on activities; learner autonomy where learners oversee their own learning; social interaction where the learners work together in groups with opportunities for cognitive conflict; and learner-centered learning where learners' ideas and opinions are important. In this respect, it can also be concluded that the teacher's role here is more of a facilitator.

## 2.9 Generative Model of Multimedia Learning

This study is informed by Generative Theory of Multimedia Learning (GTML) (Mayer, 1997). The basic theme of a generative theory of multimedia learning is that the design of multimedia instruction affects the degree to which learners engage in the cognitive processes required for meaningful learning within the visual and verbal information processing systems (Mayer, 1997, p. 7). In addition, the learner is viewed as a knowledge constructor who actively selects and connects pieces of visual and verbal knowledge together.

Generative theory contributes to the understanding that "meaningful learning occurs when learners select relevant information from what is presented, organise the pieces of information into a coherent mental representation and integrate the newly constructed representation with others" (Mayer, 1997, p. 4). According to Mayer (1997), meaningful learning in a multimedia environment consists of the learners "selecting words and selecting images from the presented material, organising words and organising images into coherent mental representations, and integrating the resulting verbal and visual representations with one another".

The figure below illustrates the generative model of multimedia learning

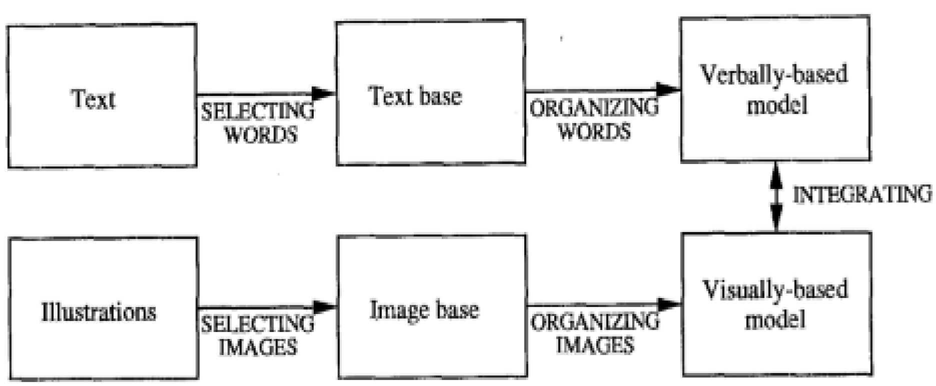



**Figure 1: A generative model of Multimedia learning (Mayer, 1997, p. 5).**

When information is represented using multimedia (ICTs), it enters our sensory register (inputs), and these inputs (or information) become part of our working (short-term) memory. If the information is to be retained, it is encoded as schematic into our stored (long-term) memory. Then the information is retrieved from our stored memory for later use (Atkinson & Shiffrin, 1968). Learners attempt to build meaningful connections between words and pictures, and they learn more deeply than they could have with words or pictures alone (Mayer, 2005 & Mayer, 2009). The words can be spoken (such as in narration) or written (such as printed words), and the pictures can be any form of graphical imagery including illustrations, photos, animation, or video clips (Sorden, 2012). Table below gives a difference between words and pictures.

**Table 3: The distinction between words and pictures**

| Mode | Example | Implementation |
|---|---|---|
| Words | Printed text | Words (on screen) |
| | Spoken text | Speech that is recorded, or synthesized |
| Pictures | Static graphics | Illustrations, drawings, photos, figures, tables (on screen) |
| | Dynamic graphics | Animation, video (on screen) |

The central work of multimedia learning takes place in the working memory. The pictures and printed text are registered through the eyes and the words that correspond to the printed text are registered through the ears. Mayer (2009) argues that the working memory is used for temporarily holding and manipulating knowledge in the active consciousness. According to Mayer (2002), learners learn better when they engage in relevant cognitive processing such as attending to the relevant material in the lesson, mentally organising the material into a coherent cognitive representation, and mentally integrating the material with their existing knowledge. This in turn yields active learning. Merely adding pictures to words cannot produce an effective instructional design to achieve maximum multimedia learning. Multimedia instructional design utilises the cognitive research by combining words and pictures in different ways to maximize learning.

From a constructivist point of view, learners build their understanding by evaluating new experiences in the light of prior knowledge. Active verbal processes occur more likely when corresponding verbal and pictorial representations are in the working memory at the same time (Mayer, 2005). In a classroom, the learner's job will be to make sense of the presented material as an active participant and ultimately, constructing new knowledge (Sorden, 2012). Learners' activities shouldn't create unnecessary activities in connection with a lesson that requires excessive attention or concentration as this may overload the working memory and prevent one from acquiring the essential information that is to be learned.

One of the channels is the auditory or verbal channel that processes the visually presented materials. The other channel is the visual or pictorial channel that processes the auditory represented material. Pictures and words come in from the outside world through a multimedia presentation like videos and enter sensory memory through the eyes and ears. The sensory memory allows for pictures and the printed text to be held as exact visual images for a very brief time period in the visual sensory memory, and for spoken words and other sounds to be held as exact auditory images for a very short time period in the auditory memory (Osamah, Fong & Ziad, 2010).

The information acquired is processed using separate channels for processing verbal and visual materials. Each channel processes only a small amount of material at a time as the amount of information that can be processed at a time is very limited in the working memory. Due to that, learners may experience difficulties in processing the information. By using both the audio or verbal channel and the visual or pictorial channel to convey new information, the channels complement each other. For example, showing an animation of a process on the screen while narrating it uses both channels to elucidate the process thus, gives the learner dual and complementary streams of information to highlight features that should be processed in the working memory. However, showing the animation while also showing printed text uses only the visual channel, and thus, overloads this channel and impedes learning (Mayer & Moreno, 2003). This has also been practiced in the Khan Academy-style tutorial which provides symbolic sketches to illustrate verbal explanations. Khan Academy is a widely used instructional tool that provides video-based instruction online, like on You-Tube. Using both channels to convey appropriate and complementary information has been shown to increase learners' retention and ability to transfer information (Mayer & Moreno, 2003). Not only that, it has also been reported that consequently, it increases learners' engagement with videos (Guo et al., 2014; Thomson et al., 2014).

The learner represents an active agent in the learning process via multimedia means. Learners construct meanings of the information presented through three major mental processes: selection, organisation and integration. Selection is a mental process where an individual learner pays attention to relevant information presented verbally or non-verbally (Osamah, Fong & Ziad, 2010). Moreover, Mayer (2009) defines selection as choosing the right information and adding it to the working memory. For example, the learners do not think that a square is a rectangle, or a square is a rhombus, and a rectangle is a parallelogram (Mayberry, 1983). After the leaner has selected the verbal and non-verbal information, the next step is organisation which involves ordering and organising information that has been selected meaningfully and logically.

The organisation process is also performed on image base "selected images" to organize them in an image model that can intercept them. As the verbal model and visual model are constructed, the integration process follows. Integration means making a connection between the verbal and image models (Osamah, Fong & Ziad, 2010). Moreno and Mayer (2003) indicate that such processes involve connecting organised information in the verbal and image models with relevant and similar information stored in the long-term memory. Connections will be made between both verbal and image models and as such, in multimedia learning, information is presented to the learner in more than a single form such as words, images, motion pictures, sounds and other forms.

When the learners are in an instructional design that involves pictures and words, one can expect that all five cognitive processes will be activated, resulting in a meaningful learning outcome, which is then stored in the long-term memory. The act of integrating verbal and pictorial representations with each other is an important step in promoting deep understanding (Mayer, 2011). Therefore, this theory was used to teach geometrical concepts using videos. It was tested to see if videos that are used to teach geometrical concepts are effective by determining the Geometry learners' performance after an intervention. The learners were assessed after an intervention and their views were determined. The learners were surveyed to see if an instruction was interesting to them after an instruction. Ten educational videos were used in this study to facilitate the teaching of Geometry concepts. In turn, this might inevitably enhance performance among Grade 12 learners. Research on multimedia learning has demonstrated more positive outcomes for learners who learn from resources that effectively combine words and pictures, rather than those that include words alone (Mayer, 2008).

## 2.10 The conceptual framework of this study

From a constructivist paradigm, Mathematics education research and curriculum development has led to the recognition of leaners as active constructors of mathematical knowledge.

*Constructivism derives from a philosophical position that human beings have no access to an objective reality, that is, a reality independent of our way of knowing it. Rather, we construct our knowledge of our world from our perceptions and experiences, which are themselves mediated through our previous knowledge. Learning is the process by which human beings adapt to their experiential world (Simon, 1995, p. 5).*

The conceptual framework of this study is influenced by the Constructivist Theory by Levy Vygotsky (1978). Vygotsky recommends that learners' zone of proximal development should be assessed regularly and be provided with enough assistance by an experienced teacher (Cole, John-Steiner, Scribner & Souberman, 1978). From a constructivist point of view, a teacher plays a role of a facilitator in the classroom for active learning to take place, for meaningful learning. In order to execute and improve learning, a teacher must ensure that learning happens meaningfully and smoothly. In Namibia, there is a general lack of instructional materials that are designed for the learners (Hamilton, Kapenda, Miranda & Ngololo, in press; United Nations Children's Fund [UNICEF], 2011). Due to this, in most of the times teachers use materials from the internet, that is YouTube, to support learning. Hence Kapenda (2008) in her study recommended that teachers should be encouraged to use a variety of teaching and learning media that stimulate learners' interest, especially nowadays with the introduction and implementation of Information, Communication and Technology (ICT) policy in Namibia.

When information is represented using multimedia forms (ICTs), it contains both visual-based and verbal-based materials. The information enters the sensory register and it becomes part of our working (short-term) memory. If the information is retained, it is encoded as schematic into our stored (long-term) memory and retrieved from our stored memory for later use (Atkinson & Shiffrin, 1968). Learners’ attention and engagement with these resources helps them to process the information into working memory. When learners meaningfully interact with the multimedia information, they encode this information into their long-term memory. Teachers can support learners to process information by helping them to organise new information, link it to their existing knowledge and use memory aids to retrieve information. In support of the idea of using ICT, Eady and Lockyer (2013) state that digital learning resources and computer software can be used to facilitate these processes, and in this case, educational videos were used.

Cobb (1994) observes that teachers are guilty of teaching by transmission more than by stimulating learners' reflection and problem solving. It is disturbing that instructional statements consistent with this interpretation of the maxim are sometimes used as absolute standards against which to assess pedagogical alternatives. In such instances, the judgment that the alternative "is not constructivist" apparently constitutes an adequate counterargument (Cobb, 1994). Thus, the discourse of this kind makes genuine inquiry possible in Mathematics education. Morgan and Watson (2002) argue that teachers can accumulate a multidimensional (and hence more valid) view of leaners' Mathematics by assessing them over time, using responses to a variety of tasks in several situations, and having knowledge of the context within which the learners are working. This meaningful interaction can involve learning activities within the digital resource itself and/or as a lesson that is created by the teacher. However, not all information that is presented in multimedia form supports learning. For learning to occur, the resources themselves need to be designed using sound educational principles, and they need to be purposefully integrated into the learning experience by the teacher. It is for this reason that after a multimedia presentation, learners' performance was determined using the post-test, and their views; hence the figure below illustrates the conceptual framework guiding this study.

The figure below illustrates the conceptual framework of this study.

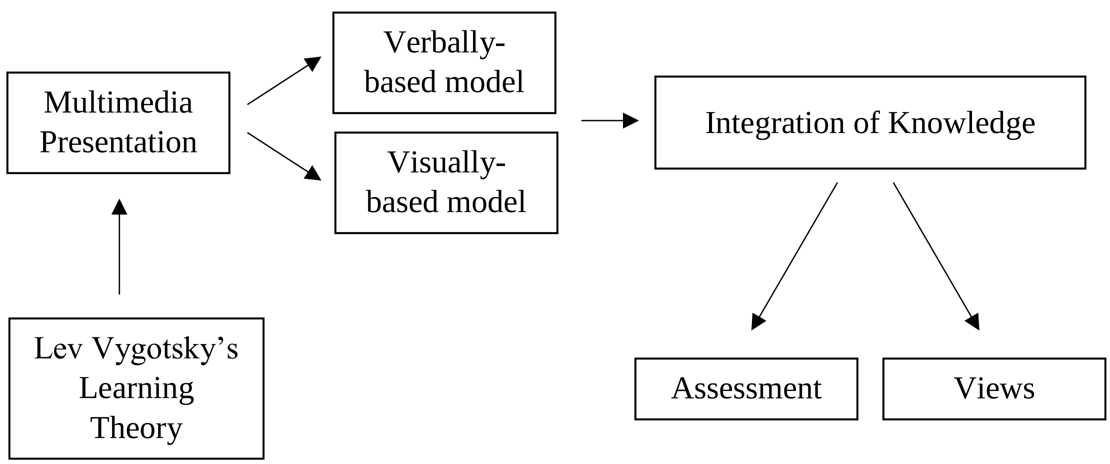



**Figure 2: A conceptual framework of this study**

Figure 2 above represents a conceptual framework of this study as guided by Mayers' Generative Theory of Multimedia Learning of 1997. From a constructivist point of view, learners are active constructors of mathematical knowledge. They learn from the experiences around them, that is, by interacting with the environment. This meaningful interaction can involve learning activities within the digital resource itself and/or as a lesson that is created by the teacher. In this study, educational videos that contain both text and the verbal mode were used, of which information is processed simultaneously to enhance the learning of Geometry concepts. Their performance was then determined as well as their views towards the ICT tool used. It is for these reasons that after multimedia presentation learners' performance was determined using the post-test and their views.

## 2.11 Conclusion

In conclusion, this chapter reviewed aspects related to educational videos. It began by explaining how Geometry is taught in the Namibian context. Later, the use of videos and how the videos are produced was discussed; and lastly the conceptual framework guiding the study. The next chapter discusses the methodology guiding this study.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter presents the research design, the population, sample and sampling procedures, research instruments as well as data collection and analytical procedures used in this study. Furthermore, it presents the pilot study, the validity and reliability of instruments, data analysis, ethical considerations as well as the conclusion.

## 3.2 Research design

A mixed method approach was used to find answers to the research questions of this study. A quasi-mixed design was used in which both quantitative and qualitative data are gathered but not integrated in answering a research question (Cohen, Monion & Morrison, 2011). This strategy led to the adoption of an embedded mixed method design. An embedded mixed method design was adopted as it allows for the researcher to understand experimental results by incorporating perspectives of individuals (Cresswell, 2014). Furthermore, this approach is biased towards collecting quantitative data through pre-test and a post-test; and a small amount of qualitative data on learners' views on the use of educational videos (Bryman, 2012). This study also adopted a non-equivalent quasi-experimental design as it is a pre-test, and post-test experimental and control group design. Cresswell (2014) defined quasi-experimental research design as a design in which participants are not randomly assigned to groups. In this study this design was used to test for the differences between the two groups. The difference between pre-test and post-test results determined whether videos influenced learners' performance in learning Geometry. A survey was used to collect learners' views using a questionnaire.

### 3.3 Population

A population is a group of individuals with at least one common characteristic which distinguishes a group from other individuals. The population of this study comprised of 440 Mathematics learners at two selected senior secondary schools in Oshikoto Education Region who were in Grade 11 at the time when the study was conducted.

### 3.4 Sample and sampling procedures

A random sampling technique was used in the study. This technique allows the researcher to select individuals for the sample on a completely chance basis (Mills & Gay, 2016). Papers with numbers that were equal to the number of Grade 11 classes at the selected schools were placed in a box and only one paper was selected to form the sample at each school. Only one class at each school was selected in order to reduce the contamination of data (Neuman, 2009). One class acted as a control group and another class at a different school acted as an experimental group. Each Grade 11 class had 40 learners in a class. The total number of learners that participated in the study was 80; 40 in the control and another 40 in the experimental group. One school was purposively assigned as a control group and the other as the experimental group respectively. The school with a computer lab was purposively made as the experimental group as the other school did not have a computer lab.

The following criteria were used in identifying the two schools that were used in the study:

- The two selected schools should have Grade 11-12 as that was the focus grade of this study. In other words, the selected schools should be senior secondary schools.
- The two schools should have a performance that is at the same level (similar performance).
- They should be less than 20 km apart to ensure the smooth movement of the researcher between the participating schools; and, in consideration of the time as the experimental group was taught immediately after the control group in the afternoon.

## 3.5 Research instruments

### 3.5.1 Treatment instrument

The treatment instrument used in this study was developed by the researcher. The researcher developed the instrument because she observed that commercially produced videos do not cover all the relevant basic competencies in the National Senior Secondary Certificate (NSSC) syllabi. The videos were produced based on the NSSC contents of the Mathematics syllabi, Grades 11 – 12, and were used as a treatment of the study. The instructional material covered the Geometry content, focusing on angle properties, including circle Geometry. Circle geometry was referred to as poorly answered by the learners in the Examiners' Report of 2015 to 2017 (DNEA, 2015-2017). Based on the lesson plan, the researcher developed educational videos on Geometry concepts, focusing on angle properties.

The treatment instruments developed by the researcher in this study were the videos. The videos were recorded by the researcher using a Pen-based Tablet, using Camtasia Studio 8 software. Its features enabled for text (or anything on the screen) to be recorded on the screen and it also captured the audio at the same time. Furthermore, it allowed for one to view and edit the videos. Thus, images were produced with sound explaining the concepts. The videos portrayed texts, diagrams, symbols, animations and sound. A total of ten (10), 10 – 16 minutes long educational videos were developed for use in the experiment. Thus, the educational videos were used as a medium of instruction for the learners in the experimental group and used as treatment in the study. The content of the videos is presented in Table 4 as follows:

**Table 4: The content of the educational videos produced**

| Video No. | Specific objective | Curriculum area |
|---|---|---|
| | *Learners will be able to calculate unknown angles using the following geometric properties (only reasons required but no proofs)*: | |
| Video 1 | angles at a point<br>angles on a straight line and intersecting straight lines | Line Geometry |
| Video 2 | angles formed within parallel lines | Line Geometry |
| Video 3 | angle properties of triangles | Triangle Geometry |
| Video 4 | angle properties of quadrilaterals | Quadrilateral Geometry |
| Video 5 | angle properties of regular polygons | Polygon Geometry |
| Video 6 | angle properties of irregular polygons | Polygon Geometry |
| Video 7 | angle properties of irregular polygons | Polygon Geometry |
| Video 8 | angle in a semi-circle | Circle Geometry |
| Video 9 | angle at the center of the circle is twice the angle at the circumference | Circle Geometry |
| Video 10 | angles in the same segment are equal<br>angles in opposite segments are supplementary | Circle Geometry |

### 3.5.2 Test instruments

#### *3.5.2.1 Pre-test*

A pre-test was used to determine the learners' prior knowledge on Geometry, particularly on angle properties. The pre-test consists of objective items adopted from the past examination question papers for NSSC 2009 to 2016, as well as IGCSE Cambridge papers (South Africa Mathematics question papers) from the year 2008 to 2012. The pre-test consisted of 8 questions on angle properties and tested on the competencies as they appear in Table 3.1.

#### *3.5.2.2 Post-test*

A post-test was administered on the participants at the end of the study in the academic year 2017. The purpose of the post-test was to determine if there is any improvement in results between pre-test and post-test after an intervention. The post-test was administered to both groups (experimental and control groups) at the end of the study. The post-test on angle properties was prepared and marked by the researcher.

### 3.5.3 Questionnaire survey for the learners

This development of the questionnaire was influenced by Arbain and Shukor (2015), in which they identified the views of the learners towards GeoGebra software use. In this study, a self-designed questionnaire was used to measure the views of the learners on the use of educational videos in the Mathematics classroom. Thus, the questionnaire was used to determine if learners had passed or not, have found the educational videos useful or not, and whether they would prefer to be taught using videos or not when learning Geometry on angle properties. Drawing from Arbain and Shukor (2015), the themes of the questionnaire included the following constructs: usefulness of videos; learning environment; and learning experiences. The questionnaire contained 14 items to measure how learners felt about the use of educational videos. The questionnaire was designed to include a 5-point Likert scale, where 1 = strongly disagree to the concept, 2 = disagree to the concept, 3 = undecided to the concept, 4 = agree to the concept, and 5 = strongly favourable to the concept. According to Losby and Wetmore (2012), a Likert scale is an ordered scale from which respondents choose one option that best aligns with their view. In this study, a Likert scale was used to measure respondents' views by asking the extent to which they agree or disagree with a question or statement.

### 3.6 Data collection procedures

Immediately after the researcher obtained permission from the relevant authorities (the Permanent Secretary, the Director of Education, school principals of the affected schools and the learners’ parents), the researcher went into the field to carry out the main study. The researcher started off by explaining research purpose to the participants and informing them that they have the right to withdraw from the study if need be. The researcher also informed the participants that they would be writing two tests, the pre-test and the post-test; and it is only the experimental group that would be taking the questionnaire.

On the first day, the researcher administered a pre-test on angle properties to School B (control group) and then proceeded to School A (experimental group) after school hours. Thereafter, the researcher taught the competencies on angle properties to both the experimental and the control group (in the afternoons). One video was viewed per day by the experimental group learners and the same competency (as they appear in Table 3.1) was used to teach the control group. Each lesson was one (1) hour long and it lasted for ten (10) consecutive days.

**Phase 1: Pretest**

Learners at both schools were given a pre-test at the start of the unit to determine their pre-knowledge on angle properties. The pre-test results were determined using the Mann-Whitney U test (DeCoster, 2006). This was done in order to avoid masking the effects of technology by other factors that include prior knowledge.

**Phase 2: Intervention strategies**

The intervention strategies outline how the teaching strategies have occurred at the two groups; School A being the experimental group and School B as the control group. School A was taught first before School B. The description of what happened is illustrated below.

**Experimental group**

The learners in the experimental group were exposed to educational videos as a treatment of the study. The videos on angle properties were pre-loaded into Personal Computers (PC) at School A to display angle properties concepts and for the learners to view. Ten videos of approximately 10 – 16 minutes long were viewed during class time. During the teaching and learning, the experimental group learners watched, listened and read from the video as the lesson progressed. This was done during class time for one (1) hour per day for a period of two weeks. One video per lesson was watched by the learners at the beginning of the lesson, during the first 20 minutes. Thereafter, the teacher facilitated the lesson to enhance teaching and learning. The learners had a chance to rewind or forward the video in the classroom and to play it as many times as they wished. At the same time, the learners took class notes, answered the teachers' questions and performed classroom tasks (activities). Immediately after the post test at the end of the study, the learners were given a questionnaire to determine if they liked to be taught with the videos or not.

The figure below illustrates the processes that occurred in the experimental group using educational videos.

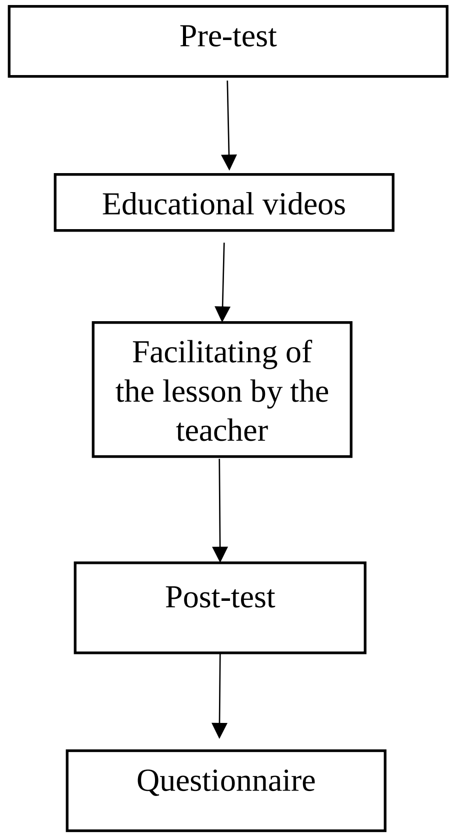



**Figure 3: Processes that occurred in the experimental group**

**Control Group:** The control group was taught using the traditional way of teaching, that is, the ‘chalk and talk’ method of instruction only. The learners in the control group were taught the same content which is like the content in the videos. The control group learners received the same class notes as well as the same class activities and homework like the experimental group learners.

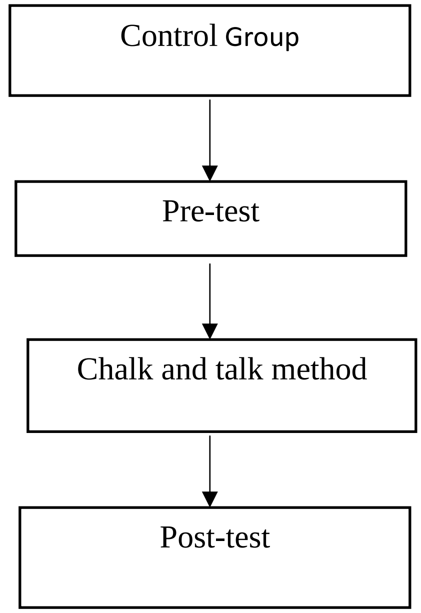



**Figure 4: Activities that occurred in the control group**

**Class work:** Learners in both groups were encouraged to take notes, ask questions and solve some mathematical problems. Both groups received the same notes and exercises on Geometry concepts at the end of every lesson.

**Phase 3: Post-test**

After two weeks of teaching, all learners were given a post-test to determine if there is any significant difference between the groups of the learners taught using videos and those taught using the traditional way, and to measure overall differences between the control and treatment classes. The post-test was administered to all the learners (experimental and control group) after two weeks of the treatment. The post-test was set differently from the pre-test but the researcher tried to ensure that the tests were of the same quality. Thus, the same basic competencies that were set in the pre-test were like the post-test basic competencies. All tests were set out of 25 marks and lasted for 40 minutes.

**Phase 4: Sourcing learners' views towards the use of educational videos**

At the fourth phase of data collection, views of learners in the experimental group towards videos use were sought to determine the usefulness of educational videos. Learners were asked to answer a questionnaire that took the learners 20 minutes to answer.

## 3.7 Pilot study

To assess the research instruments formally, one can field-test some aspects of a study by using a small-scale trial of the study before a full-scale study (Airasian, Mills & Gay, 2011). Denscombe (2014, p.165) states that "a method should always be tested in advance to check how well it works in practice". In this study, the research instruments were tested out at a different secondary school in OER and that school did not form part of the main study. It was purposively selected given that its performance is congruent to the performance of the two participating schools. The pilot school had similar characteristics as the selected schools for the study. One class was randomly selected and it had 42 learners. These learners were divided into two equal groups, namely the control and experimental group, consisting of 21 learners. It was assumed that learners' prior knowledge was more likely at the same level.

A pre-test was administered to the learners in their respective groups; experimental and control group. Both groups were taught the same topic. The experimental group was taught Geometry topics using educational videos while the control group was taught using traditional teaching approaches. The post-test was administered to both groups after the lessons. The questionnaire was then administered to the experimental group immediately after the post-test.

**Pilot study results**

- *Changes made with regards to the pre-test and the post-test*

  The problem discovered was that the total marks in the post-test (set out of 27 marks) exceeded a total set mark (25 marks) with two marks. Therefore, some questions on angle properties in the post-test were removed so that the two tests would weigh an equal number of marks in the main study. The learners struggled to answer the post-test questions, although the same competencies were assessed in the post-test.

- *Changes made with regards to the questionnaire*

  Question 4 sought information on whether videos can help the learners to increase achievement in Mathematics. The researcher felt that it was inappropriate to ask the learners about whether the videos would increase their achievement in Mathematics or not. This question was therefore removed completely. Again, Question 3 and 5 seemed to have measured the same thing, and the researcher removed question 5 and remained with question 3 only. On top of that, the results for question 3 and 5 were found to be closely related, with question 3 obtaining 82.8% on strongly agree and agree; and question 5 obtaining a total of 85.7% on strongly agree and agree.

Lastly, the researcher modified the last statement that read "What I liked about the videos is that I was able to pause, rewind and forward the videos", to a statement that reads "I was able to pause, rewind and forward the video, and this made it easy for me to learn at my own pace".

### 3.8 Validity

The research instruments were validated by experts in Mathematics education at the University of Namibia (UNAM) and the Ministry of Education, Arts and Culture (MoEAC). To be specific, the tests (pre-test and post-test) and the treatment instruments were reviewed by the Senior Education Officer (SEO) for Mathematics at the OER, the Head of Department of Mathematics (HoD) at School A as well as by colleagues. When the instruments were designed, the researcher gave them to the Head of Department (HoD) of Mathematics at their school as well as by colleagues for their inputs. Thereafter, the researcher proceeded to the SEO in Mathematics education and then lastly to experts in Mathematics at UNAM. All this was done to ensure content validity (Cohen, Manion & Morrison, 2011).

The educational videos were prepared to achieve the intended learning outcomes in angle properties and the test instruments were piloted at a different school other than the participating schools to test if they were measuring what they are supposed to measure (Patton, 2002). The quality of the videos and test instruments were checked by one Head of Department in Mathematics at OER and experts in educational videos at UNAM. The content of the questionnaire was checked for face validity by the experts. This was done to evaluate whether the questions/statements in the questionnaire effectively capture the topic under investigation.

**3.9 Reliability**

Best and Kahn (2006) define reliability as “the degree of consistency that the instrument or procedure demonstrates: Whatever it is measuring, it does so consistently” (p. 289). In this study, questionnaire items were pilot tested for reliability by using Cronbach’s alpha. Cronbach’s alpha provides an estimate of how all items relate to other test items and to the total test items (Mills & Gay, 2016). The recommended value of the statistical significance level of the correlation coefficient is 0.70 or higher if the reliability is guaranteed. Furthermore, Cohen, Manion and Morrison (2011) state that this reliability over a sample is particularly useful in piloting tests and questionnaires in a quantitative study, hence this was the case in this study. By using the SPSS (Statistical Package for Social Sciences), the Cronbach’s alpha of the questionnaire (0.78) was found to be less than the statistical value, hence the questionnaire items were to be relied on. In addition, learners had access to view them at any time using the PC they were provided by the researcher. This was done to increase chances of accessibility.

**3.10 Data analysis**

Through comparing the scores of the two groups, this study employed both descriptive and inferential statistics. Frequency counts were used as part of the descriptive statistics to determine the number of participants in the study and to determine the number of participants that agreed or disagreed with a statement in the questionnaire. The responses that indicated strongly agree and agree were added together to denote that learners had agreed on the particular statement while responses that indicated strongly disagree and disagree were added to denote that learners had disagreed on the particular statement. These were presented in percentages.

The inferential statistics employed the following tests: Kolmogorov-Smirnov test, Mann Whitney U test, and an independent T-test. Cronbach alpha was used to determine the reliability of instruments at 5% (0.05) significance level. Furthermore, the Kolmogorov-Smirnov test was used to test for normality of data (Shier, 2004). Results from Kolmogorov-Smirnov test indicated that pre-test results for both groups (i. e. control group and experimental group) were not normally distributed (p-value = 0.01 and p-value = 0.003 < 0.05) respectively. Thus, Mann-Whitney U test was opted for to determine the significance difference, which is a non-parametric test, and does not depend on the normality assumption. The result of this test indicated that there is no difference in performance of these two groups $p = 0.669$, $p > 0.05$, in prior knowledge, hence it is interpreted that the two groups are equal in terms of the knowledge that learners hold and therefore further analysis could be performed.

Furthermore, the inter-group comparison was made to compare the post-test results of the learners in both groups, to determine whether the use of videos had an effect on the learners' performance. An independent T-test was used as an inferential statistic to compare the mean scores of the two groups after an intervention. To compare the performance of the two groups, a T-test was run as the test for normality indicating that data were normally distributed (p-value = 0.250 and $\propto$=0.05, respectively, Table 5). Results of the test indicated p-value = 0.026, which was less than $\propto$= 0.05. The null hypothesis was rejected; hence it was found that learners who were taught Geometry using videos performed better than those who were taught using traditional or conventional ways of teaching. Lastly, Pearson Chi-square ($\chi^2$) was used to determine whether there is a relationship between learners' performance and their views.

### 3.11 Ethical considerations

The researcher sought for permission to conduct this study from the following offices: Centre for Research and Publications (UNAM) and then the Ministry of Education, Arts and Culture (MoEAC). In turn, the school principals of the schools involved were informed of this study through a letter prior to the start of the study. After entering the research site, the participants were fully informed about the objectives, risks and potential rewards of the research. The participants' parents were asked to give consent to allow learners to participate in the study (see Appendix F). They were further informed that participation in this study was voluntary, and no learner would be punished if they decided not to partake in the study. Furthermore, they were informed that they would be allowed to comfortably withdraw from the study at any time without a penalty, if need be. The information that the participants provided was kept strictly confidential in the researcher's Personal Computer, with the password only known to the researcher. The data will be kept safely for two years before being destroyed by deleting the file with the data from the computer. Participants’ expectations and rights to privacy and confidentiality were honored.

### 3.12 Conclusion

This chapter presented the type of research design used in the study. It also tackled on sampling procedures, research instruments and how data were analysed. Issues of validity and reliability were also addressed through a pilot study. This chapter also discussed ethical issues related to data collection and procedures. The next chapter presents detailed results of the present study.

# CHAPTER 4: PRESENTATION OF RESULTS AND DISCUSSIONS

## 4.1 Introduction

This chapter presents the results as well as discussion of the findings of this study. Firstly, the descriptive statistics of the learners are presented by giving an overview of the groups' characteristics. Secondly, inferential statistics results are presented to give the comparative analysis between the two groups and within the experimental group, thereby showing answers to the research hypothesis. Thirdly, results on learners' views towards educational video use and the relationship between learners' performance are presented in view of the second research question. Lastly, the findings are presented and discussed to give meanings to the context of this study.

## 4.2 Descriptive statistics of the study groups

Two study groups were used in this study, namely, the experimental group and the control group, referred to as school A and school B respectively.

**Table 5: Descriptive statistics of the learners in the Experimental group and the Control group**

| School | Number of learners | Boys | Girls |
|---|---|---|---|
| School A | 39 | 18 | 21 |
| School B | 34 | 15 | 19 |
| Total | 73 | 33 | 40 |

This study consisted of 73 learners that formed part of the sample (Table 5). Of this sample 39 learners were enrolled in the experimental group (school A), with 18 boys and 21 girls. Similarly, School B (control group) had 34 learners, with 15 boys and 19 girls. This formed a total of 73 learners that participated in this study, consisting of 33 boys and 40 girls.

## 4.3 Presentation of results

### 4.3.1 Normality of data

A test of normality was conducted to assess whether the data are normally distributed before running any statistical test on the pre-test and post-test data (Mills & Gay, 2016). This was necessary as it allows the researcher to determine which statistical tests to use on the data, whether parametric or non- parametric tests. The test for normality of this study was assessed using Kolmogorov-Smirnov Test. This test verifies that a sample comes from a population with a known distribution, such as a normal distribution, and the sample is drawn from the population by the process of random sampling, at significance level $\alpha = 0.05$ (Sarantakos, 2007).

The following hypotheses were used to test for normality:

*$H_0$: The test scores are normally distributed.*

*$H_1$: The test scores are not normally distributed.*

There are several methods of assessing whether data are normally distributed or not. They fall into two categories: graphical and statistical method (see Figure 5).

The result of the normality test for this study are by using the two categories are presented below:

#### *4.3.1.1 Graphical method*

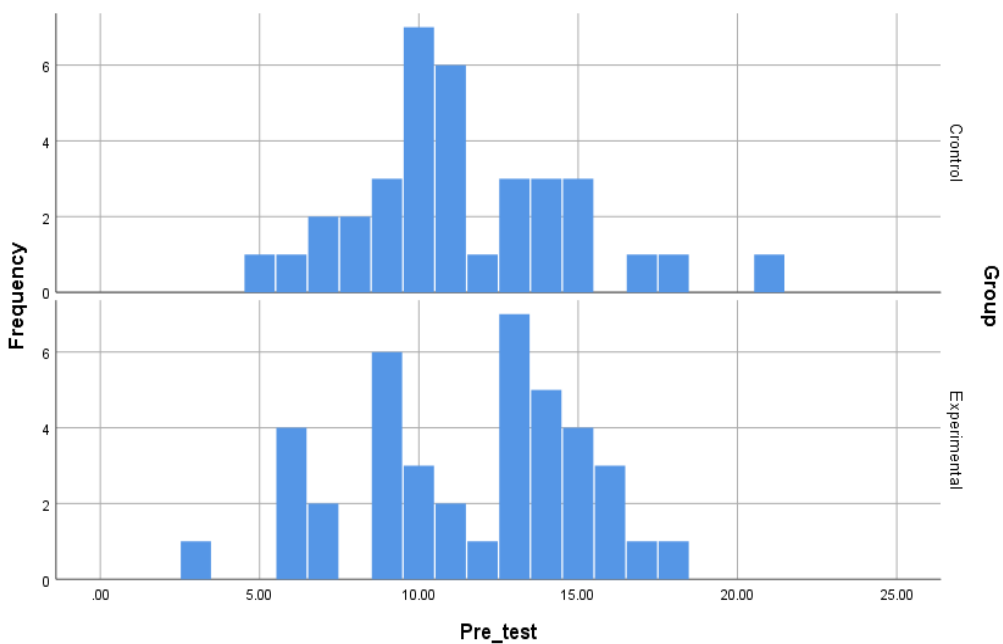



**Figure 5: Distribution of pre-test Geometry results for grade 11 learners**

From Figure 5, it appears that the pre-knowledge in Geometry does not differ among learners for both the control and experimental groups. Also, the distribution of results for both groups seems to follow a normal distribution. In addition, the post-test results were also tested if they are normally distributed.

Figure 6 below illustrates the distribution of the post-test data.

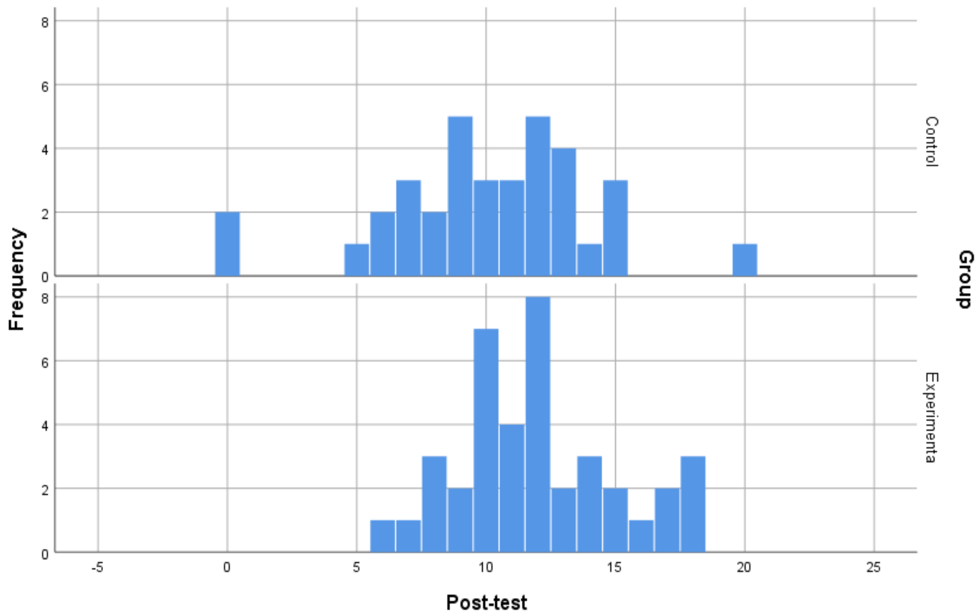



**Figure 6: Distribution of post-test Geometry results for grade 11 learners**

Figure 6 gives the impression that post-test results are not normally distributed. Moreover, it can also be noted that most learners in the control group scored less than 10, whereas many learners from the experimental group scored more than 10. In addition, the mean and the standard deviation of the scores were also determined. The table below illustrates the results.

**Table 6: Mean and standard deviation of the scores**

| Tests | Groups | N | Mean | Std. deviation |
|---|---|---|---|---|
| Pre-test | Control | 34 | 11.37 | 3.422 |
| | Experimental | 39 | 11.58 | 3.608 |
| Post-test | Control | 34 | 10.09 | 4.010 |
| | Experimental | 39 | 11.68 | 3.398 |

Table 6 presents the mean scores and the standard deviation of the pre-test and the post-test of both groups. The mean shows the average scores for each group by comparing the outcome mean of the tests. From Table 6, the pre-test mean score of the control and the experimental group was 11.37 and 11.58 respectively. Also, the post-test mean score of the control and the experimental group was 10.09 and 11.68 respectively. This shows that the range of the post-test mean scores (1.59) was greater than that of the pre-test mean scores (0.21), indicating that the post-test mean scores were more spread from one another than the pre-test (greater range) after the intervention. On the same note, the standard deviation shows how the scores deviated from the mean. A low standard deviation indicates that most scores are close to the mean, while a high standard deviation indicates that most scores are far from the mean. The results of this study show that the pre-test scores of the control deviated with 3.422 from the mean, and on the experimental group the standard deviation was at 3.608 away from the mean. This means that the control group pre-test scores were closer to the mean than the experimental group pre-test scores. Furthermore, on the post-test, the control group had a standard deviation of 4.010 scores away from the mean and a standard deviation of 3.398 scores away from the mean. A low standard deviation was obtained in the post-test. This implies that most scores were closer to the mean in the post-test as compared to the pre-test scores. The data were also analyzed using inferential statistic to test for normality. The inferential method used was as follows:

#### 4.3.1.2 Inferential statistics

With this method, an analytical test was carried out to determine whether the tests are normally distributed. The Kolmogorov-Smirnov test was used as an analytical test to test for normality of data (Shier, 2004). Table 7 illustrates the results of the Kolmogorov-Smirnov test.

**Table 7: Tests for Normality of pre-test and post-test scores**

| | Groups | Total | Test statistic | Asymptotic Sig (2-tailed) |
|---|---|---|---|---|
| Pre-test scores | Control | 34 | .172 | .010 |
| | Experimental | 39 | .179 | .003 |
| Post-test scores | Control | 34 | .108 | .200 |
| | Experimental | 39 | .139 | .050 |

Table 7 shows the test of normality of learners' achievement in Geometry, which was done at significance level 0.05. From the Kolmogorov-Smirnov test result, the results of the pre-test show that for the control group the p-value acquired was 0.010 while for the experimental group, the p-value = 0.03 was obtained. It was found that the pre-test results for both groups (i. e. control group and experimental group) were not normally distributed (p-value: 0.01 and 0.003, respectively, which is less than the significance value ($\propto = 0.05$). Thus, Mann-Whitney U test was used to compare the mean value of the pre-test scores. The Whitney U test is a non-parametric test and hence it does not depend on the normality assumption (DeCoster, 2006). Furthermore, the normality of test for post-test results was also determined using Kolmogorov-Smirnov test. The normality of test reveals that the results of the control (p-value = 0.200) and the experimental group (p-value = 0.050) were normally distributed. Since the p-value > $\propto$ (0.05), this shows that there was no statistically significant difference between the groups' post-test scores. Therefore, it can be concluded that the sample of achievement tests does not come from a normally distributed population. Hence, the Whitney U test, a non-parametric test was used.

### 4.3.2 Comparison of prior knowledge in Geometry between learners in the Control group versus the Experimental group

The homogeneity of the groups was done to determine whether the prior knowledge of the learners was at the same level. This was done in order to avoid the effects of technology being masked by other factors that include prior knowledge; hence, a pre-test to assess the prior knowledge of learners in Geometry was given to the learners. An ideal test to compare two groups is a T-test (DeCoster, 2006). However, this test relies on the assumption that data are normally distributed. The result of this test indicated that there is no difference in the performance of these two group (p-value =0.669, Table 8) as follows.

**Table 8: Mann Whitney U test**

| Independent Mann- Whitney U Test | | |
|---|---|---|
| Null Hypothesis | *Sig.* | *Decision* |
| The distribution of the pre-test is the same across categories | .669 | Retain the null hypothesis |

Table 8 shows the outcome of the Independent Mann-Whitney U Test that was run on the pre-test scores of the experimental and the control group. This was done to determine whether the learners had the same level of knowledge before the Geometry test. The results indicate that the prior knowledge of the learners was the same. The p-value obtained was 0.669 which is greater than the significant value ($\propto$ =0.05). Hence, the null hypothesis was not rejected.

### 4.3.3 Inter-group comparisons of the Control and Experimental groups post-test results

The inter-group comparison was made to compare the post-test results of the learners in both groups. This was done to determine whether the use of videos influenced the learners' performance. The table below indicates the mean and the standard deviation of the two groups in respect to post-test data.

**Table 9: Mean and standard deviations**

| Group Statistics | | | | | |
|---|---|---|---|---|---|
| | Group | N | Mean | Std. Deviation | Std. Error Mean |
| Post-test | Control | 35 | 10.09 | 4.010 | .678 |
| | Experimental | 39 | 11. 97 | 3.099 | .496 |

Table 9 above indicates the mean and the standard deviation of the two groups of post-test results. The results indicate that the mean of the control group is 10.09, whereas the mean of the experimental group is 11.97. Since the experimental group mean score was greater than that of the control group, this shows that the experimental group scored high marks than the control group in the test. On the same note, the standard deviation of the control group is 4.010 and for the experimental group it is 3.099. A low standard deviation was obtained in the post-test of the experimental group, which indicates that most scores were closer to the mean in the experimental group as compared to the control group. In addition, in order to determine whether a significant difference existed between the post-test scores of the control as well as the experimental group, the following hypothesis was tested:

$H_0$: *There is no significant difference between the performance of learners who were taught Geometry using educational videos and those taught using 'chalk and talk' methods.*

*($H_0$: µControl = µExperimental).*

$H_1$: *There is a significant difference between the performances of learners who were taught Geometry using educational videos and those taught using traditional methods.*

*($H_1$: µControl ≠ µExperimental).*

Table 10 indicates independent T-test results of the groups to determine whether there was a significant difference between the two groups in the post-test scores.

**Table 10: Independent Samples T-test: experimental and control group post-test scores**

| | | **Levene's Test for Equality of Variances** | | **T-test for equality of Means** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *F* | *Sig.* | *t* | *Df* | *Sig. (2-tailed)* | *Mean difference* | *Std error difference* |
| *Post-test* | *Equal variances assumed* | 1.347 | .250 | -2.279 | 72 | 0.026 | -1.889 | .829 |
| | *Equal variances not assumed* | | | -2.248 | 63.813 | 0.028 | -1.889 | .840 |

Table 10 shows the independent T-test results for the post-test on Geometry topics with the degree of freedom, $df$ = 72, p-value = 0.027 for Levene's test is less than $\propto$ = 0.05). This indicates that the variances are unequal in both groups. Since the p-value is 0.028, it can be concluded that the performance for the two groups is different.

The learners in the experimental group were taught Geometry with the aid of video technology whereas the traditional method of teaching was used in the control group. Thereafter, an independent test was given to both groups. To compare the performance of the two groups, a T-test was run as the test for normality indicating that data were normally distributed with p-value = 0.250 and $\propto$ = 0.05) respectively, (Table 9). It was found that learners who were taught Geometry using videos performed better than those who were taught using traditional or conventional ways (p-value = 0.026, $p < 0.05$). Therefore, results of this study indicate that the use of videos had a significant impact on grade 11 learners' performance in Geometry.

The results of this study agree with several researchers such as Gambari et al. (2016); Harwood and McMahon (1997); Kok (n.d.) and Osokoya (2007). These studies found a significant difference when videos were shown. Statistically, a study carried in California revealed that learners who received the video enhanced instruction scored significantly higher than those who were not exposed to any intervention (Harwood & McMahon, 1997). The significance level of Harwood and McMahon's (1997) study was at $F = 24.04$, $p < .01$, hence the two groups were significantly different. In another study, learners taught with the video-taped instruction scored significantly higher than learners taught with the ‘chalk and talk’ method of teaching (Osokoya, 2007). The study adopted the quasi-experimental research design using video-taped instruction and conventional strategies. The mean score of $\bar{x}$ =25.30 and $\bar{x}$ = 20.12 were obtained in favour of the experimental group learners. The great achievement was reportedly due to the use of videos. The study by Osokoya (2007) was done in History but the result findings can be generalised to other subjects like Mathematics.

In another study conducted in Nigeria, learners taught using videos performed better than the colleagues taught in a conventional teaching method in Mathematics (Gambari et al., 2016). Similarly, this study adopted a quasi-experimental design. The treatment for the study was that the researcher developed video type instructional packages on the trigonometry concept. A validated TRAT was used for data collection; administered as a pre-test and as a post-test. Data obtained were analysed using ANCOVA and Sidak Post-hoc test. The results revealed that there is a significant difference in the mean achievement score of learners taught Mathematics using video type instructional packages. The video type instructional packages had an average mean gain scores of $\bar{x}$ = 37.43, while the traditional method had the least mean gain scores of $\bar{x}$ = 21.67. This shows that all the groups benefited but with the video package having the highest post-test performance mean. This information was relevant as the experimental group learners in Gambari et al. (2016) used researcher designed videos in Mathematics, likewise that was the case in the present study. However, these results disagreed with Perry’s (2013) study, where it was indicated that showing videos with direct instruction may not necessarily produce significant gains in the achievement for learners in secondary school science (Biology) classes. An independent T-test was used to test for significance of the data and reported no significant difference, after comparing the post assessment scores $p = 0.791$, with a significance level of 0.05. Since $p > 0.05$, the null hypothesis was not rejected. Examples of literature from other subjects provided above were used as a backup of this study, the reason being that literature in Mathematics education especially using educational videos is still minimal. Furthermore, literature on subjects like Biology are part and parcel of Science subjects, of which Mathematics is no exemption, hence findings of these studies can as well be applied in a Mathematics context, to a Mathematics class.

Section 4.3.4 that follows highlights learners' views towards the use of educational videos.

### 4.3.4 Learners' views towards the use of educational videos

Learners' views towards the use of educational videos were determined to ascertain to what extent learners liked to be taught Geometry using videos. The views of the learners were determined using a closed-ended questionnaire. There were 14 items in the questionnaire categorised into three parts: 1) usefulness of videos; 2) learning environment; and 3) learning experiences (see Appendix). The results are presented in bar graphs, indicating percentages of learners' responses and compared to the literature accordingly.

*4.3.4.1 Usefulness of videos*

Learners were asked to indicate their views about the use of videos in the classroom. On the usefulness, learners were asked to determine their views on excitement, engagement and interest. Furthermore, learners were asked to state whether videos helped increasing learners' achievement, and if they had enjoyed the lessons.

The results of the learners' responses on the usefulness of videos are indicated in the Figure 7.

**Perceptions of learners on 'igniting excitement'**

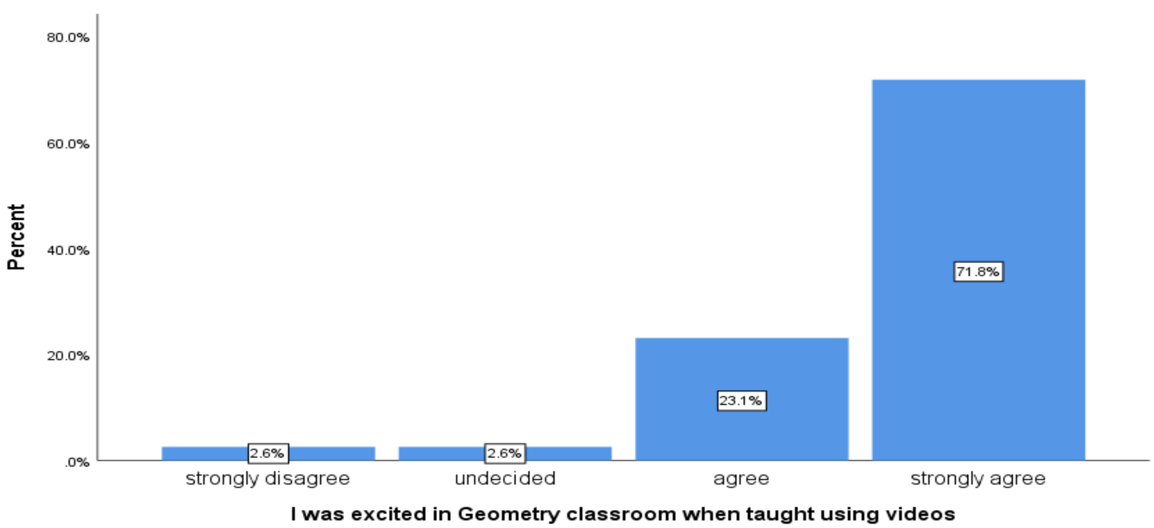



**Figure 7: Perceptions of learners on 'igniting excitement**

The graph above (Figure 3) indicates that 94.9% of the learners were excited in the classroom about the use of videos. Meanwhile, 5.2% of the learners disagree, with 2.6% being unsure.

**Perceptions of learners on lessons engagement**

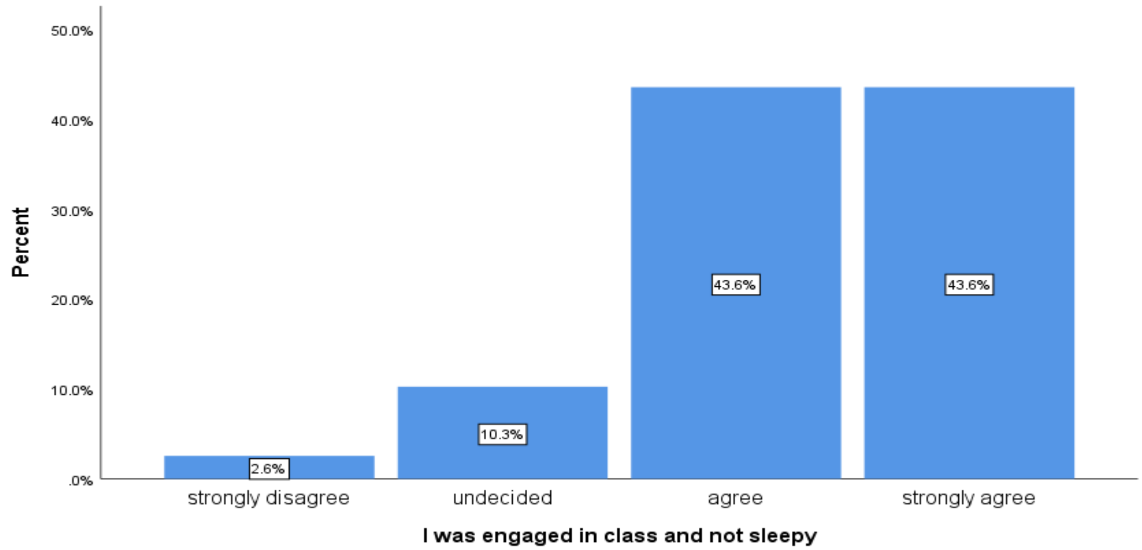



**Figure 8: Perceptions of learners on lessons engagement**

Figure 8 indicates that 87.2% of the learners agree and strongly agree that they were engaged in the classroom, whereas, 10.3% were undecided and the rest strongly disagree.

**Perceptions of learners on interest in lessons**

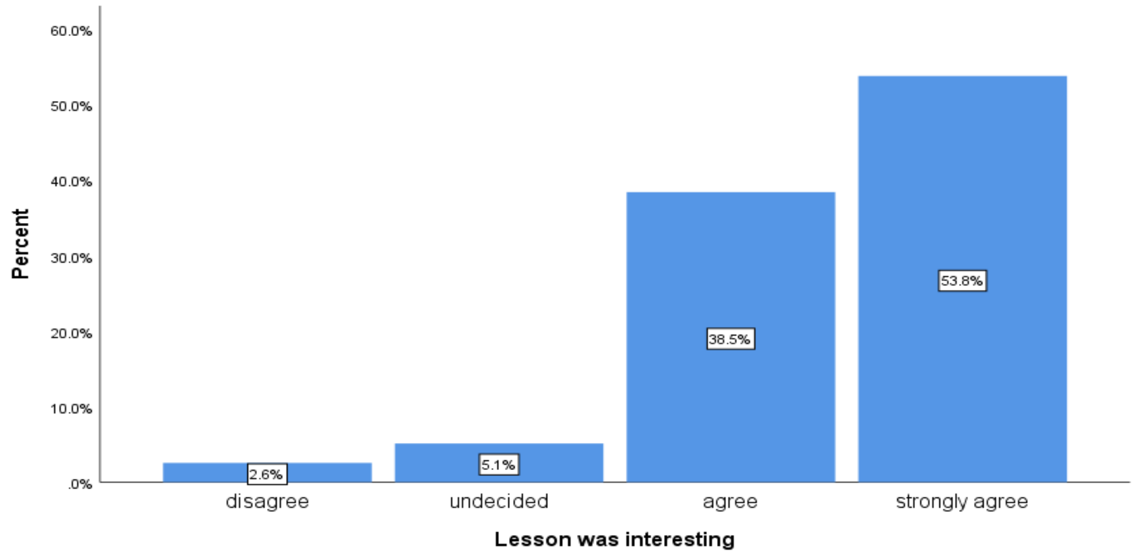



**Figure 9: Perceptions of learners on interest in lessons**

Figure 9 indicates that 53.8% strongly agree that the lesson was interesting, while 38.5% agree. However, 2.6% of the learners believed videos were not interesting to them and 5.1% were undecided.

**Perceptions of learners on increased achievement**

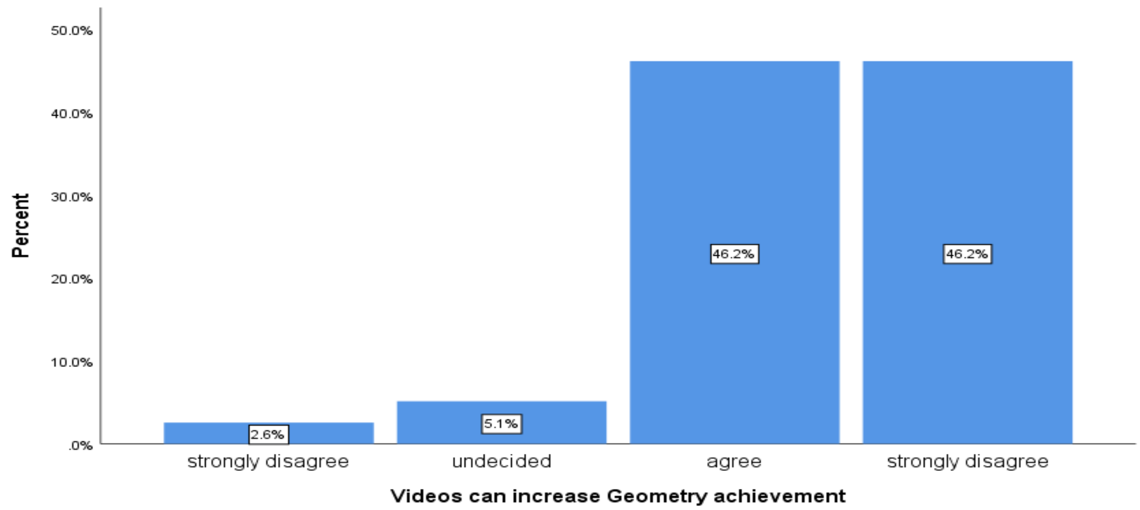



**Figure 10: Perceptions of learners on increased achievement**

Figure 10 shows that most learners (92.4%) indicated that learning from videos could increase their Mathematics achievement. The rest of the learners strongly disagree and are undecided.

**Perceptions of learners on lesson delivery mode**

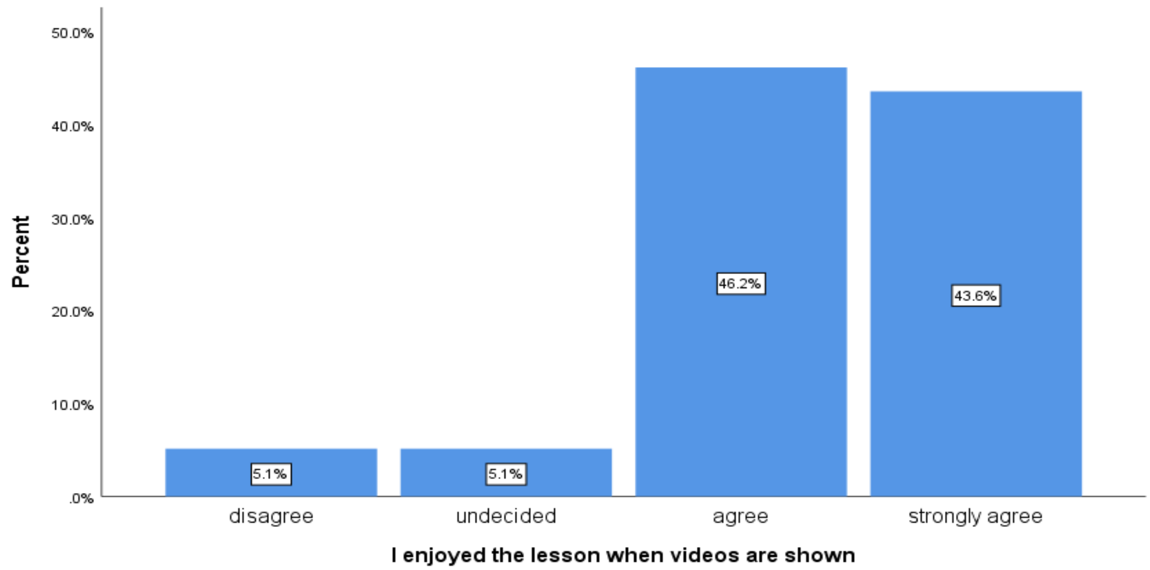



**Figure 11: Perceptions of learners on lesson delivery mode**

Figure 11 indicates that 89.8% of the learners agree and strongly agree that they enjoyed the lesson when videos were shown. Less than a quarter of the learners (10.2%) disagree. This indicates that learners enjoyed learning Mathematics much more when taught using videos.

The results indicate that 94.9% of the learners were excited in the classroom about the use of videos. Moreover, 87.2% of the learners agree and strongly agree that they were engaged, 92.3% agreed that the lesson was interesting and 92.4% of the videos will increase achievement and 89.8% of learners agree that they enjoyed the lesson. Generally, these results indicate that the video were useful (91.2%). This study finding is supported by Huang et al. (2009) who stress that among multimedia learning materials, video is the learners' most favourite as it blends in many multimedia resources, like text, images, sound and speech; hence, this leads to the learners being excited in the classroom. Furthermore, Stockwell et al. (2015) and Perry (2013) indicated that video use may add value for learner preparation in a Mathematics classroom because learners may find the lesson more engaging than in a typical lecture. Similarly, Eady and Lockyer (2013), and Ayinde (1997) second this finding by stating that videos have a potential in stimulating interest. Furthermore, Akpabio (2004) commented that videos are viewed as a potential window that can expose the minds and heart of many learners to modern practices and environmental concepts, far more than what the traditional classroom teaching can achieve. Moreover, Anston (n.d.) claims that using representations such as educational video clips in teaching and learning led to higher standards of performance in Mathematics.

#### *4.3.4.2 Learning environment*

Learners in this study were asked to determine if they have found the classroom environment supportive and conducive for learning. Learning environment refers to the contexts in which learners learn (The Glossary of Education Reform, 2014). A good learning environment is interactive and engaging. In this study, the learning environment tested for learners' freedom in class, accessibility to the videos and teacher support. Learners' responses on the learning environment are reported as follow.

**Perceptions on learners' freedom**

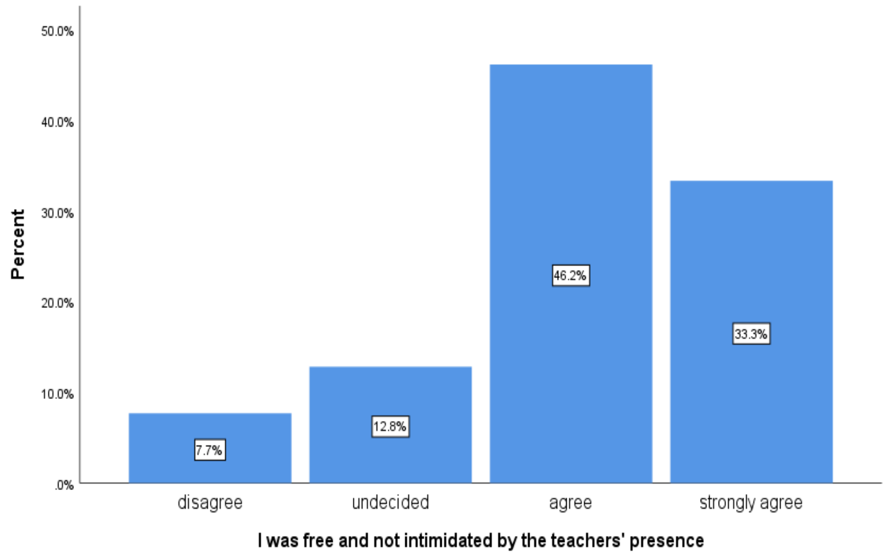



**Figure 12: Perceptions on learners' freedom**

The bar graph above (Figure 12) indicates that 79.5% of the learners agreed that they were free in the classroom and not intimidated by the teacher's presence. A total of 21% of learners were either unsure or totally disagreed with the question.

**Perception of learners on accessibility**

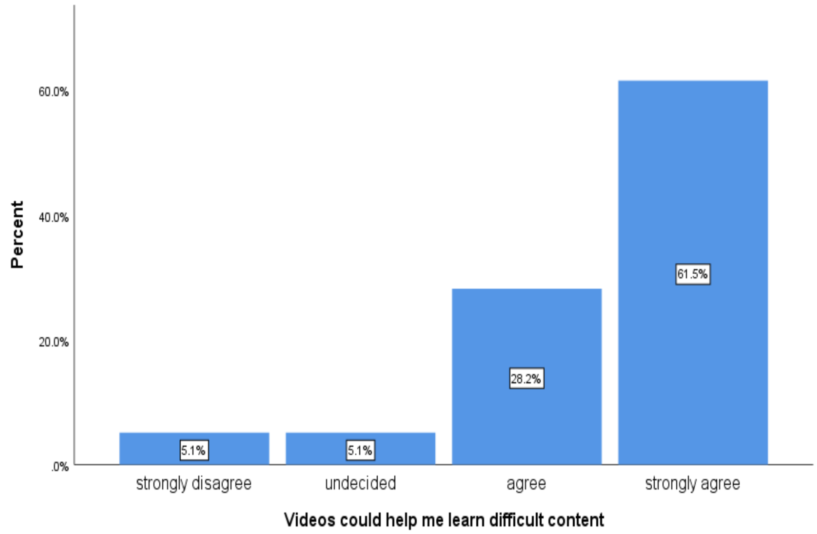



**Figure 13: Perception of learners on accessibility**

Figure 13 above shows that 61.5% of learners strongly agreed that they had access to the videos and 28.2% agreed. This gives a total of 89.7%. However, 5.1% of the learners strongly disagreed and another 5.1% were undecided.

The results on the learning environment indicate that 79.5% agreed that they had freedom in the classroom, and they were not intimidated by the teacher's presence. Furthermore, 89.7% of the learners agreed that they had access to videos, and this could enable them to learn difficult content at any point in time. As a result, a total of 84.6% was obtained, indicating a good learning environment.

According to the literature, these findings are supported by De Boer (2013) who indicated that videos which are pre-recorded files, and which are usually publicly available can be made available to the learners at any time, hence they can be viewed at a speed and time that is convenient to the learners. Also, this idea is supported by Bransford, Brown and Cocking (2000) who argued that videos used in the classroom help learners to learn if properly used by being able to re-visit and review the material as many times as possible. Furthermore, Kok (n.d.) found that learners who used videos felt the provision of real-world examples of mathematical concepts, and by so doing, videos helped the learners to understand the ideas being taught to them in the classroom. The interpretation of these responses from the learners is that videos made it possible to contextualize mathematical concepts in ways that would be very difficult to achieve without the use of technology like videos.

*4.3.4.3 Learning experiences*

Learners were further asked to share their learning experiences after video use. Learning experience refers to any interaction and the experiences learners attained in the classroom, in which learning takes place (The Glossary of Education Reform, 2013). Learning experiences is built around principles and practices that expressly ensure that the learning journey is enjoyable, engaging, relevant, and informative. The construct assessed was the variable on the retrieval of content, making connections to real life situations and knowledge. Furthermore, learners were asked using questionnaire to state if they would like lessons to be presented using Geometry soon. The results are presented in bar graphs below.

**Perceptions of learners on content recalling**

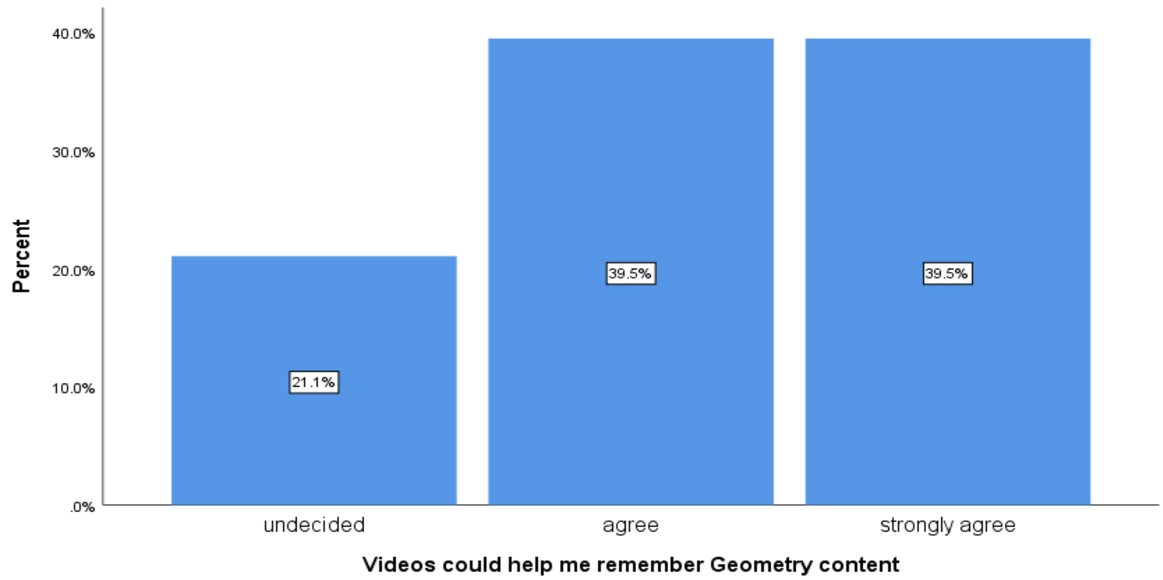



**Figure 14: Perceptions of learners on content recalling**

Figure 14 shows that 79% of learners indicated that videos could help them remember the content, of which 39.5% of them agreed and another 39.5% of the learners strongly agreed. None of the learners strongly disagreed with the statement whilst 21.1% of the learners were uncertain.

**Perceptions of learners on connections with real life situations**

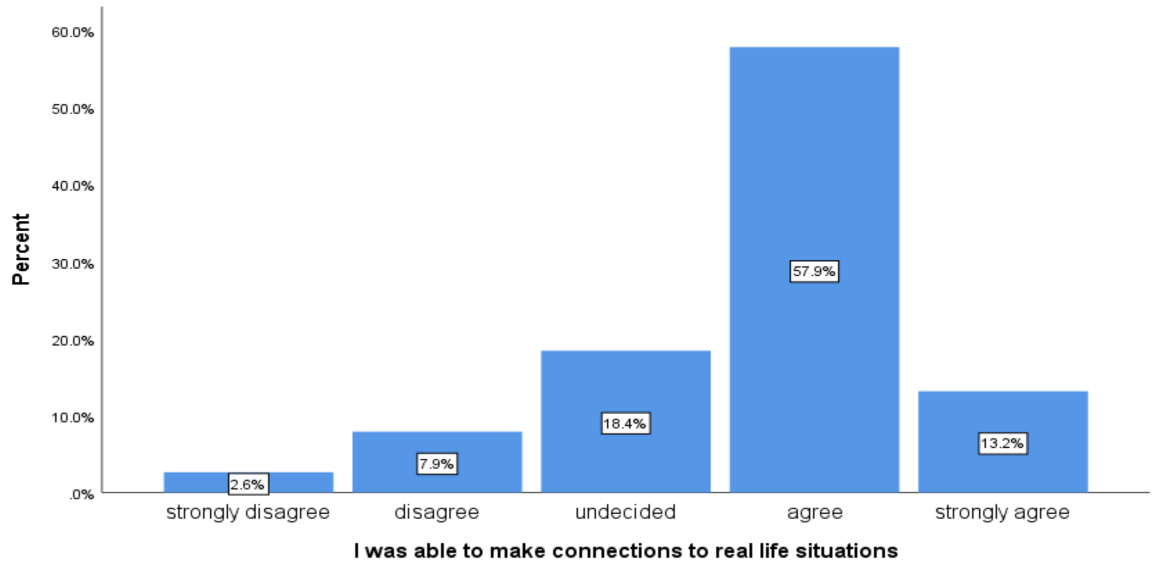



**Figure 15: Perceptions of learners on connections with real life situations**

Figure 15 indicates that 71.1% of the learners were able to make connections and the rest of the learners were either undecided (18.4%) or disagreed (10.5%).

**Perceptions of learners on Angle properties an easy topic after video use**

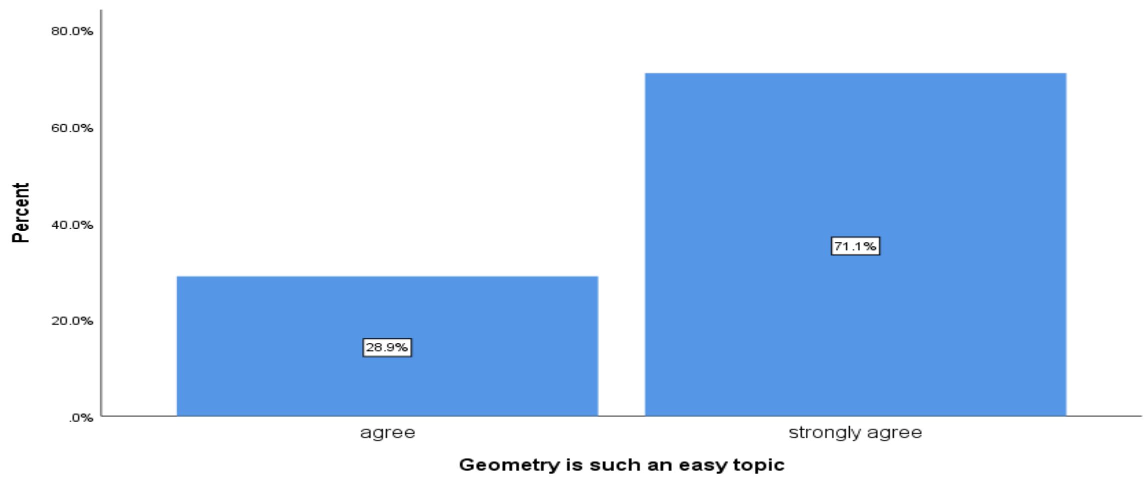



**Figure 16: Perceptions of learners on Angle properties an easy topic after video use**

Figure 16 indicates that all learners (100%) agreed and strongly agreed that 'Angle properties' is an easy topic after being exposed to videos.

**Perceptions of learners on wanting to be taught using videos**

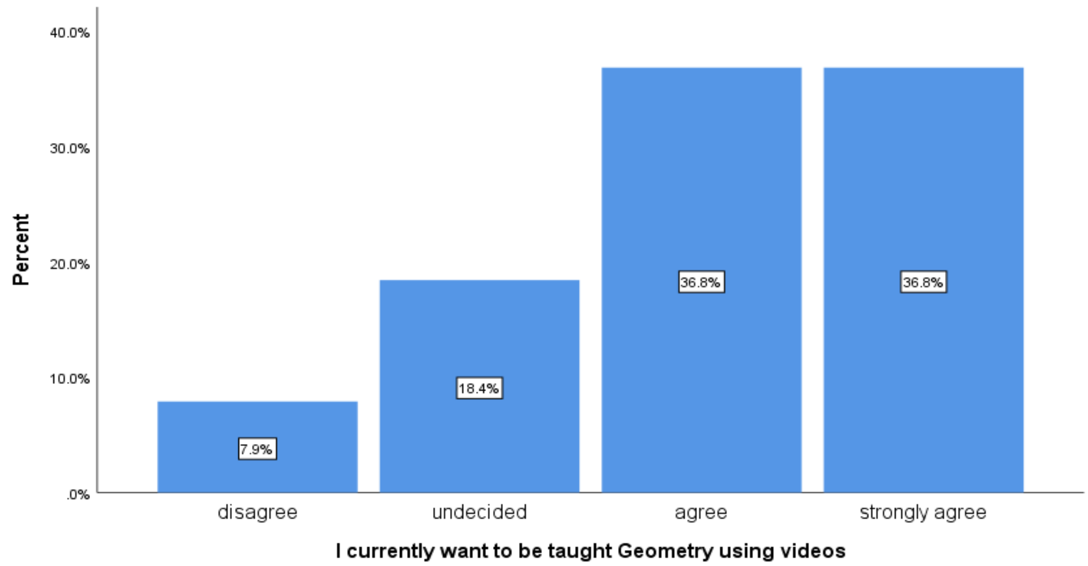



**Figure 17: Perceptions of learners on wanting to be taught using videos**

From Figure 17 above, 73.9% of the learners (36.8% agree + 36.8% strongly agree) indicated that they currently want to be taught Angle properties using educational videos (of which 36.8% of the learners strongly agreed and another half of 36.8% agreed to the statement). About 18.4% of the learners were undecided and it is only 7.9% of the learners that disagreed completely with the statement. Although these learners have previously indicated that Geometry is such an easy topic (Fig. 16) when shown the videos, this did not make them to deviate from their usual way of being taught Geometry using videos as 7.9% of the learners disagreed completely.

**Recommendations on the use of videos**

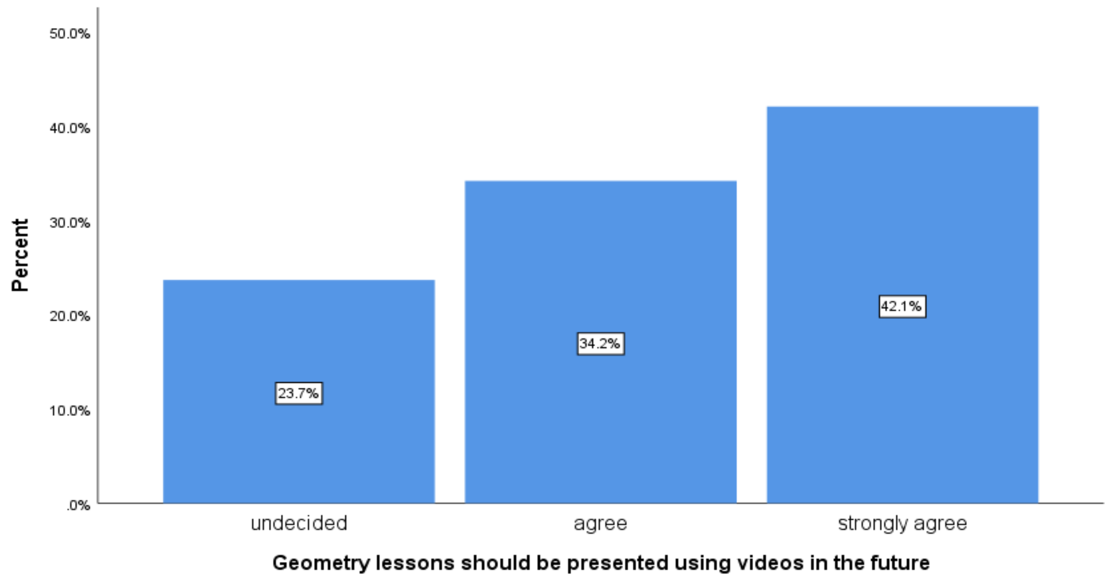



**Figure 18: Recommendations on the use videos**

Figure 18 indicates that 34.2% and 42.1% of the learners agree and strongly agree respectively that Geometry lessons should be presented using videos in the future. However, 23.7% of the learners were undecided of which some the learners could still agree and disagree. None of the learners disagreed.

**Perceptions of learners on video use**

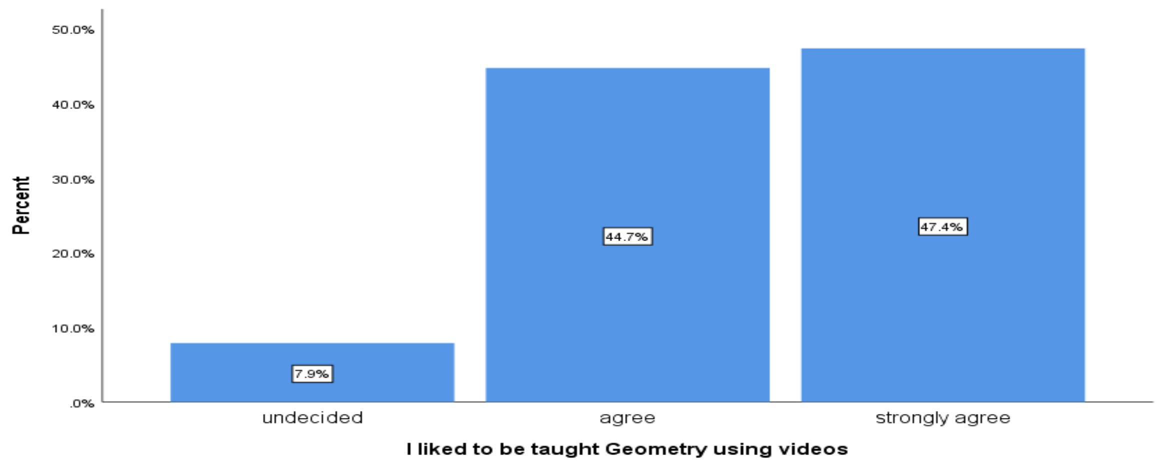



**Figure 19: Perceptions of learners on video use**

Figure 19 shows that 47.4% of the learners strongly agree that they liked to be taught Geometry using the videos and 44.7% agree. This gives a total of 92.1% of learners in agreement to the perception and 7.9% were not sure with the impression that videos bring to the classroom.

**Perceptions of learners' ability to learn at own pace**

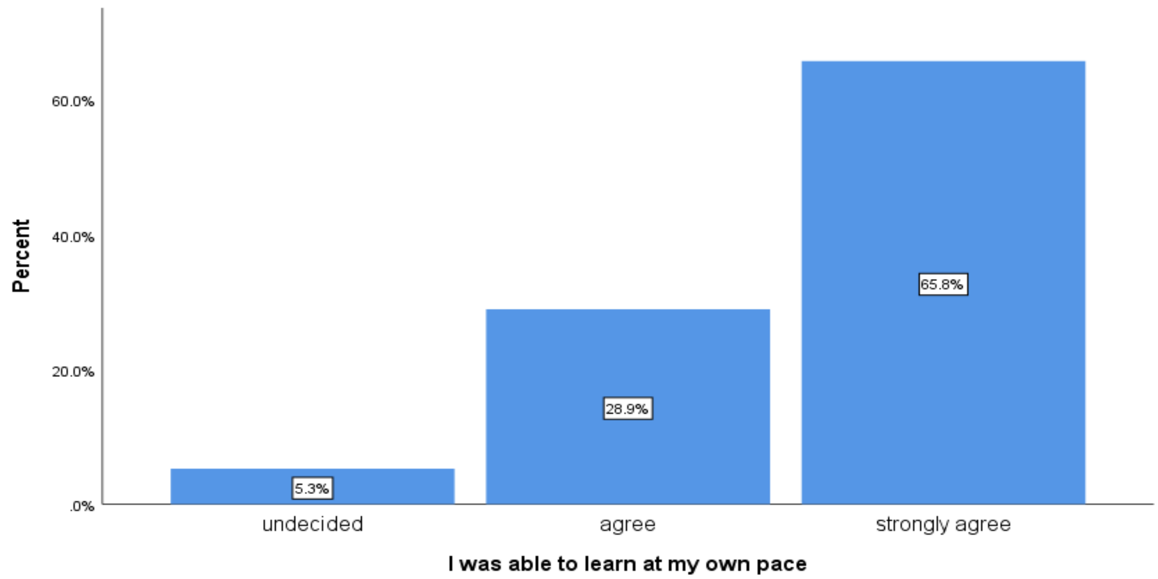



**Figure 20: Perceptions of learners' ability to learn at own pace**

From Figure 20, the graph indicates that 94.7% of the learners were able to learn at their own pace. About 5.3% of the learners were unsure whether they learned at their own pace or not.

Results on the learning experiences of learners indicate that 79% of participants stated that videos could help them recall the content, whereas 71.1% of the learners specified that they were able to make connections of what was learnt to real life situations. Moreover, 100% of learners agreed that after being taught with videos, the learners felt that Geometry is an easy topic, while 73.9% want to be taught Geometry using educational videos. Furthermore, results indicate that 76.3% of the learners recommended that Geometry lessons should be presented using videos soon and this leads to 92.1% of learners that agreed to having liked the videos as 94.7% of the learners were able to learn at their own pace. These results indicated that (83.9%) have agreed to have achieved relevant and enjoyable learning experiences.

After learners were taught using videos, learners indicated that Geometry was such an easy topic. From literature, videos are said to simplify abstract concepts like Geometry (Mudaly, 2014; George & Sandes, 2017) and multimedia technology allows for mathematical learning difficulties to be overcome. Furthermore, Perry (2013) notes that the video on its own does not enhance performance but it should rather be accompanied by an instruction. Additionally, Akpabio (2004) maintains that videos can expose the minds and heart of many learners to modern practices and environmental concepts, far more than what the traditional classroom teaching can achieve. Hence videos can be used in the formal school system for teaching and learning in a rich and entertaining manner. Woolfitt (2015) cautions that videos have to be well organised so that they can measure what they are supposed to measure. Furthermore, De Boer (2014), Kanandjebo (2017) and Marshall (2002) recommend the use of technology in the classroom as technology improves learners' Mathematics test scores.

### 4.3.5 The relationship between performance and opinions expressed by learners

A test of the relationship between the Geometry performance of the learners and learners' views was determined. Pearson chi-square test was conducted to determine whether there exists a significant association between learners' performance and learners' views that were expressed about educational videos. Tests of relationships between performance (measured as failure or pass) was done on each of the 14 items in the questionnaire. The Geometry post-test mark scores were measured as a 'Pass or a Fail'. A pass was recorded on any learner with a mark ≥13 and a mark <13 was considered as a fail. The test totalled 25 marks.

A Pearson chi-square test was performed at 0.05 level of significance and the results are presented in Table 11 below.

**Table 11: $\chi^2$ test (Pearson) results**

| **Learners' views** | **Performance (p-value)** | **Relationship** |
|---|---|---|
| *1. Learners excited about the use of videos* | 0.203 | ✗ |
| *2. Learners engagement in class* | 0.249 | ✗ |
| *3. Lesson interesting and fun* | 0.219 | ✗ |
| *4. Videos increasing Mathematics achievement* | 0.422 | ✗ |
| *5. Learners enjoyed the lesson* | 0.191 | ✗ |
| *6. Learners' free and not intimidated by the teachers' presence* | 0.854 | ✗ |
| *7. Educational videos could learners to learn difficult content* | 0.512 | ✗ |
| *8. Videos helping learners to remember content easily* | 0.371 | ✗ |

| **Learners' views** | **Performance (p-value)** | **Relationship** |
|---|---|---|
| *9. Learners able to make connections to real life situations* | 0.767 | ✗ |
| *10. Geometry such an easy topic after learning from videos* | 0.609 | ✗ |
| *11. Learners want to be taught Mathematics using videos* | 0.184 | ✗ |
| *12. Mathematics lessons presented using educational videos soon* | 0.225 | ✗ |
| *13. Learners liked to be taught Geometry using educational videos* | 0.489 | ✗ |
| *14. Learners were able to pause, rewind and forward the educational videos* | 0.427 | ✗ |

**Key**: ✓ *There is a relationship between learners' views and Geometry performance*

✗ *No relationship between learners' views and Geometry performance*

From Table 11, $\chi^2$ (Pearson) results indicated that in all 14 questions, there was no statistically significant relationship between opinions expressed by the learners and their Geometry performance. In all instances, the p-value was greater than the statistically significant value ($p > 0.05$). This implies that the null hypothesis was not rejected. This indicates that learners' performance whether passed Geometry test or not, it has not influenced the learner's opinions about being taught Geometry using educational videos.

These results contradict Nketiah-Amponsah et al.'s (2017) study results. Nketiah-Amponsah et al. (2017) conducted a cross-sectional survey among 320 final year undergraduate students at the University of Professional Studies, Accra, Ghana, on the views of the student teachers at the college. The ordinary least square was employed to estimate the effect of ICT on academic performance. The study showed a positive and statistically significant relationship between some selected ICT tools and applications for learning and academic performance.

#### 4.3.4.4 Summary of the results

The analysis of data has shown that learners who responded with strongly agree and agree to the statements had the highest percentage compared to other responses. The results revealed that most learners possess positive attitudes towards the use of educational videos, with learners receiving the most percentage on videos being able to simplify abstract concepts and 100% of them indicated that they agree and strongly agree. From the results it can be concluded that the use of educational videos can increase learners' interest, confidence and their motivation when taught Angle properties in Geometry. The study revealed that learners had a positive attitude towards video use (91.3%), a good learning environment (84.6%) and relevant and enjoyable learning experiences (83.9%). Kanandjebo's (2017) study found that 70.8% of the experimental group held a positive perception towards ICT use in a Mathematics classroom. Thus, learners are strongly encouraged to use technology like videos in the teaching of Angle properties to enhance performance in Geometry.

## 4.4 Conclusion

This study investigated the effects of teacher-designed videos on Grade 11 learners' Geometry performance. A T-test was used to compare the mean scores of the two groups after the intervention. The independent T-test results for the post-test on p-value = 0.026, indicates that the variances are unequal in both groups. Since the p-value = 0.026 $p < 0.05$, the null hypothesis was not accepted, hence there is a significance performance difference between the two groups. The chi-square tests for relationships between performance and opinions expressed by learners for each of the 14 items were conducted. In all instances it was shown $p > 0.05$, which implies that the null hypothesis was not rejected. Hence, there were no relationships found between performance and opinions expressed by learners for each of the14 items that were conducted. This may imply that whether a learner passed Geometry or not, it has not influenced the learners' opinions about being taught Geometry using educational videos.

# CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter highlights the study background and summarizes the research processes. Furthermore, it presents and discusses the research findings of this study. Conclusions and recommendations based on the findings are also presented. The recommendations outline possible actions that teachers and policy makers can take as well as possible areas for further research.

## 5.2 Summary of the research processes

The study investigated the effects of teacher-designed educational videos on Grade 11 learners' Geometry performance in Oshikoto Education Region, Namibia. Over the years, Mathematics performance has been reportedly poor (DNEA, 2008 – 2017), of which Geometry has been identified as one of the difficult topics for learners in Namibia. Kapenda (2008), Ngololo, Howie and Plomp (2012), Ploesser (2016), and Kanandjebo (2016) recommended a need for developing classroom related ICT resources, such as specific software for Science subject teaching, assessment tools and mounting a portal with specific-based activities. Geometry being a conceptually demanding Mathematics requires innovative approaches on how it is being taught; there is no single best practice and no simple formula on how it should be taught. This study therefore aimed to seek interventions in which Geometry learning could be enhanced to improve Mathematics results.

The following research questions and hypothesis guided the compilation for the current study:

1. What is the effect of Teacher-Designed educational videos on Grade 11 learners' Geometry performance?
2. What are views of learners in the experimental group on the use of videos?

Strategically, this study tested the following hypothesis: to determine whether there is a significance difference between learners taught with videos and those who are not. An embedded mixed method research design was adopted using a non-equivalent pre-test-post-test quasi experimental design and a survey. This design was used to collect quantitative data through pre-test and post-test; and a small amount of qualitative data through a questionnaire on learners' views on the use of educational videos. For this study, two secondary schools in Oshikoto Education Region formed a population of 440 learners and in total 73 learners formed the sample. The school with a computer lab was purposively assigned as the experimental group (School A) and the other school without a computer lab as the control group (School B). These two schools were selected on the basis that they have the same level of performance. At each school, one Grade 11 class was randomly assigned to form a sample; as a result, two Grade 11 classes from two different schools formed a sample of this study.

The researcher developed educational videos for the transmission of Geometry content on angle properties. The videos were 10 – 16 minutes long and contained content on angle properties. The videos portrayed texts, diagrams, symbols, animations and sound and they were pre-loaded into Personal Computers (PC) for the learners to view. The videos were used as the treatment instrument of the study for the experimental group. During the teaching process, the experimental group learners watched, listened and read from the video as the lesson progressed. This was done during class time for one (1) hour per day for a period of two weeks. One video per lesson was watched by the learners at the beginning of the lesson during the first 20 minutes. Thereafter, the teacher facilitated the lesson and the learners completed the classwork. On the other hand, the control group was taught using the traditional way of teaching, the 'chalk and talk' method of instruction only. All groups received the same class notes as well as the same class activities and homework. Thereafter, the learners received a post-test to test if there is any improvement in performance after the learners were taught using different methods of teaching. A survey was administered to the experimental group at the end of the study, after the post-test. Learners were asked to rate how much they agreed with each statement by circling a number (1 - 5) on a Likert scale (where a 1 means strongly disagree and a 5 is strongly agree) to measure learners' views. Furthermore, Pearson Chi-square test (x^2) was used to test for the significant association between learners' views towards videos use versus their performance categories (measured as a pass or fail) in the Geometry post-test.

## 5.3 Summary of the research findings

At the beginning of the study, all learners were given a pre-test to determine the pre-knowledge of the learners. The results of the pre-test indicated that the pre-knowledge of the learners was at the same level. The pre-test mean score of the control and the experimental group was 11.37 and 11.58 respectively. A Kolmogorov-Smirnov test was used to test for normality of data of the pre-test data, which indicated that the control group and experimental group data were not normally distributed (p-value = 0.01 and p-value = 0.003) respectively. As a result, a non-parametric test (Mann-Whitney U test) was opted for to determine the significance difference. The result of the test indicated no difference in performance of these two groups ($p = 0.668$) in prior knowledge, hence the pre-knowledge of the two groups was equal. In addition, a T-test was used to compare the mean scores of the two groups after the intervention. The Levenes' test result (independent sample T-test) showed that the experimental and the control group were different ($F = 1.347$, $p <0.027$) less than $\alpha$ (0.05). The independent T-test results for the post-test on p-value = 0.026, $p < 0.05$. Since the p-value = 0.026 < 0.05, it can be concluded that the performance for the two groups is different. Thus, learners who were taught Geometry using videos performed better than those who were taught using traditional or conventional ways of teaching. The post-test results of this study are in agreement with Gambari et al. (2016), and Harwood and McMahon (1997). These studies found a significant difference in leaners' performance when videos were shown. Gambari et al. (2016) found a significant difference in the mean achievement score of learners taught Mathematics using videos with $p = 0.000 < 0.05$. Furthermore, Harwood and McMahon (1997) reported that learners who received the video enhanced instruction scored significantly higher than those who were not exposed to any intervention at $F = 24.04$, $p < .01$. Furthermore, the survey results revealed that the learners had a positive attitude towards video use with most learners indicating more percentages on strongly agree and agree (70%). This finding is like Kanadjebo (20l6) that 70.8% of the experimental group held a positive perception towards ICT driven pedagogy.

Lastly, Pearson Chi-square results indicated that there was no statistically significant relationship between opinions expressed by the learners and their Geometry performance. In all 14 cases there was p-value > 0.05 (see Section 4.2.6, Table 6). This indicates that whether the learners passed the Geometry post-test or not, it did not influence the learners' opinions about being taught Geometry using educational videos. Though the results of the survey did not show statistically significant results, learners in general liked watching videos in class. If learners are more engaged and more motivated to learn, then achievement is likely to increase. If attitude and performance are improved, then video use in classrooms would be supported (Perry, 2013). When learners have a more positive attitude towards class and the content learned, then achievement can follow.

## 5.4 Reflection

As stated in Chapter 2, the conceptual framework adopted for this study recognises learners as active constructors of mathematical knowledge; and their experiential world is necessary for consideration in teaching. As a teacher, one as has to ensure that learning happens meaningfully and smoothly. Kapenda (2008) recommends that teachers should be encouraged to use a variety of teaching and learning media that stimulate learners' interest. The Cognitive Theory of Multimedia Learning was therefore adapted for use in this study. The theory assumes that learners who meaningfully interact with the multimedia information encode the information into their long-term memory for later use. Eady and Lockyer (2013) also argue that digital learning resources and computer software can be used to facilitate the learning processes visually and verbally.

Having assessed the learners, the results of this study support the view that multimedia can improve learners' performance in Geometry when integrated into the lesson by the teacher (see Section, 2.8). The difference in learners' performance in angle properties is explained in Figure 21.

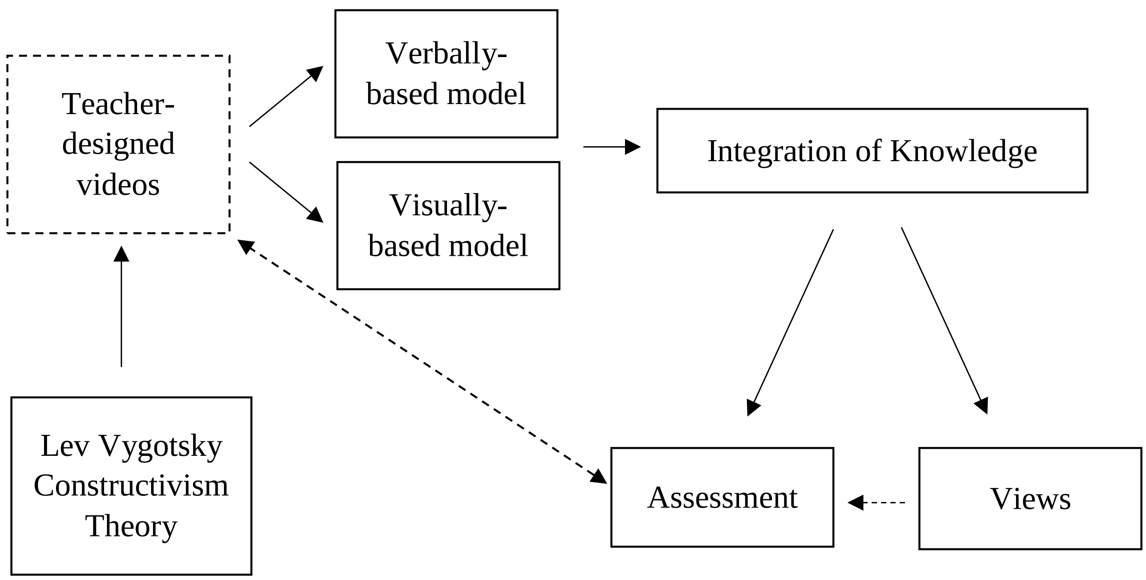



**Figure 21: The adapted conceptual framework of this study**

Figure 21 above represents a conceptual framework of this study, guided by Mayers' Cognitive Theory of Multimedia Learning of 1997. Meaningful interaction can involve learning activities within the digital media, in this case teacher-designed videos. The designed videos contain both the text and verbal mode of which information is processed simultaneously to enhance the integration of knowledge. The learners' performance was then determined using the post-test as well as their views towards the designed videos but necessary to make social judgements, behaviours and decision making (Kanadjebo, 2016). From the study results presented, the Geometry performance of the learners does not influence their views towards video use. However, most learners liked to be taught with videos, hence this study advocates for teachers to integrate teacher-designed videos in their classrooms.

## 5.5 Conclusion

This study investigated the effects of teacher-designed videos on Geometry performance in the OER. The results indicate an increase in performance among learners taught Geometry using videos, hence this study concludes on the following:

- The use of educational videos might improve learners’ performance in Mathematics. Therefore, the learning and teaching of Mathematics should not be focused on purely traditional methods of teaching but should employ a variety of learning approaches that involve the use of teaching aids that are proven to help stimulate learners' interest in Mathematics.
- The use of educational videos can increase learners’ interest, engagement and creativity in learning Geometry.
- The performance of the learners in Geometry did not influence their views towards the use of educational videos to like or dislike the videos. Hence there is no relationship between the views of the learners and learners’ performance categories.

## 5.6 Recommendations

Based on the findings, the following recommendations were identified with regards to the current study:

**Learners**

- Although resources and infrastructures remain hindering factors in developing countries, it is recommended that learners use ICTs in learning Angle Properties in Geometry. Specifically, teacher-designed videos should be used to arouse interest, engagement and creativity in teaching Geometry. Also, the use of videos might promote meaningful learning and motivation and consequently improve performance in Angle Properties.

**Researchers**

- The study recommends that future researchers need to consider in-depth qualitative studies such as classroom observations and in-depth interviews to investigate the effects of teacher-designed videos on learners' performance.
- Furthermore, this study calls for more research to be done in ICT, especially in educational videos in the Namibian context as literature is very limited.

## 5.7 Possible areas for further research

The researcher suggests the following for further research:

1. This study was limited to learners from OER only and therefore there is need to replicate the study in other regions of the country. Such studies may consider changing the population and the sampling procedures for better representation of the population and data collection methods as utilised in the present study. A larger sample could produce more reliable and valid results; hence the better the sample, the more reliable the data.
2. Another study can be carried out to investigate the effects of researcher-designed educational videos versus You-tube educational videos on (Geometry) the performance of learners in Mathematics at secondary grade.

**REFERENCES**

Akerele J. A. & Adeola F. A. (2012). Effect of video on the teaching of library studies among undergraduates in Adeyemi College of Education, Ondo Library Philosophy and Practice 2012. Retrieved from http://unllib.unl.edu/LPP/

Akpabio, E. (2004). Nigerian home video films as a catalyst for Nigerian development. Journal of Sustainable Development, 1(1), 5-10.

Alaku, P.O. (1998). Instructional strategies and audio-visual aids for teacher effectiveness. Bichi Journal of Education, 2(1), 114-117.

Ali, I., Bhagawati, S., & Sarmah, N. (2014). Performance of Geometry among the secondary school students of Bhurbandha CD Block of Morigaon District, Assam, India. International Journal of Innovative Research and Development, 3(11), 73 – 77.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: a proposed system and its control processes. Retrived from https://pdfs.semanticscholar.org/5e32/b2242241de92d6f20fd315c2bebc1f251cb7.pdf.

Ayinde, A.T. (1997). Resources for effective teaching and learning of Agricultural science. Bichi Journal of Education and Planning, 1(1), 6-8.

Baggett, P. (1984). Role of temporal overlap of visual and auditory material informing dual media associations. Journal of Educational Psychology, 76(3), 408–417.

Bal-Gezegina, B. (2014). An investigation of using video vs. audio for teaching vocabulary. Procedia - Social and Behavioral Sciences, 143(2014), 450 – 457.

Best, J. W., & Kahn, J. M. (2006). *Research in education*. (10th ed.). New York, NY: Pearson Education, Inc.

Berk, R. A. (2009). Multimedia teaching with video clips: TV, movies, YouTube, and mtvU in the college classroom. *International Journal of Technology in Teaching and Learning, 5*(1), 1–21.

Bottge, B. A., & Hasselbring, T. S. (1993). A comparison of two approaches for teaching complex, authentic Mathematics. Exceptional Children. *Academic Research Library* 59(6), 556-566. Retrieved from https://www.researchgate.net/profile/Brian_Bottge/publication/14680589.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn; Brain, mind, experience and school.* Washington, DC: National Academy Press.

Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. Nashville, MA: Center for Teaching and Department of Biological Sciences.

Bryman, A. (1993). Quantity and quality in social research: Contemporary social research: Ontarion, Canada: Routledge.

Choi, H. J., & Johnson, S. D. (2005). The effect of context-based video instruction on learning and motivation in online courses. *The American Journal of Distance Education*, *19*(4), 215–227.

Choi, H. M., & Yang, M. (2011). The effect of problem-based video instruction on student satisfaction, empathy, and learning achievement in the Korean teacher education context. *High Educational*, *62*,551–561.

Clarine, B. (2016). *11 reasons why video is better than any other medium.* Retrieved from https://www.advancedwebranking.com/blog/11-reasons-why-video-is-better/

Clements, D. H. & Battista, M. T. (1992). Geometry and spatial reasoning. In D. A. Grouws (Ed.), *Handbook on mathematics teaching and learning* (pp. 420-464). New York, NY:  Macmillan.

Cobb, P. (1984). An Exchange: Constructivism in Mathematics and Science Education. *Educational Researcher, 23*(7), 4. Retrieved from http://www.jstor.org/stable/1176932

Cohen, L., Manion, L., & Morrison, K. (2011). Research Methods in education, (7th ed.). Canada: Routledge.

Cresswell, J. W. (2014). Research design: Qualitative, quantitative and mixed method approaches. Sage publications: London.

De Boer, J. (2013). *Learning from video: viewing behavior of students*. Retrieved from https://research.hanze.nl/ws/portalfiles/portal/10366905/ProefschriftJelle_deBoer_1_.pdf.

DeCoster, J. (2006). Testing group differences using T-tests, ANOVA, and Nonparametric Measures. Retrieved from http://www.stat-help.com/ANOVA%202006-01-11.pdf

Denscombe, M. (2014). *The good research guide for small scale social research*. New York, NY: Bell and Bain Ltd.

Diezmann, C. M., & Watters, J. J. (2002). *A theoretical framework for multimedia resources: A case from science education*. In Proceedings Australian Association for Research in Education Conference, Brisbane.

DNEA. (2014). *Examiner's report: Mathematics NSSC core and extended examinations*. Windhoek: DNEA.

DNEA. (2015). *Examiner's report: Mathematics NSSC core and extended examinations*. Windhoek: DNEA.

DNEA. (2016). *Examiner's report: Mathematics NSSC core and extended examinations*. Windhoek: DNEA.

Dobbins, A., Gagnon, J.C., & Ulrich, T. (2014). *Teaching Geometry to Students with Math difficulties using graduated and peer-mediated instruction in a response-to-Intervention Model, preventing school failure: Alternative education for children and youth, 58:1*, 17-25, DOI: 10.1080/1045988X.2012.743454

Duruji, M., Azuh, D., Segun, J., Olanrewaju, I. P., & Okorie, U. (2014). *Teaching method and assimilation of students in tertiary institutions: A study of Covenant University*. Nigeria Proceedings of EDULEARN14 Conference 7th-9th July 2014, Barcelona, Spain.

Eady, M. J., & Lockyer, L. (2013). *Tools for learning: technology and teaching strategies*. Retrieved from http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1413&context=asdpapers

Eick, C., & King Jr., D. T. (2012). Non-science majors' perceptions on the use of YouTube video to support learning in an Integrated Science lecture. *Journal of College Science Teaching*, *42*(1), 26-30.

Esperanza, G., Medina, V., & Valdés, L. M. (2014). Dynamic models as change enablers in educational Mathematics. *Procedia-Social and Behavioral Sciences*, 176, 923–926.

Fischbein, E., & Nachlieli, T. (1998). Concepts and figures in geometrical reasoning. *International Journal of Science Education*, *20*(10), 1193–1211.

Gambari, I. A., Yaki, A. A., Gana, E. S., & Ughovwa, Q. E. (2014). Improving secondary school student's achievement in Biology through video-based multimedia instruction. *A journal of Scholarly Teaching*, 9, 78 - 91.

Gambari, A. I., Tajudeen, S. A., Olutunu, D. F., & Adeyi, J. M. (2016). Effects of video instructional packages on achievement of senior secondary schools students in Mathematics in Minna, Nigeria. *ATBU Journal of Science, Technology and Education*, *4*(2), 179–196. Retrieved from http://www.atbuftejoste.com/index.php/joste/article/view/222

Gay, L, R., Mills, G, E. & Airasian, P. (2011). *Educational research: Competencies for analysis and applications.* (10th ed.). New York: Pearson Education, Inc.

George, A., & Sanders, M. (2017). Evaluating the potential of teacher-designed technology-based tasks for meaningful learning: Identifying needs for professional development. *Education and Information Technologies*, *22*(6), 2871–2895. https://doi.org/10.1007/s10639-017-9609-y

Guo P J., Kim J., Robin R. (2014). *How video production affects student engagement: an empirical study of MOOC videos.* L@S'14 Proceedings of the First ACM Conference on Learning at Scale (pp. 41–50). New York, NY: ACM.

Gutierrez, A., & Boere, P. (2006). *Handbook of research on the psychology of Mathematics education, past, present and future*, 273-304. Retrieved from https://www.sensepublishers.com/media/457-handbook-of-research-on-the-psychology-of-mathematics-educationa.pdf.

Hamilton, E., Kapenda, L., Miranda, H., & Ngololo, E. (In press). *Sub-Saharan STEM Teacher Professional Development with Digital Ink: Follow-up,* in *Inspiring Students through Digital Ink: Impact of Pen and Touch Technology on Education*, M.P. Tracy Hammond, & Anna Stepanova (editors), Springer.

Hamilton, E., Kapenda, L., Mbasu, Z., Miranda, H., Ngololo, E., Ogwel, J.C., Sarmanpol, S., & Stern D. (2016). A Model and research agenda for teacher and student collaboration using Pen-Based Tablets in Digital Media Making in Sub-Saharan Africa. In: Hammond T., Valentine S., Adler A. (eds) *Revolutionizing Education with Digital Ink. Human–Computer Interaction Series*. Springer, International Publishing.

Harwood, W. S., & McMahon, M. M. (1997). Effects of integrated video media on student achievement and attitudes in high school chemistry. *Journal of Research in Science Teaching*, 34, 617-631.

Herron, C., Morris, M., Secules, T., & Curtis, L. (1995). A comparison study of the effects of video-based versus text-based instruction in the Foreign Language Classroom. *French Review* 68, 775-795.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371–404). Charlotte, NC: Information Age Publishing.

Hooper, S., & Rieber, L.P. (1995). *Teaching with technology*. In A. Ornstein (Ed.), Teaching: Theory into practice, pp. 154-170. Neeham Heights: Allyn & Bacon.

Howie S. J., & Blignaut, A. S. (2009). South Africa's readiness to integrate ICT into Mathematics and Science pedagogy in secondary schools. *Education and Information Technologies. 14,* 345 – 363 Retrieved from https://www.researchgate.net/publication/225362702

Howie, S. J., Muller, A., & Paterson, A. (2005). Information and communication technologies in South African secondary schools. Cape Town, RSA: SITES HSRC Press.

Hwang, W-Y., Lin, L-K., Ochirbat, A., Shih, T. K., & Kumara, W. G. C. W. (2015). Ubiquitous Geometry: Measuring authentic surroundings to support Geometry Learning of the Sixth-Grade students. *Journal of Educational Computing Research*, *52*(1), 26–49.

Inan, F., & Lowther, D. (2010). Laptops in the K-12classrooms: Exploring factors impacting instructional use. *Computers and Education*, 55(3), 937-944.

Retrieved http://essentialconditionswiki.pbworks.com/w/file/fetch/61204860/Article%20for%20technology.pdf.

Jones, K. (2002). *Issues in the teaching and learning of Geometry*. *In: L. Haggarty (Ed), Aspects of Teaching Secondary Mathematics: perspectives on practice.* (London, Routledge), pp.121-139. ISBN: 0-415-26641-6.

Kanandjebo, L. N. (2017). *Effects of Information and Communication Technology (ICT)-driven Pedagogy on performance of Grade 12 Geometry Ordinary Level learners in the Omusati Educational Region, Namibia.* Unpublished Master thesis. University of Namibia, Windhoek.

Kankaanranta, M. (2009). National policies and practices on ICT in education: Finland. In T. Plomp, R. E. Anderson, N. Law, and A. Quale. *Cross-national information and communication technology: Policies and practices in education. A volume in research in educational policy: Local, and global perspectives* (pp. 135-152). Charlotte, NC: Information Age Publishing.

Kapenda, H. M. (2008). *Translating policy into practice: Aspects of learner-centred classroom practices in Mathematics in Namibia*. (Doctoral thesis, University of the Western Cape, Cape Town, RSA). Retrieved from https://etd.uwc.ac.za/bitstream/handle/11394/3645/Kapenda_PHD_2008.pdf?sequence=1&isAllowed=y.

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computer Human Behaviour*, 28, 820–831.

Kay, R., & Kletskin, I. (2012). Evaluating the use of problem-based video podcasts to teach Mathematics in Higher Education. *Computers & Education*, *59*(2), 619-627.

Kgabi. N., & Tyobeka, E. (2013). Namibia's performance in Mathematics and Physical Science: Implications for technical skills. *Multidisciplinary Research Journal*, *3*(1), 1-8.

Kok, Y, H. (n.d.). *A research on case studies on the use of video-based instruction for the teaching and learning of mathematics*. Retrieved from https://pdfs.semanticscholar.org/f2a3/b6e0c397af82bb35cd8588bd8981fa25391f.pdf.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research*, *61*(2), 179 – 211.

Krishnasamy, H. N., Veloo, A., & Hooi, N. (2013). Perception of teachers towards media usage in teaching Mathematics in secondary schools. *Procedia - Social and Behavioral Sciences*, 112(2014), 1093 – 1098.

Lee, Y.Y., Cheon, J., & Key, S. (2008). Learners' perceptions of video games for Second/Foreign language learning. In K. McFerrin, R. Weber, R. Carlsen & D. Willis (Eds.), *Proceedings of SITE 2008--Society for Information Technology & Teacher Education International Conference* (pp. 1733-1738). Las Vegas, Nevada: Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/p/27445/.

Losby, J., & Wetmore, A. (2012). *CDC Coffee Break: Using Likert scales in evaluation survey work.* Retrieved http://www.cdc.gov/dhdsp/pubs/docs/cb_february_14_2012.pdf.

Mamali, N. R. (2015). *Enhancement of learners' performance in Geometry at secondary schools in the Vhembe district of the Limpopo province*. (Master thesis, University of Venda, RSA). Retrieved from http://univendspace.univen.ac.za/bitstream/handle/11602/730/Dissertation%20-%20Mamali%2C%20n.%20r.-.pdf?sequence=1&isAllowed=y.

Marshall, J.M. (2002). *Learning with technology: Evidence that technology can, and does, support learning.* White paper prepared for Cable in the Classroom. Downloaded from http://www.medialit.org/sites/default/files/545_CICReportLearningwithTechnology.pdf.

Mateer, G, D., Ghent, L, S., Poter, T., & Purdon, R. (2014). Using media to enhance teaching and learning. Pedagogy in Action. Downloaded from http://serc.carleton.edu/sp/library/media/index.html.

Mayberry, J. (1983). The van Hiele levels of geometric thought in undergraduate pre-service teachers. *Journal of Research in Mathematics Education*, 14, 58-69.

Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist*, 32(1), 1-19.

Mayer, R. E. (2002). *Psychology of learning and motivation. Cognitive Theory of Multimedia Learning*. University of California: Santa Barbara.

Mayer, R.E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational psychologist*, 38, 43 – 52.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R.E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press.

Mayer, R. E., & Johnson, C. (2008). Revising the redundancy principle in multimedia learning. *Journal of Educational Psychology, 100,* 380-386.

Mayer, R. E. (2009). Multimedia learning (2nd ed). New York: Cambridge University Press.

Meaningful vs Rote learning (2007). *The difference between meaningful and rote learning*. Retrieved from https://www.oxfordlearning.com/difference-rote-learning-meaningful-learning/.

Mejia-Ramos, J. P., Fuller, E., Weber, K., & Rhoads, K., & Samkoff, A. (2011). An assessment model for proof comprehension in undergraduate Mathematics. *Education Student Mathematics, 79,* 3–18. DOI 10.1007/s10649-011-9349-7

McKenney, S., Kali, Y., Markauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: An ecological framework for investigating assets and needs. *Instructional Science*. DOI: 10.1007/s11251-014-9337-2

Merkt, M., Weigand, S., Heier, A., & Schwan, S. (2011). Learning with videos vs. lerning from print: The role of interactive features. *Learning and Instruction, 21*(2011), 687-704.

Midgett, C. W., & Eddins, S. K. (2001). NCTM's Principles and Standards for School Mathematics: Implications for administrators. *Math and Science education, 89*(623), 35–42. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.911.8561&rep=rep1&type=pdf.

Mills, G. E., & Gay, L. R. (2016). *Educational Research: Competencies for Analysis and Applications*. (11th Ed). England: Pearson Education Ltd.

Ministry of Education. (2006). *National ICT policy implementation Plan*. Windhoek: Ministry of Education.

Morgan, C., Watson, A. (2002). The interpretative nature of teachers' assessment of students' Mathematics: issues for equity. *Journal for Research in Mathematics Education, 3*(2), 78–110. Retrieved from https://s3.amazonaws.com/academia.edu.documents/36596295/JRME2002-03-78a.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1542723513&Signature=Sjp%2Bwz2nEPa7XQQsUwAjbvJHCO8%3D&response-content-disposition=inline%3B%20filename%3DThe_Teacher_As_Examiner_the_Case_of_Math.pdf.

Mudaly, V. (2014). A visualization-based semiotic analysis of learners' conceptual understanding of graphical functional relationships. *African Journal of Research in Mathematics Science and Technology Education, 18*(1), 3 – 13.

Muyeghu, A. (2008). *The use of the van Hiele theory in investigating teaching strategies used by Grade 10 Geometry teachers in Namibia.* (Master thesis, Rhodes University, Grahamstown, RSA). Downloaded from https://core.ac.uk/download/pdf/145046033.pdf.

Nambira, G., Kapenda, L., Tjipueja, G., & Sichombe, B. (2009). *Performance of Learners in Mathematics at Upper Primary Phase in Namibia: Examining Reasons for Low performances.* Professional and Resource Development Research Unit, NIED, MoE: Okahandja.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

Neuman, W. L. (2009). *Understanding research*. Pearson Education, Inc.: United States of America.

Ng, W., & Gunstone, R. (2003). Science and computer-based technologies: Attitudes of secondary science teachers. *Research in Science and Technological Education, 21*(2), 243-264.

Ngololo, E.N. (2011). *An evaluation of the implementation of ICT Policy for Education in rural Namibian schools*. Doctoral Thesis, University of Pretoria, RSA.

Ngololo, E. N., Howie, S. J., & Plomp, T. (2012). An evaluation of the implementation of the National ICT Policy for Education in Namibian rural science classrooms. *African Journal of Research in MST Education, 16*(1), 4–17.

Nikopoulou-Smyrni, P., & Nikopoulos, C. (2010). Evaluating the impact of video-based versus traditional lectures on student learning. *International Research Journals, 1*(8) 304 - 311.

Nketiah-Amponsah, E., Asamoah, M.K., Allassani, W., & Aziale, L. K. (2017) Examining students' experience with the use of some selected ICT devices and applications for learning and their effect on academic performance. *Journal of Computers in Education, 4*(4), 441 – 460. Retrieved from https://doi.org/10.1007/s40692-017-0089-2

Osamah, A. M., Fong, S. F., & Ziad, A, W. (2010). Effects of multimedia-based instructional designs for Arabic language learning among pupils of different achievement levels. *International journal of social, behavioral, educational, economic, business and industrial engineering, 4*(3), 267-273. Retrieved from https://pdfs.semanticscholar.org/c2a9/1ddcaad0829cd0b2d4d75709498fc6f7c233.pdf.

Osokoya, I. O. (2007). Effects of video-taped instruction on secondary school students' achievement in History. *International Journal of African & African American Studies*, *vi*(1), 26 – 34.

Oshikoto Education Directorate. (2017). Performance of schools in top order: NSSCO Mathematics results (performance of achievement in qualified passes, A* - C).

Ozerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *International Journal of New Trends in Arts, Sports & Science Education*, *1*(4), 23-35.

Perry, M. J. M. (2013). *The effects of visual media on achievement and performance in a secondary Biology classroom*. (Master's research thesis, Ohio University, Nigeria. Retrieved from https://www.ohio.edu/education/academic-programs/upload/Michelle-Perry-Masters-Research-Paper-copy.pdf.

Petko, D. (2012). Teachers' pedagogical beliefs and their use of digital media in classrooms: Sharpening the focus of the 'will, skill, tool' model and integ rating teachers' constructivist orientations. *Computers & Education*, *58*(4), 1351-1359.

Ploesser, A. L. (2016). Student producers: OneNote, Camtasia studio, and the authentic project. Hammond T., Valentine S., Adler A. (Eds.). *Revolutionising Education with Digital Ink: The Impact of Pen and Touch Technology on Education. pp. 231-240.* Switzerland: Springer International Publishing.

Prieto, J. N., Juanena, Star, (2013). Designing Geometry 2.0 learning environments: a preliminary study with primary school students. International Journal of Mathematical Education in Science and Technology, 1-21.

Prieto, J. N., Juanena, S. J., & Star, J. R. (2013). Designing Geometry 2.0 learning environments: a preliminary study with primary school students. *International Journal of Mathematical Education in Science and Technology, 45*(3), 396–416. Retrieved from http://dx.doi.org/10.1080/0020739x.2013.837526.

Pudi, T. I. (2007). *Understanding Technology education from a South African perspective*. Van Schaick Publishers, South Africa.

Ramdhani, B., Usodo, B., & Subanti, S. (2017). Discovery learning with scientific approach on Geometry. *Physics Journal, Conf. Ser*., *895*, 012033.

Saha, R. A., Ayubb, A. F. M., & Tarmizic. (2010). The effects of GeoGebra on Mathematics Achievement: Enlightening Coordinate Geometry Learning. *Procedia-Social and Behavioral Sciences,* 8(2010), 686 – 693.

Saltrick, S. (2004). *Television goes to the school: The impact of video on student learning in formal education*. Retrieved from http://cct.edc.org/sites/cct.edc.org/files/publications/PBS_tv-school.pdf

Sarantakos, S. (2007). *A toolkit for quantitative data analysis using SPSS*. Beijing, China: Palgrave Macmillan.

Shier, R. (2004). *Statistics: 2.3 The Mann-Whitney U Test, Mathematics, learning support centre.* Retrieved from http://www.statstutor.ac.uk/resources/uploaded/mannwhitney.pdf

Shirvani, H. (2010). The effects of using computer technology with lower-performing students: Technology and student mathematics achievement. *International Journal of Learning*, 17(1), 143-154.

So, W. W., Pow, J. W., & Hung, V. H. (2009). The interactive use of a video database in teacher education: Creating a knowledge base for teaching through a learning community. *Computers & Education*, 53(3), 775–786. doi:10.1016/ j.compedu.2009.04.018.

Sorden, S. D. (2012). *The Cognitive Theory of Multimedia.* Downloaded from http://sorden.com/portfolio/sorden_draft_multimedia2012.pdf.

Southern Africa Consortium for Monitoring Educational Quality (SACMEQ) (2013). Retrieved from www.sacmeq.org/sacmeq-projects.

The Glossary of Education Reform. (2014). *Teaching in a digital age*. Retrieved www.opentextbc.ca/teachinginadigitalage/chapter/5-2-what-is-a-learning-environment/.

The Glossary of Education Reform. (2013). Retrieved www.edglossary.org/learning-experience/.

United Nations Children's Fund (UNICEF) (2011). *Improving quality and equity in education in Namibia: A trend and gap analysis.* Retrieved from www.unicef.org/namibia/UNICEF_2011_Ninnes_Trends_and_Gaps_final_combined.pdf

Weng, P-L., Savage, M. N., & Bouck E. C. (2014). Video-based instruction using iPads. *Teaching Exceptional Children, 47*(1), 11 –19.

Wong, W.-K., Yin, S.-K., Yang, H.-H., & Cheng, Y.-H. (2011). Using computer-assisted multiple representations in learning Geometry proofs. *Educational Technology & Society, 14*(3), 43–54.

Woolfitt, Z. (2015). *The effective use of video in higher education*. Lectoraat Teaching, Learning and Technology. Inholland University of Applied Sciences. UK.

Yang, J. C., Huang, Y. T., Tsai, C. C., Chung, C. I., & Wu, Y. C. (2009). An automatic multimedia content summarisation system for video recommendation. *Educational Technology & Society*, 12 (1), 49-61.

**APPENDICES**

## Appendix A: Letter to the Oshikoto Regional Director of Education

---

Box 1606, Ondangwa

10th October 2017

To: The Director of Oshikoto Education Region

Private Bag 2028, Ondangwa

Dear Sir

Re: Request for permission to conduct a research study at two Secondary Schools in Oshikoto Education Region

I am Linda Ugulu, a Masters' degree student at the University of Namibia in Mathematics Education. To qualify for my Masters' degree, I am required to write a research project on a topic of interest. My research title is: "An investigation on the effects of teacher-designed educational videos on learners' geometry performance in Oshikoto education region".

It has been consecutively reported that learners perform poorly in Mathematics, therefore designing ways to help the teaching and learning of Mathematics is crucial. This study therefore will investigate the effects of teacher-designed educational videos on Geometry performance of the learners.

I kindly request your good office to allow me to use two selected secondary schools in Oshikoto region. The study will be conducted with one class at each school that will be selected. The data will be collected using learners' pre-test and post-test scores as well as a questionnaire. The lessons will be based on Geometry, a topic in the NSSC Mathematics syllabus. This will last for one full week from 15H00 – 16H00. I hope to complete this study before the end of November 2017. The schools and participants will be assured of confidentiality and anonymity in the final report. A time table for class session times of visits will be provided and will not by any chance disturb normal class teaching time at the schools. Attached please find a copy of ethical clearance letter from the University of Namibia.

Thanking you in advance.

Sincerely yours,

________________________________

Linda Ugulu

## Appendix B: Letter to the School Principal

P O Box 1606, Ondangwa

10 October 2017

The School Principal ______________________ School

Dear Sir/Madam

Re: RESEARCH TO BE CONDUCTED AT ______________________________ SCHOOL.

I am Linda Ugulu, a Masters' degree student at the University of Namibia in Mathematics Education. To qualify for my Masters' degree, I am required to write a research report on a topic of interest. My research title: "An investigation on the effects of teacher-designed educational videos on learners' Geometry performance in Oshikoto Education Region".

I therefore kindly, request your good office to allow me to carry out my research at your school. Attached please find the proof of permission to conduct the research in the Oshikoto Education Region, granted by both the office of the Permanent Secretary as well as the office of the Oshikoto Regional Director of Education, respectively.

The data will be collected using a pre-test & post-test and a questionnaire. The lessons will be based on Geometry, a topic in the ordinary level Mathematics syllabus. I hope to complete this study before the end of November 2017. The participants will be assured of confidentiality and anonymity in the final report. A time table for class sessions with dates and times of visits will be provided, and will not interrupt the normal class teaching time.

Thanking you in advance.

Sincerely yours,

______________________________________

Linda Ugulu

# Appendix C: Ethical clearance

UNAM
UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

**Ethical Clearance Reference Number:** FOE/266/2017 **Date:** 10 October, 2017

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

**Title of Project:** An Investigation On The Effects Of Educational Videos On Geometry Performance In Oshikoto Education Region, Namibia

**Researcher:** Linda Uugulu

**Student Number:** 200819780

**Faculty:** Faculty of Education

**Supervisors:** Dr. E. N. Ngololo (Main) Dr. F. Vatileni (Co)

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.

(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.

(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.

(d) The UREC retains the right to:

(i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,

(ii) Request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Prof. P. Odonkor: UREC Chairperson

Ms. P. Claassen: UREC Secretary

# Appendix D: Permission to conduct research from the Directorate of Education

**REPUBLIC OF NAMIBIA**

OSHIKOTO REGIONAL COUNCIL
*DIRECTORATE OF EDUCATION, ARTS AND CULTURE*

Tel (065) 281900
Fax (065) 240315
Enq: Ms H Tende

Private Bag 2028
ONDANGWA
17 October 2017

**Ref: 12/3/10/1**

Ms Linda Ugulu
PO Box 1606
Ondangwa
Cell: 0813697212
E-mail: linda.ugulu3@gmail.com

Dear Ms Ugulu

**REQUEST FOR PERMISSION TO CONDUCT A RESEARCH STUTY AT TWO SECONDARY SCHOOLS IN OSHIKOTO REGION**

1. We acknowledge receipt of your letter dated 10th October 2017, seeking for approval from the office of the Director to conduct a research study at two secondary schools, namely, Uukule SS and Nehale SS.

2. The writing of this letter therefore serves to inform you that permission has been granted to you to conduct research at the afore mentioned schools on the following conditions:

- You have to consult the school principal well in advance to ensure a proper co-ordination of other school activities.
- The research should not interfere with the normal teaching and learning process at school.
- Participation in the research should be on a voluntary basis.
- And the information to be gathered should be treated as confidential and only for research purposes.

3. With that in mind, it is my wish that your research study will yield satisfactory results, towards the completion of your qualification.

Yours Faithfully

17/10/2017

OSHIKOTO REGIONAL COUNCIL
Director
17 OCT 2017
PRIVATE BAG 2028
ONDANGWA
DIRECTORATE OF EDUCATION, ARTS AND CULTURE

**MR LAMEK T. KAFIDI**
**DIRECTOR OF EDUCATION**
**OSHIKOTO REGION**

CC: Principal, Uukule & Nehale SS

## Appendix E: Consent letter for the School Principal

Consent for the school principal

Linda Ugulu is hereby given permission to use ______________________________ School as the research site for the research study she is required to conduct in partial fulfilment for the Masters' degree in Education at the University of Namibia.

I understand that:

1. The data for analysis will be collected by making use of educational videos in the teaching of Grade 11 Ordinary level Mathematics learners, administering the Mathematics pre-test & post-test and filling in a questionnaire on their views on the use of educational videos.

2. The information from these instruments may be used in the final report of this study.

I have been assured that the school and the teachers will have anonymity in the final report and the information collected will be used for the sole purpose of the study.

___________________________ ______/______/2017

Signature Date

## Appendix F: Consent for the parent

Consent letter: learners' parent

I __________________________________________________, the parent of ________________________________ a grade 11 learner at ________________________________ hereby gives consent to my child to be a subject in the study entitled "An investigation on the effects of teacher-designed educational videos on Geometry performance in Oshikoto Education Region" by attending the lessons and write the tests.

I further understand that:

1. My child is under no obligation to participate and may withdraw from the study at any point prior to the publication or presentation of research results.

2. Anonymity will be maintained using pseudonyms. The name of my child will not be reported.

3. The research will be used for academic and professional presentations and publications.

__________________________ ____________________

Signature Date

# Appendix G: Lesson Plans

## Lesson Plan 1

**Topic:** ***Geometry***

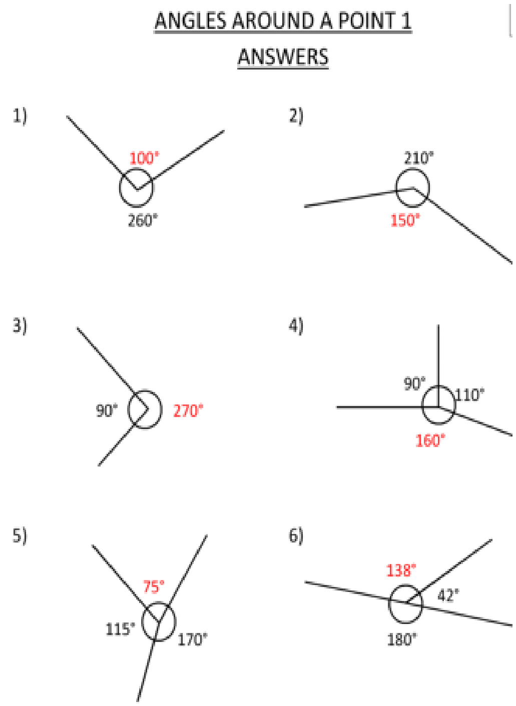
***Theme:*** Angle properties

***Specific objectives***: Learners will be able to calculate unknown angles using (reasons may be required but no formal proofs)

- Angles at a point and on a straight line
- Angles on intersecting straight lines
- Angles formed within parallel lines

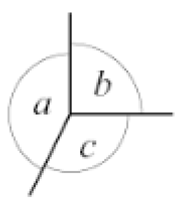
| | ***Control group*** | ***Experimental group*** |
|---|---|---|
| Teaching aids and resources to be used: | Chalkboard<br>Handouts | Educational videos<br>Handouts |

**1. Introduction:** Angles around a point will always add up to **360 degrees.**




NB:

**2. Lesson presentation:**




$$a + b + c = 360°$$

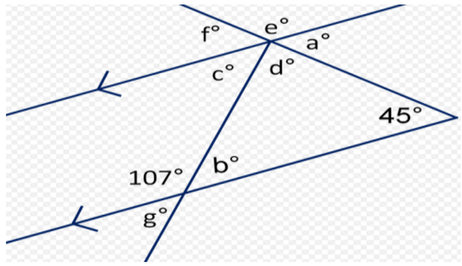
**3. Learners' activities:** Learners will listen attentively to the teacher, take notes, do classwork and ask questions as well as answer the teachers' questions. Learners in the experimental group will learn from the videos, they can forward the video, pause, rewind, etc.

**4. Homework/Task:** The learners will be asked to do classwork.

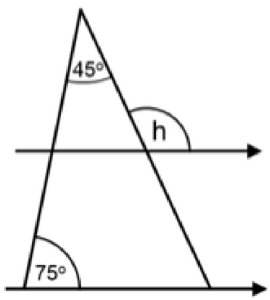
**5. Lesson reflection:** The teacher concludes the lesson.

Worksheet 1 (10 marks)

1. Calculate the sizes of the angles indicated with letters.




2. Calculate the size of the missing angle indicated with letter h.




**Lesson Plan 2**

**Topic:** ***Geometry***

***Theme:*** Angle properties

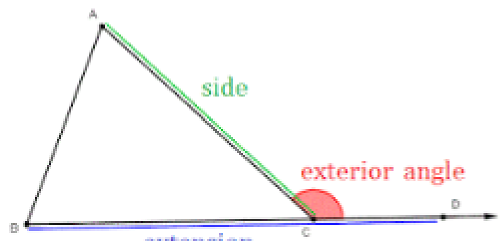
***Specific objectives***: Learners will be able to calculate unknown angles using (reasons may be required but no formal proofs)

- Angle properties of triangles and quadrilaterals

| | ***Control group*** | ***Experimental group*** |
|---|---|---|
| Teaching aids and resources to be used: | Chalkboard<br>Handouts | Educational videos<br>Handouts |

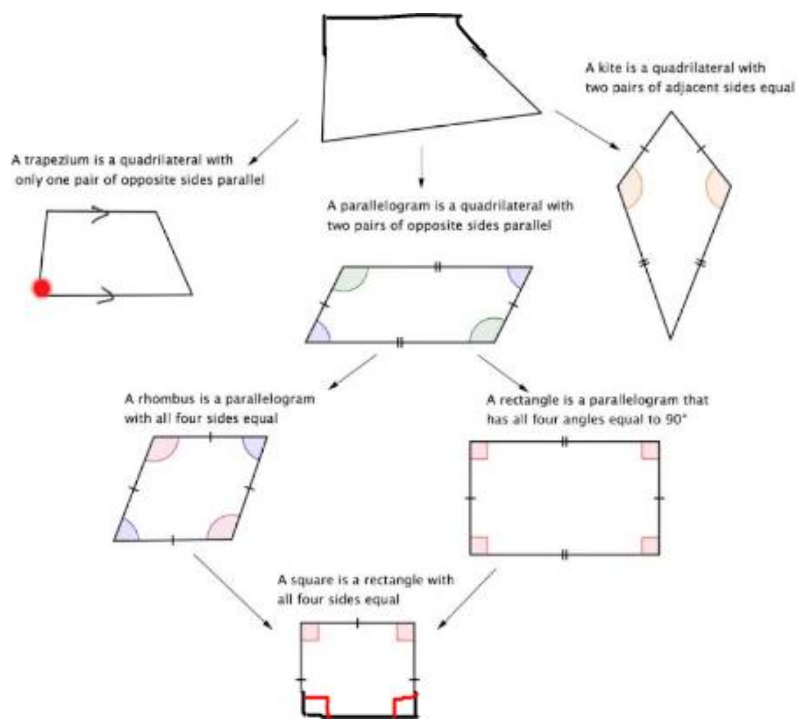
**1. Introduction:** The teacher will give a brief introduction and expect answers from the learners as per prior knowledge. Learners are expected to know that the sum of the interior angles of a triangle is 180° as well as angle formed on a straight line is 180°. Any closed four-sided figure is called **Quadrilateral**.

**2. Lesson presentation:** The teacher will explain to the learners different properties of triangles. For instance, the exterior angle of a triangle is equal to the sum of two interior opposite angles.




*L*A + *L*B = exterior angle

The teacher will then also present to the learners' different types of quadrilaterals, their properties and how they are related.



**3. Learners' activities:** Learners will listen attentively to the teacher, take notes, do classwork and ask questions as well as answer the teachers' questions. Learners in the experimental group will learn from the videos, they can pause the video, rewind, forward, etc.

**4. Homework/Task:** Homework will be given at the end of the lesson to measure if the learners have attained what they are supposed to know at the end of the day.

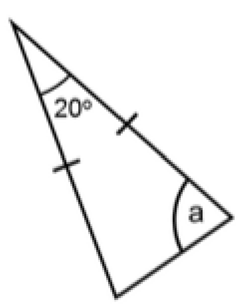
**5. Lesson reflection:** The teacher reflects on the lesson and call it a day.

Code: ……………………………

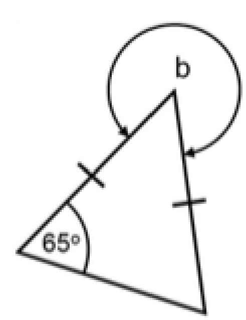
**Worksheet 2** (8 marks)

Find the sizes of angles marked with letters and workings shown properly.

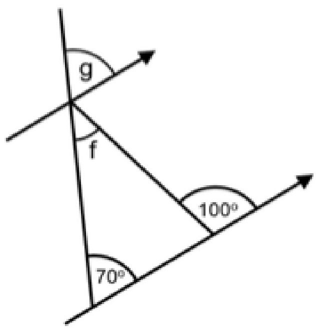
a)



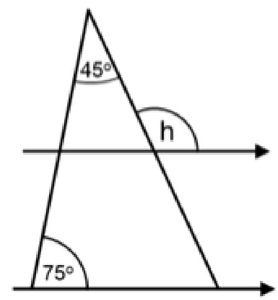

b)



c)




d)




**Classwork (Worksheet 3)**

1. (a). What is the sum of the interior angle of a 15-sided polygon? (2)

   (b). Determine the measure of each interior angle of a 15-sided polygon. (1)

2. How many sides does a polygon have if the sum of the interior angles is 3240? (2)

3. How many sides does a regular polygon has if one exterior angle measures $30^{\circ}$? (2)

**<u>Lesson Plan 3</u>**

**Topic:** ***Geometry***

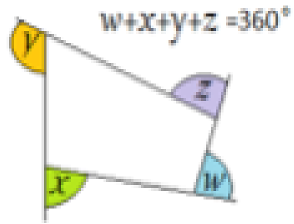
***Theme:*** Angle properties

***Specific objectives***: Learners will be able to calculate unknown angles using (reasons may be required but no formal proofs)

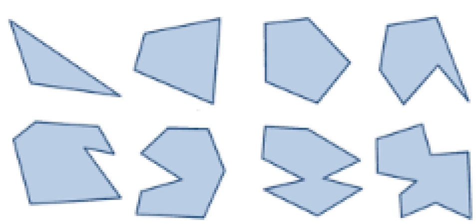
- ❖ Angle properties of regular polygons and irregular polygons

| | ***Control group*** | ***Experimental group*** |
|---|---|---|
| Teaching aids and resources to be used: | Chalkboard<br>Handouts | Educational videos<br>Handouts |

**1. Introduction:** A polygon is any closed figure. Regular polygon has sides of equal length, and all its interior are of equal in size. Unlike regular polygon, irregular polygon has sides of any length and angles of any size.The sum of the exterior angle of any polygon is equal to 180°.



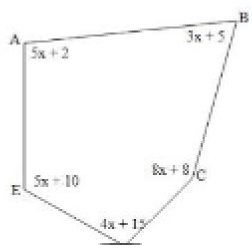

Examples of irregular polygons



**2. Lesson presentation:** The formula for calculating the sum of the interior **angles** of a regular **polygon** is: (n - 2) × 180° where n is the number of sides of the **polygon**. This formula comes from dividing the **polygon** up into triangles using full diagonals.

| Number of Sides | Polygon Name | Number of Triangles Formed | Interior Angle Sum Measure |
|---|---|---|---|
| 3 | Triangle | 1 | 180° |
| 4 | Quadrilateral | 2 | 360° |
| 5 | Pentagon | 3 | 540° |
| 6 | Hexagon | 4 | 720° |
| 7 | Heptagon | 5 | 900° |
| ⋮ | ⋮ | ⋮ | ⋮ |
| $n$ | $n$ - gon | $(n-2)$ | $(n-2)\cdot 180°$ |

To find the sizes of unknown interior angles of an irregular polygon, one can use algebra to answer the questions.




**3. Learners' activities:** Learners will listen attentively to the teacher, take notes, do classwork and ask questions as well as answer the teachers' questions. Learners in the experimental group will learn from the videos, they can forward the video, pause, rewind, etc.

**4. Homework/Task:** The learners will be given classwork to work on.

**5. Lesson reflection:** The teacher briefly summarises the lesson and call it a day.

**<u>Lesson plan 4</u>**

**Topic:** ***Geometry***

***Theme:*** Angle properties

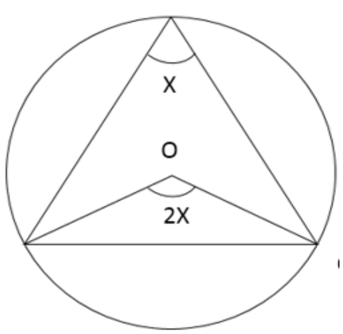
***Specific objectives***: Learners will be able to calculate unknown angles using (reasons may be required but no formal proofs)

- Angle at the centre of the circle is **twice** the angle at the circumference.
- Angles in the same segment are **equal**.
- Angles in opposite segment are **supplementary.**

| | ***Control group*** | ***Experimental group*** |
|---|---|---|
| Teaching aids and resources to be used: | Chalkboard<br>Handouts | Educational videos<br>Handouts |

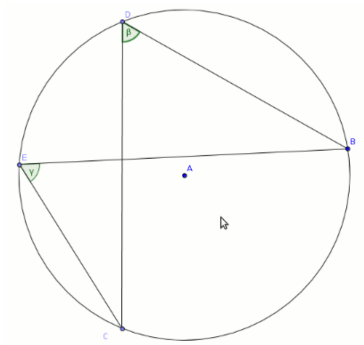
**1. Introduction:** The teacher recap on the previous lesson.

**2. Lesson presentation:** If O is the centre of the circle then it follows that angle at the centre of the circle is twice the angle at the circumference.



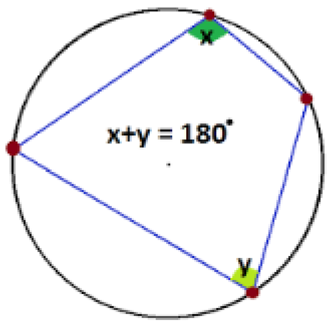

If $x = 48°$, then $2x = 96°$.

Angles in the same segment are **equal.** This means that angles subtended (made) by the same arc at the circumference are the same. For instance, the diagram below show two angles that are in the same segment.




On the diagram, $y = \beta$

Angles in opposite segment are **supplementary,** which means sum add up to 180°**.** *x* is opposite to *y*. This is shown on the diagram below,




**3. Learners' activities:** Learners will listen attentively to the teacher, take notes, do classwork and ask questions as the lesson progresses; and answer the teachers' questions. Learners in the experimental group will learn from the videos, they can forward the video, pause, rewind, etc.

**4. Homework/Task:** Homework will be given to the learners.

**5. Lesson reflection**: The teacher will recap on the main points of the day which are: angle at the centre of the circle is twice the angle at the circumference; angles in the same segment are equal and lastly angles in opposite segment are supplementary and then call it a day.

# Appendix H: Pre-test

***Participant code…….***

Mathematics Pre-test

*Instructions to participants*

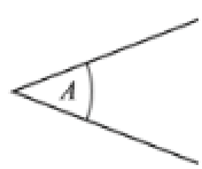
- Do not write your name on this test paper.
- Answer all the questions and show workings at all times.
- Write your answers on the spaces provided.

1.

| | | | | |
|---|---|---|---|---|
| similar | acute | line | perpendicular | radius |
| reflex | obtuse | parallel | congruent | isosceles |

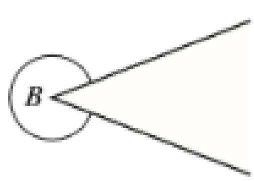
Choose the correct word from this box to complete each of these statement.

a)



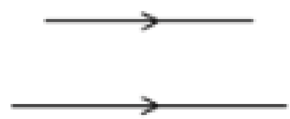

angle A is …………...…………… [1]

b)



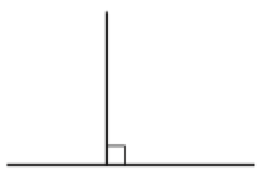

angle B is ….……………………… [1]

c)



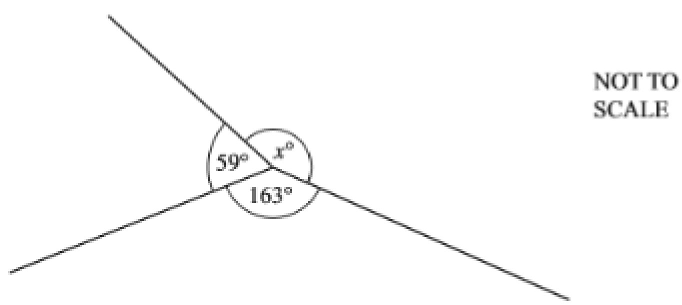
These lines are …………………… [1]

d)



These lines are ………………….. [1]

2.



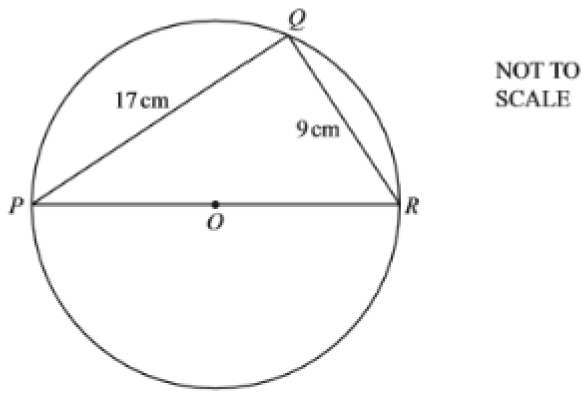

(a) Find the value of x.

answer (a) x =.................................... [2]

(b) One of the angles is 163°. What type of angle is this?

answer (b).......................................... [1]

3.




The diagram shows a circle, centre O. P, Q and R are points on the circumference. PQ = 17 cm, QR = 9 cm and PRQ = 50°.

(a) Explain why angle PQR is 90°.

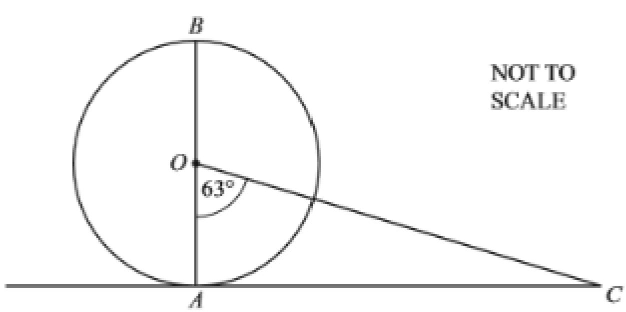
Answer(a)……………………………………………………………………………………………………

…………………………………………………………………………………………………………… [1]

(b) Calculate the size of angle QPR.

answer (b) QPR = ................................... ° [2]

4.



The diagram shows a circle, centre O with diameter AB = 15 cm.  AC is a tangent to the circle at A and angle AOC = 63°.

(a)  Work out the size of angle ACO.

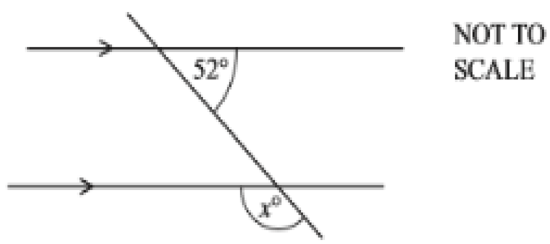
answer (b)(i) .......................................... [2]

(b)  Give one geometrical reason for your answer to part (a).

Answer(b)(ii).........................................................................................................................

........................................................................................................................  [1]

5.

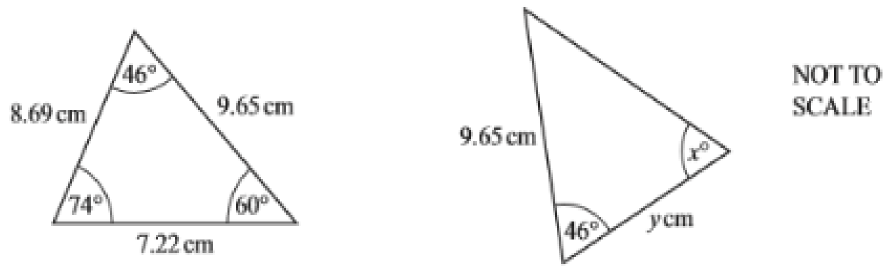



In the diagram above, a straight line intersects two parallel lines.

a) Find the value of *x*.                                answer *x* =  .....................................  [1]

b) Give a reason to your answer in a)  …………………………………………… [2]

6. These two triangles are congruent.

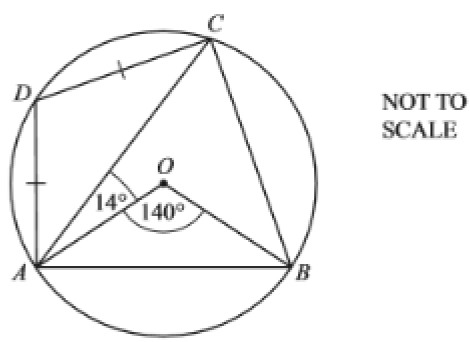



Write down the value of

(a) $x$, answer (a) $x$ = ................................. [2]

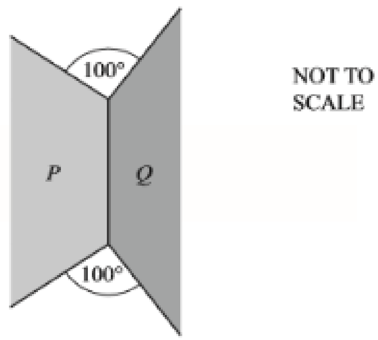
(b) $y$. answer (b) $y$ = ................................. [1]

7. A, B, C and D are points on the circle centre O. Angle AOB = 140° and angle OAC = 14°. AD = DC. Calculate angle ACD.




answer ....................................... [3]

8. The diagram below shows parts of shape P and shape Q. Shape P is a regular hexagon and shape Q is another regular polygon. The two shapes have one side in common.




Find the number of sides in shape Q. Show each step of your working.

answer ....................................... [3]

**______________________________END______________________________/25]**

## Appendix I: Post-test

***Participant code……..***

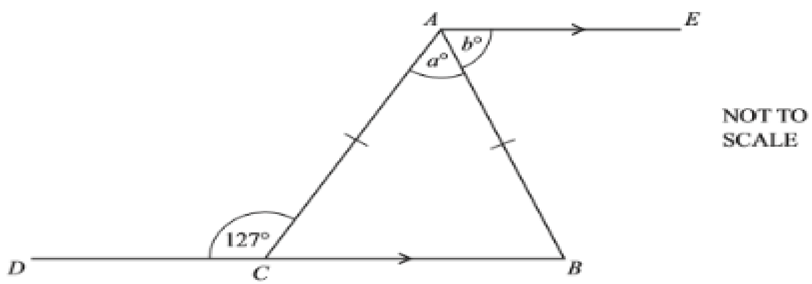
Mathematics Post-test

*Instructions to participants*

- Do not write your name on this test paper.
- Answer all the questions and show workings at all times.
- Write your answers on the spaces provided.

---

1.




The diagram shows an isosceles triangle ABC.

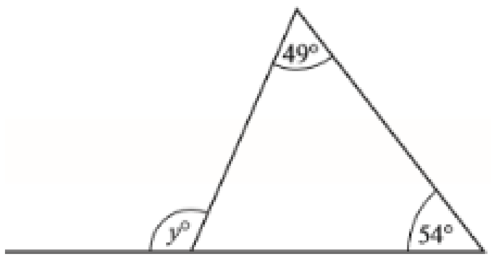
DCB is a straight line and is parallel to AE. Angle DCA = 127°.

Find the value of:

a) $a^o$ answer (a) $a^o$ =........................................ [2]

b) $b^o$ answer (b) $b^o$ = .................................... [1]

2.

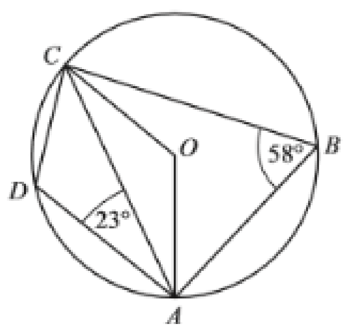



NOT TO SCALE

Work out the value of y.

answer y = ............................... [2]

3.




NOT TO SCALE

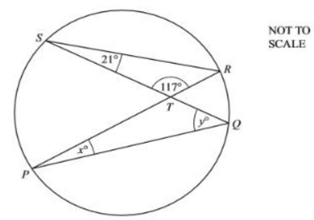
A, B, C and D lie on a circle centre O. Angle ABC = 58° and angle CAD = 23°.

Calculate

(a) angle OCA, answer (a).................................. [2]

(b) angle DCA. answer (b) ……......................... [2]

4.

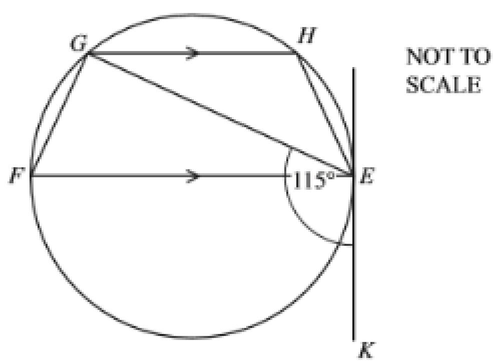



(a) The chords PR and SQ of the circle intersect at T. Angle RST = 21° and angle STR = 117°.

Find the values of x and y. answer (a) x = ...................................................... [2]

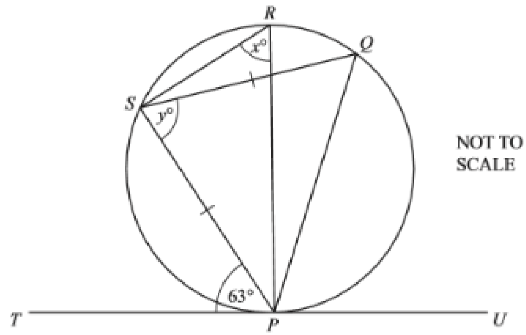
y = ..................................................... [2]

(b) EFGH is a cyclic quadrilateral. EF is a diameter of the circle. KE is the tangent to the circle at E. GH is parallel to FE and angle KEG = 115°.




Calculate angle GEH. answer (b) ................................. [4]

5.




P, Q, R and S are points on a circle and PS = SQ. PR is a diameter and TPU is the tangent to the circle at P. Angle SPT = 63°.

Find the value of

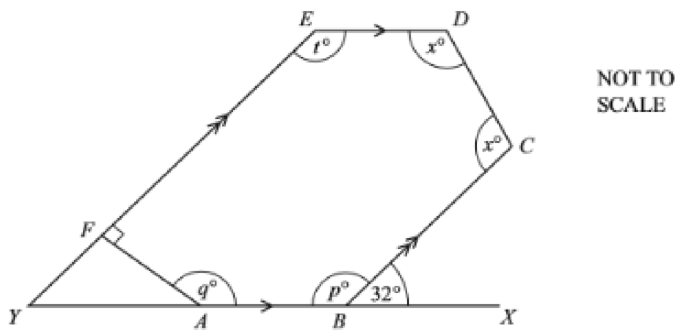
(i) $x$,

answer (i) $x =$ .................................. [2]

(ii) $y$.

answer (ii) $y =$.................................. [2]

6.




ABCDEF is a hexagon. AB is parallel to ED and BC is parallel to FE. YFE and YABX are straight lines. Angle CBX = 32° and angle EFA = 90°.

Calculate the value of

(i) $p$, answer (a)(i) $p$ = .................................. [1]

(ii) $q$, answer (a)(ii) $q$ = ................................ [2]

(iii) $t$, answer (a)(iii) $t$ = ................................ [1]

(iv) $x$. answer (a)(iv) $x$ = ................................ [2]

**/25]**

## Appendix J: Learners mark scores

**Experimental Group Results (A)**

| **Participants codes** | **Pre-test** | **Post-test** |
|---|---|---|
| D01 | 3 | 10 |
| D02 | 11 | 7 |
| D03 | 6 | 10 |
| D04 | 16 | 9 |
| D05 | 10 | 16 |
| D06 | 15 | 12 |
| D07 | 14 | 12 |
| D08 | 13 | 6 |
| D09 | 16 | 12 |
| D10 | 11 | 18 |
| D11 | 15 | 13 |
| D12 | 14 | 10 |
| D13 | 17 | 12 |
| D14 | 7 | 10 |
| D15 | 12 | 14 |
| D16 | 13 | 17 |
| D17 | 13 | 18 |
| D18 | 6 | 15 |
| D19 | 6 | 10 |

| | | |
|---|---|---|
| D20 | 9 | 10 |
| D21 | 13 | 0 |
| D22 | 18 | 14 |
| D23 | 9 | 18 |
| D24 | 16 | 11 |
| D25 | 9 | 12 |
| D26 | 9 | 8 |
| D27 | 13 | 11 |
| D28 | 9 | 12 |
| D29 | 10 | 13 |
| D30 | 13 | 15 |
| D31 | 7 | 12 |
| D32 | 9 | 8 |
| D33 | 10 | 11 |
| D34 | 13 | 8 |
| D35 | 15 | 14 |
| D36 | 14 | 9 |
| D37 | 15 | 12 |
| D38 | 14 | 11 |
| D39 | 14 | 17 |
| D40 | 6 | 10 |

**Control group results (B)**

| **Participants codes** | **Pre-test** | **Post-test** |
|---|---|---|
| A01 | 10 | 12 |
| A02 | 10 | 9 |
| A03 | 14 | 7 |
| A04 | 11 | 0 |
| A05 | 11 | 13 |
| A06 | 13 | 11 |
| A07 | 13 | 12 |
| A08 | 15 | 15 |
| A09 | 8 | 12 |
| A10 | 14 | 10 |
| A11 | 10 | 9 |
| A12 | 10 | 5 |
| A13 | 9 | 13 |
| A14 | 10 | 8 |
| A15 | 21 | 14 |
| A16 | 17 | 20 |
| A17 | 11 | 13 |
| A18 | 9 | 10 |
| A19 | 9 | 11 |
| A20 | 7 | 15 |

| | | |
|---|---|---|
| A21 | 18 | 12 |
| A22 | 8 | 6 |
| A23 | 10 | 0 |
| A24 | 7 | 6 |
| A25 | 11 | 8 |
| A26 | 12 | 12 |
| A27 | 5 | 7 |
| A28 | 13 | 11 |
| A29 | 14 | 9 |
| A30 | 6 | 9 |
| A31 | 15 | 7 |
| A32 | 10 | 9 |
| A33 | 11 | 13 |
| A34 | 15 | 10 |
| A35 | 11 | 15 |

## Appendix K: Questionnaire for learners

---

**Learners Survey** **Code:** ……………….

Please indicate the extent of agreement with each statement by circling the number you think is appropriate for strongly agree, agree, undecided, disagree and strongly disagree. Please use the following scale to rate each statement below.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Strongly Disagree | Somewhat Disagree | Undecided | Somewhat Agree | Strongly Agree |

---

**Gender** (Please tick appropriately)

| | |
|---|---|
| Female | |
| Male | |

**a) Usefulness of videos**

1. I was very much excited in math class when taught Geometry using videos.

1 2 3 4 5

2. I was more engaged in class and not sleepy.

1 2 3 4 5

3. Lesson was interesting.

1 2 3 4 5

4. Videos can increase Mathematics achievement.

1 2 3 4 5

5. I enjoyed the lesson when videos are shown.

1 2 3 4 5

**b) Learning environment**

6. I was free in the lesson and not intimidated by the teachers' presence

1 2 3 4 5

7. Videos would help me learn difficult content.

1 2 3 4 5

**c) Learning experiences**

8. Videos could help me remember Geometry content.

1 2 3 4 5

9. I was able to make connections to real life situations.

1 2 3 4 5

10. Geometry is such an easy topic.

1 2 3 4 5

11. I currently want to be taught Geometry using videos only.

1 2 3 4 5

12. Mathematics (Geometry) lessons should be presented using videos in the near future.

1 2 3 4 5

13. I liked to be taught Geometry using videos.

1 2 3 4 5

14. I was able to learn at my own pace.

1 2 3 4 5