Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.8, No.6, 2018

The Impact of Earth Model in Understanding of Earth Geometry by In-Service Student Teachers: A Case of Mukuba University, Zambia

Garry Simukoko[1*] Sakala William[2]
1. Mukuba University, School of Mathematics and Computer Science, P.O. BOX 20382, Kitwe, Zambia
2. School of Mathematics and Natural Sciences, Copperbelt University, P.O. BOX 21692, Kitwe, Zambia

Abstract
This study was conducted to show the impact of Earth Model in understanding of Earth Geometry by in-service Student Teachers. The problem of poor performance of the Grade 12 pupils in mathematics especially in Earth Geometry and students at Mukuba University has been a matter of concern. To alleviate this problem a study was conducted because teachers are the ones in charge of responsibility of initiating knowledge. The study population included all third year in-service student teachers of mathematics education (MED 330) pursuing a degree programme by distance learning at Mukuba University. The study was based on three research questions and two hypotheses. The research method used was a mixed approach. The sample size was 35 in-service students Teachers comprising 23 male and 12 female students. The Shapiro-wilks test was used for this purpose because of the small sample size. Also, the design used for the study was a quasi-experimental. The two groups were made from a homogeneous class at random. Particularly, 17 students were assigned to the experimental and 18 students to the control group. These two groups were subjected to a pre-test. The experimental group was taught using the Earth model approach while the control group was taught using conventional approach. The analysis of data was done with the help of SPSS, considering the mean, standard deviation. Also, the Independent sample t-test was conducted at alpha (α) = 0.05 to analyse the results of the pre-test and post-test scores. The study showed there was statistically significant difference in the post-test scores for the experimental group (Mean = 60, standard deviation = 19.28) and the control group (Mean = 42.36, standard deviation = 17.98) , p = .01.Therefore, incorporating Earth Model in teaching Earth Geometry was found to have a positive impact on in-service student teachers understanding Earth Geometry. The study also revealed that learners had challenges in calculating the surface area between two meridians and the shortest distance between points on the same latitude which are not diametrically opposite. Also, the study suggested that the concepts of geometry are abstract in nature and require more visualization tools to the students understanding.
Keywords: Earth Geometry, Earth model, Challenges, Conventional approach and in-Service Student Teachers.

1. INTRODUCTION
Mathematics is the most fundamental of all curriculum subjects, and mathematical understanding influences decision making in all areas of life. Mathematics education is a key to increasing post-school and citizenship opportunities of young people (Glenda and Margaret, 2009). Today's mathematics curriculum must prepare students and pupils for their future roles in society. It must equip them with essential mathematical knowledge and skills; critical thinking, problem solving, communication and most importantly, the ability and incentive to continue learning on their own. According to the Curriculum Development Centre (2013), Mathematics is an important tool for the development and improvement of a person's intellectual competence in logical reasoning, spatial visualization, analysis and abstract thought. The contributors for the CDC analyze the teaching and learning of mathematics in Zambia from several perspectives. A branch of mathematics that is concerned with spatial visualization is Geometry. The word 'geometry' comes from two ancient Greek words, 'geo', meaning earth and 'metry', meaning to measure (Jones, 2002). In fact, Larson et al. (1995) defines Geometry as a branch of mathematics that studies the shapes of objects, their sizes, properties and relationships. There are two types of Geometry; that is plane and solid geometry. Geometry is a wonderful area of mathematics to teach. It is full of interesting problems and rich in theorems. It is open to many different approaches. It has a long history, intimately connected with the development of mathematics. In addition, Jones (2002) refers to Geometry as an integral part of people's cultural experiences and serves as a vital component of numerous aspects of life from architecture to design in all its manifestations. Ali, Bhagawati and sarmah (2014) assert that Geometry is a unifying theme to the entire mathematics curriculum and a rich source of visualization for arithmetical algebraic and statistical concepts. As a result, it can be a topic that captures the interest of learners, especially those who may find other areas of mathematics, such as number and algebra, to be difficult. Teaching Geometry can as well mean enabling more students to succeed in mathematics (Jones, 2002). In Zambia, policy makers and educators are always concerned about improving the teaching and learning of Mathematics. That is why in 2004 the government thought it wise to re -introduce Earth Geometry, which was removed from the Ordinary level syllabus in the 1980s. Earth Geometry is a topic taught at Grade 12 level and it is the branch of mathematics that

deals with location of places, distances between two points and time differences between points. It is a topic which is taught using different methods that attract different attitudes from learners which may have an implication on their performance and understanding of the concepts. But today, as in the past, many learners struggle with Mathematics. In spite of the helpfulness of Mathematics and Earth Geometry in particular, there has been repeated high failure rates in the subject by many learners in Zambia (ECZ, 2016). The analysis of performance in the Grade 12 Mathematics examination report 2016 indicates that the mean performance was 24.39%. This performance is still poor because it is below 30%. Besides, the low performance was recorded on earth geometry. For instance, the overall failure rate reduced from 5.47 in 2014 to 5.24 in 2015. Additionally, the highest failure rate recorded was in Mathematics and Science subjects averaging 39.12%. MOGE (2016) attributes this failure rate to the limited number of Science and Mathematics teachers as well as inadequate laboratories that are equipped with the relevant materials. Mukuba University is not an exception. For instance, in 2015 academic year distance examination in MTM 430 (Mathematics teaching method) had the pass percentage of 67%. Analyzing the performance on each topic of the course revealed that only 54% of the students attempted the question on Earth Geometry and only 36% of them got the question correct. The MOE through the Teacher Education Department introduced the Open Distance Learning at Mukuba University to ensure that teachers upgrade to degree level to help them teach effectively. Such concerns are a clear sign that interventions are needed to improve the results. It is in light of this, that the study seeks to assess the impact of using earth model in understanding earth geometry by in-service student teachers with the view of improving the results. This study is also being motivated by the need for learners to have the 21st century skills of which creativity is one of them.

1.1. Statement of the problem

In Zambia, the education system has improved over the years in terms of enrolment numbers. The ECZ has been given the mandate by the government to oversee the running of examination in Zambia. However, malpractice and poor results have characterized the education system. According to ECZ (2015) examination performance report, the mean performance scores in mathematics were 17.42% and there are a very low proportion of candidates obtaining school certificates. The poor results have been attributed to a number of reasons. For instance, limited contact time with pupils, pupils' negative attitudes towards the subject and pupils' poor grasp of mathematical concepts. In fact, in mathematics Earth Geometry questions have been one of the major concerns since most of the pupils fail to answer them correctly. For instance, the chief examiner reported that questions on statistics and Geometric graphs were fairly and well handled by most candidates while questions on Earth Geometry were poorly done (ECZ: 2008).

The poor performance at school certificate level in mathematics and Earth Geometry, in particular has been a thorn issue to mathematics educators, school managers, standards officers, examiners and other stakeholders. Earth Geometry has been cited to be problematic (ECZ, 2004, 2006). This has actually lead to a number of speculations, such as teachers are not well prepared for the subject while others state that there is lack of better teaching approaches. Likewise, the performance of student teachers at Mukuba University in earth geometry has continued to be poor and has remained a pipe dream. In an effort to find ways and means of improving performance, Tembo (2013) conducted a study on the perceptions of teachers and pupils regarding the teaching and learning of Earth Geometry. The study revealed that student teachers faced challenges to grasp concepts of Earth Geometry thereby transferring those difficulties to pupils. Furthermore, the Ministry of Education introduced the number of interventions such as in-service education training (INSET) and also involved International Corporation which was heavily involved in strengthening science, mathematics and technology education (SMASTE). Despite all these efforts, the problem of students performing poorly has continued to haunt the Ministry of Education. Therefore, this study was assessed the impact of using Earth Model in understanding of Earth Geometry by in- service student teachers at Mukuba University, since teachers are the ones charged with a responsibility of addressing this quality education landscape.

1.2. Objectives of the study

The study explored the following objectives:

(i) To assess the impact of using Earth model in understanding Earth Geometry.
(ii) To determine the best teaching approaches in Earth Geometry.
(iii) To establish other measures that can be used to improve the understanding of Earth Geometry.

1.3. Research questions

The above research objectives translate into the following research questions:

(i) What is the impact of using earth model in understanding Earth Geometry?
(ii) What are the best teaching approaches in Earth Geometry?
(iii) What other measures can be used to improve the understanding of Earth Geometry?

1.4 Participants
The participants for the research were all 35 third year in-service student teachers of mathematics who are pursuing Bachelor's Degree in Mathematics Education at Mukuba University through open distance learning (ODL). A population is a group of individuals, objects or items from which samples are taken for measurement (Kombo and Tromp, 2006). The research was under taken in the Mathematics Education course (MED 330) and Earth Geometry is one of the new topics the students learn at Mukuba University.

2. LITERATURE REVIEW
The literature is drawn from different parts of the world and then narrowed down to Zambia. Moreover, it has been arranged into sub headings for clear understanding as related to the research objectives.

2.1 The role of models in teaching and learning geometry
A model is a three dimensional representation of real thing. A model is broadly defined as a simplified representation of a limited part of reality with related elements to reproduce the characteristics of the geometrical phenomena, system, or process that help to understand better the geometrical concepts. It helps to represent and view already existing information or to visualize abstract concepts of geometry (Zemene, 2015). Physical mathematical models include reproductions of plane and solid geometric figures made of wire, and models of surfaces of higher order that make it possible to visualize abstract mathematical concepts. These models can help bridge the gap between conceptual understandings. Using relevant teaching method students can visualize the abstract concepts of earth geometry through models which emphasized under study which carries images of the abstract concepts of earth geometry. Mathematical concepts are abstract that one needs highly cognitive achievements to assimilate them (Baki, 1998). Specifically, there are many reasons that substantiate the use of visualization for learning and teaching of mathematics at all levels of schooling, from elementary to university passing through the middle and high school levels. The Challenges secondary school pupils experienced in learning and understanding Geometry in Malaysia were attributed to the following factors: the problem of geometrical language, lack of visualization abilities, for instance, of three dimensional shapes and the continuous use of traditional methods of teaching such as chalk board and textbooks which hinder geometry optimal learning (Lim and Hwa, 2007). According to Kalejaiye (2000) states that poor performance in Geometry is as a result of teachers who do not involve learners in their teaching and that they had adopted the rote learning style. However, this did not imply that immersing learners in real world situations automatically led to Geometrical understanding (Schwartz, 2008). It is argued that hands-on activities were a popular way to establish a connection between instruction and real-life.

2.2 Experiences from Europe, Asia and America
A Report by Jones (2000) entitled teacher knowledge and professional Development in Geometry articulated that, many beginning teachers of Mathematics, do not possess the sort of repertoires of subject matter knowledge and pedagogical content knowledge of geometry which would enable them teach geometrical topics. One such study was a study by Noraini (2009) entitled "The impact of using Geometers sketchpad on Malaysian Students Achievement and van Hiele Geometric Thinking" reviewed that, The introduction of geometers' sketchpad gave mathematics educators opportunities to help students not only solve geometry problems but also to discuss, justify, and help improve thinking. Knight (2006) charged that, pre-service elementary school mathematics teachers' reasoning stages were below level - (III) (ordering). In support of this Mayberry (1983) stated that the pre-service elementary school teachers involved in her study were not at a suitable van Hiele level to understand formal geometry and that their previous instructions had not helped them to attain knowledge of geometry consistent with level – IV. Although these results were for pre-service teachers, they will be useful in assessing the impact of earth model in understanding of Earth Geometry by in-service mathematics student teachers. In the study which was done in India by Bhagat and Chang (2015) entitled, use of geogebra in geometry learning concluded that learners need a guide to explore and visualize mathematics, especially geometrical concepts.

2.3 Experiences from Africa and Zambia
In the study conducted by Tembo (2013), revealed that the teachers of mathematics should utilize visual stimulus such as manipulation of object (using the model), which might considerably facilitate development of geometric thinking skills. A study was conducted by Zemene (2015) at the University of Ethiopia in Addis Ababa. The main aim of the study was to investigate the role of models on students' conceptual understanding of geometry and result indicated that the use of models in teaching geometry has significance in geometry classes. Masaiti and Manchishi (2011) established that, there were gaps between what the University of Zambia programme was offering and what was obtaining in secondary schools. The study observed that, university trainee teachers were exposed to a broad content material which, in some cases, did not take into consideration what was obtaining in the Zambian secondary schools. In addition, the study revealed that UNZA prepared or

trained teachers were weak in the delivery of subject matter (methodology).The Examination Council (2016) examiners' report showed that questions on Earth Geometry topic were very poorly answered. The same report concluded that teachers did not get adequate support in the area of geometry in their teacher preparation programme. Thus, they went into the field with the same challenges that they had when they were pupils themselves in schools.

A Study which was done by chisemba (2017), entitled, challenges encountered by secondary school teachers and pupils in earth geometry in Zambia at Copperbelt University revealed that learners faced challenges in calculation of the shortest distance between points on the same latitude. Furthermore, literature indicate that students often face challenges in mathematics content, especially when trying to make sense of abstract concepts such as shortest distance in Earth Geometry and the students have a poor foundation in mathematics (Adolphus, 2011). These findings by previous researchers are not unique to previous studies but also apply to the present study. Therefore, it is clear that teachers need to help learners acquire knowledge of visualisation and skills in solving Earth Geometry. In earth geometry learning, visualization factors focus on the learners' ability to imagine, locate places and knowing the distances between places. According to Kirby (1991), Visualization is the cornerstone of learning geometry.

3. METHODOLOGY AND PROCEDURE

A mixed method approach was used in this research. Qualitative and quantitative data were collected and analysed. According to Wisdom and Mihas (2014) mixed methods usually refers to contexts in which a researcher collects, analyses, and integrates both qualitative and quantitative data within a single study. A pretest-posttest experimental design was employed in this study. Students were assigned randomly to the experimental and control groups. This gave the study internal validity. Random selection, however, was not carried out in picking a particular class. This was because Mukuba University had only one class who were studying MED 330. The following instruments were used are Pre-test, post-test and questionnaires. Student's achievement in both pre-test and post-test made up the quantitative data while questionnaire responses made up the qualitative data. The research started in June 2017 and ended in January 2018.

3.1 Pre-Test and Post-Test Measurements

The pre-test was administered to the class. This test was given before the intervention was administered. This test helped to establish the homogeneity of the experimental and control groups. Understanding of students in the pre-test was the dependent variable while the independent variable in this case was the earth model used. A post-test was administered to the class after the intervention. The results were compared. The comparison was done between the experimental group and the control group's post test scores. This was done in order to determine the group which achieved higher than the other.

3.2 Questionnaire

A questionnaire had three parts that is, traits of sample, likert items and open ended questions.

3.3 Data analysis

Descriptive and inferential statistics were computed for both pre-test and post-test. Data collected was entered into Statistical Package for Social Sciences (SPSS) statistics 20 program for Windows. Percentages, mean, standard deviation and frequencies where generated under descriptive statistics. Descriptive statistics made no predictions, but just reported on what had been observed. Descriptive statistics provides simple summaries about the sample (Trochim, 2006). Before a t-test was performed the data was first tested to determine if it was normally distributed. The normality check was necessary. If not checked, the interpretations and inferences of results based on the data may not be reliable. A t-test is effective for data which is normally distributed. The Shapiro-Wilks test was chosen for this purpose because of the small sample size. Boyer (2013) suggested that the Shapiro-Wilk test of normality is valid only for a small number of observations of say between 5 and 38. The null hypothesis of this test is that the scores are normally distributed. Consequently, if the p-value is less than the chosen alpha level, then the null hypothesis is rejected. This would imply that the data is not normally distributed. The analysis of data was done with the help of SPSS. Shapiro-Wilk normality test was then carried out for the control and the experimental group. On the output the column labeled "Sig" which is the p-value was checked. If the column displayed a number above 0.05, then the data was considered to be normally distributed. In other words the significance level for two-tailed was set to 0.05. For the Shapiro-Wilk test, the closer the "Sig" value is to 1, the more normal the sample is. According to Institute for Digital Research and Education (2014) an independent t-test is designed to compare means of same variable between two groups. Independent sample t-test was carried out on the pre-test scores for both the control and experimental group. This procedure was to compare the mean score of both the control and experimental groups. Independent sample t-test was also carried out on the post-test scores for both the control and experimental group. This procedure was meant to compare the mean scores of both the control and experimental groups. Hannan (2007) supports this approach by suggesting that qualitative analysis may include illustrations drawn from data of particularly significant.

4. RESULTS AND FINDINGS

We present here a sample of results and findings.

Table 1: Characteristics of the sample

Item		Frequency	Percent
Gender	Male	23	65.7
	Female	12	34.3
	Total	35	100.0
Years of experience	Below 5 years	16	45.7
	Between 5 and 10 years	11	31.4
	Above 10 years	8	22.9
	Total	35	100.0
Level at which earth geometry was first learnt	At Secondary School	16	45.7
	At College	6	17.1
	At University	10	28.6
	Others	3	8.6
	Total	35	100.0

Table 1 indicate that the majority of the respondents, 23 representing 65.7% were male while 12 representing 34.3% were female teachers and also reflects that the years of experience for the majority 45.7% is below 5 years, 31.4% ranged from 5 to 10 years, followed by 22.9% who had served for more than 10 years. Furthermore, shows the level of earth geometry was first learnt 45.7% at secondary school, at college 17.1 %, at University 28.6%, learning on their own 8.6% and at CPD workshop 0%.

Tables 2 and 3 shows the results generated using Statistical Package for the Social Sciences (SPSS) software.

Table 2: Shapiro-wilk normality test for control group

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest Score	.91	18	.096
Posttest score	.93	18	.218

Table 3: Shapiro-wilk normality test for experimental group

	Shapiro-Wilk		
	Statistic	df	Sig.
Pretest score	.91	17	.103
Posttest score	.96	17	.709

In both cases the normality test shows a Shapiro-Wilk value of more than 0.05. This indicates that the data is normally distributed. It implies that the t-test could be used.

4.1 Pre-test Results and Discussion for the Control and Experimental Group

Table 4 and 5 shows the SPSS output prior to treatment

Table 4: Descriptive statistics for the Pre-test

Test	Group name	N	Mean	Std. Deviation
Pre-test	Experimental	17	38.53	18.09
	Control	18	35.83	21.51

Table 4 above shows the difference in the pre-test mean scores between the experimental and control group is 2.7. This very small difference in mean score indicated that the two groups started off at a same level. The mean for the experimental group pre-test scores was 38.53, Standard deviation was 18.09 and the mean for the control group was 35.83, standard deviation was 21.51. This difference is statistically insignificant showing that the results could not happen by chance.

Table 5: Independent sample t-test for the experimental and control group of pre-test

Type of test	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Pre-test equal Variances assumed	.40	33	.69	2.7	6.74	-11.01	16.41

Table 5 presents the independent sample t-test for the experimental and control group of pre-test. An independent sample t-test was used to analyse whether there was a significant difference between the mean scores of the experimental group and the control group for the pre-test before administration of the treatment to the experimental group. There was no significant difference in the pre-test scores (p-value = 0.69> $\alpha = 0.05, t = 0.40$) indicating that the difference in the mean score was not significant. This result illustrated that both the students in the control and experimental group were similar in abilities before the treatment was administered. Hence, the two groups are equivalent. This conclusion is supported by Field (2009), when the P-value is greater than the level of significance, set by the researcher, the null hypothesis is not rejected and the conclusion is that the two means did not differ significantly.

4.2 Post-test Results and Discussion for the Control and Experimental Group

Table 6 and 7 shows the SPSS output after treatment

Table 6: Descriptive statistics for the Post-test

Test	Group name	N	Mean	Std. Deviation
Post-test	Experimental	17	60	19.28
	Control	18	42.36	17.98

Table 6 above shows the experimental (M= 60, SD= 19.28) group and Control (M= 42.36, SD= 17.98) group.

The results in table 7 below indicated that the difference between the post-test scores of the experimental and control group are statistically significant (p-value = 0.01< $\alpha = 0.05, t = 2.80$). According to Field (2009), when the P-value is less than the level of significance, set by the researcher, the null hypothesis is rejected and the conclusion is that the two means do indeed differ significantly. Therefore H_0 was rejected and this implied that there was a statistically significant difference in achievement between the students instructed with earth model and those instructed with conventional teaching method.

Table 7: Independent Sample t- test for the experimental and control group of post-test

	t-test for Equality of Means						
Type of test	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Posttest Equal variances assumed	2.80	33	.01	17.64	6.30	4.83	30.45

It is also possible to determine the magnitude of the effect caused by the treatment.

Effect size

According to Pallant (2005: 208) effect size statistics provide an indication of the magnitude of the differences between the control and experimental groups, and not just whether the difference could have occurred by chance. One way to obtain effect size is to manually calculate eta squared since SPSS does not provide eta squared values for t-tests. Eta squared represents the proportion of variance in the dependent variable that is explained by the independent variable.

$$\text{Eta squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

Replacing the appropriate values from the post-test independent t-test output we have;

$$\text{Eta squared} = \frac{(2.80)^2}{2.80^2 + (17 + 18 - 2)}$$

$$\text{Eta squared} = 0.19$$

The guidelines proposed by Cohen (1988) for interpreting Eta squared values are: 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect. For our post-test results we can see that the effect size has large effect.

In line with these guidelines, it is clear that the obtained Eta squared value =0.19 shows a large effect which could have not occurred by chance. These results suggest that incorporating earth model in teaching earth geometry in mathematics does have an effect on in-service student teachers' performance.

4.3 Relationship between pre-test and post-test results for control and experimental group

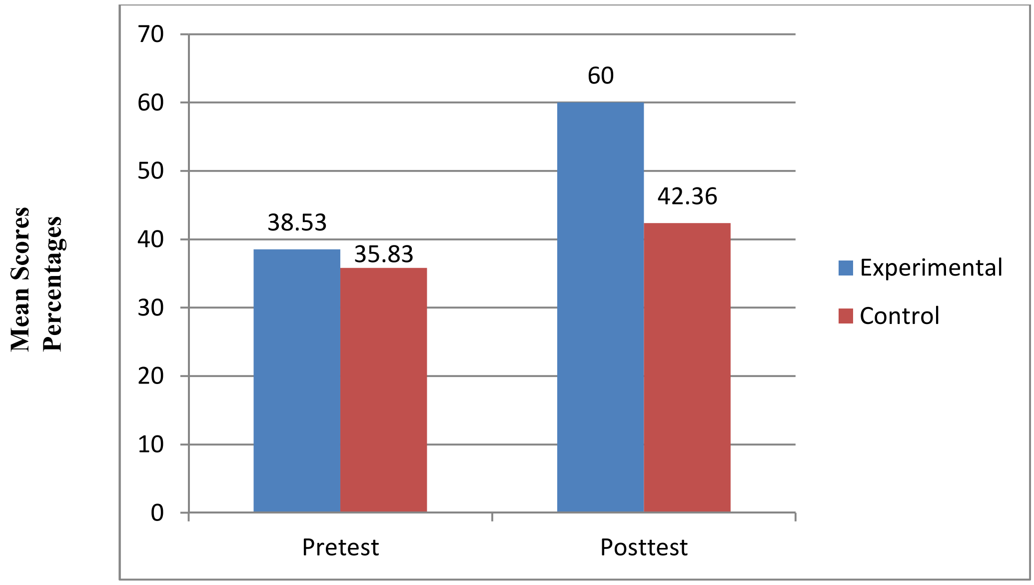

Figure 1: Pre-test and post-test results for control and experimental groups.

In this study shown that, the experimental group achieved significantly higher performance than the control group. The significant difference in mean score between the two groups is an indication of the effectiveness of the use of earth model in teaching Earth Geometry.

4.4 Questionnaire results and analysis

The response of student towards the use of earth model was discussed by making use of the questionnaire. According to survey Monkey (2014), a likert scale measures attitudes and behaviors using answer choices that range from one extreme to another (for example, not at all, likely to extremely likely). Students were asked to indicated on a 5 – point likert scale whether they strongly agree = 1, agree = 2, not sure = 3, disagree = 4 and strongly disagree = 5. This help to determine the degree of agreement about the use of earth model.

Key for the Likert Scale Items

Label	Likert Scale Item
A	Facts and concepts are learned easily.
B	Learners are able to visualize the latitudes and longitudes.
C	Learners do not easily forget the concept.
D	Imaginary lines on the earth are made visible.
E	Allow learners to explore on their own.
F	Allow learners to explain component parts of the earth using the earth model.
G	Draw the earth on the board each time you introduce a concept.
H	Provide concrete earth model for the learners.
I	ensure that learners can draw the earth and label it correctly.
J	Learners do not appreciate concrete materials.
K	Allow learners to explain their understanding of earth geometry.

4.4.1 Frequency and percentage of each response

Table 8: Students' in-service teacher's responses on the each perceived reasons on the concepts of earth model in understanding of Earth Geometry.

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
	Frequency	17	10	2	3	3
A	Percentage (%)	48.6	28.6	5.7	8.6	8.6
	Frequency	26	6	1	1	1
B	Percentage (%)	74.3	17.1	2.9	2.9	2.9
	Frequency	14	13	2	4	2
C	Percentage (%)	40	37.1	5.7	11.4	5.7
	Frequency	14	15	3	3	0
D	Percentage (%)	40	42.9	8.6	8.6	0
	Frequency	22	11	1	0	1
E	Percentage (%)	62.9	31.4	2.9	0	2.9
	Frequency	23	12	0	0	0
F	Percentage (%)	65.7	34.3	0	0	0
	Frequency	18	12	1	4	0
G	Percentage (%)	51.4	34.3	2.9	11.4	0
	Frequency	27	7	1	0	0
H	Percentage (%)	77.1	20	2.9	0	0
	Frequency	22	12	0	0	1
I	Percentage (%)	62.9	34.3	0	0	2.9
	Frequency	0	1	1	10	23
J	Percentage (%)	0	2.9	2.9	28.6	65.7
	Frequency	16	17	2	0	0
K	Percentage (%)	45.7	48.6	5.7	0	0

Brown (2011) advised against relying heavily on interpreting single items because single items are relatively unreliable. Brown went further to suggest that likert scales contain multiple items and are therefore likely to be more reliable than single items.

The data collected in Table 8 above had very few or no responses under "strongly disagree" and "disagree". Due to this observation, the responses of "strongly agree" or "agree" were converted into agree those for "strongly disagree" or "disagree" were converted into disagree for ease analysis of data. The responses converted into agree were considered to be indications of positive attitude while those converted into disagree were considered to be indications of negative attitude.

Item A investigated whether facts and concepts are learned easily. The results revealed that 17(48.6%) strongly agreed, 10(28.6%) agreed, 2(5.7%) was not sure, 3(8.6%) disagreed and 3(8.6%) strongly disagreed. After carrying out the conversions, the results reveal that 27(77.2%) students agreed and 6(17.2%) disagreed.

Item B dealt with whether the learners are able to visualize the latitudes and longitudes. The results showed that 26(74.3%) strongly agreed, 6(17.1%) agreed, 1(2.9%) was not sure, 1(2.9%) disagreed and 1(2.9%) strongly disagreed. Using the conversions, the results reveal that 32(91.4%) agreed and 2(5.8%) disagreed.

Item C dealt with whether learners do not easily forget the concept. The results revealed that 14(40%) strongly agreed, 13(37.1%) agreed, 2(5.7%) was not sure, 4(11.4%) disagreed and 2(5.7%) strongly disagreed. After carrying out the conversions, the results reveal that 27(77.1%) students agreed and 6(17.1%) disagreed.

Item D was used to investigate whether students do give a lot of examples to the learners. The results showed that 14(40%) strongly agreed, 15(42.9%) agreed, 3(8.6%) were not sure and 3(8.6%) disagreed. After carrying out the conversions, the results reveal that 29(82.9%) students agreed and 3(8.6%) disagreed.

Item E investigated whether the students do allow learners to explore on their own. The results revealed that 22(62.9%) strongly agreed, 11(31.4%), 1(2.9%) was not sure and 1(2.9%) was strongly disagreed. After carrying out the conversions, the results reveal that 33(94.3%) students agreed.

Item F dealt with whether the learners are allowed to explain the component parts of the earth. The results showed that 23(65.7%) students strongly agreed and 12(34.5%) students agreed. No student expressed the opinion that he or she did not relate the component of the earth. Converting the responses of strongly agreed or agree into agree and those for strongly disagree or disagree into disagree, the outcome suggested that all the students agreed 35(100%).

Item G was used to investigate whether students do draw the earth on the board each time they introduce a concept. The results showed that 18(51.4%) strongly agreed, 12(34.3%) agreed, 1(2.9%) were not sure and 4(11.4%) disagreed. After carrying out the conversions, the results reveal that 30(85.7%) students agreed and 4(11.4%) disagreed.

Item H was used to investigate whether the student provide concrete earth model to the learners. The results showed that 27(77.1%) strongly agreed, 7 agreed and 1(2.9%) was not sure. Using the same reasoning given earlier, the results suggest that 34(97.1%) students agreed.

Item I was used to investigate whether the students do ensure that learners can draw the earth and label it correctly. The results showed that 22(62.9%) strongly agreed, 12(34.3%) agreed and 1(2.9%) was strongly disagreed. Using the same reasoning given earlier, the results suggest that 34(97.2%) students agreed and 1(2.9%) was disagreed.

Item J dealt with whether the learners do not appreciate concrete materials. The results showed that 1(2.9%) students agreed, not sure 1(2.9%), 10(28.6%) disagreed and 23(65.7%) students strongly disagreed. Converting the responses of strongly agreed or agree into agree and those for strongly disagree or disagree into disagree, the outcome entail that the majority of students 33(94.3%) students disagreed.

Item K used to investigate whether the student allow learners to explain their understanding of earth geometry. The results showed that 16(45.7%) strongly agreed, 17(48.6%) agreed and 2(5.7%) was not sure. Using the same reasoning given earlier, the results suggest that 33(94.3%) students agreed.

4.5 In-service student teachers' responses on the open ended questions on the questionnaire

This information was collected with a view of understanding the impact of earth model and also to learn about the best teaching approaches for promoting understanding of earth geometry by in-service student teachers. It also requested the measures to be undertaken in order to improve the teaching of earth geometry by those schools that have been performing well.

4.5.1 The first question states:

Explain in what ways the use of earth model can enhance understanding of earth geometry?

The first suggestion was that learners are able to visualise the earth and they don't forget the concept easily and accounted for 77.14%. The second suggestion was that the earth model enhances the attention for the learners resulting in understanding of earth geometry and accounted for 25.7%. The last suggestion was that learners develop interest and grasp the concept easily and the response was 34.28%.

4.5.2 The second question states:

State the best methods that can be used in teaching the topic earth geometry effectively?

The highest best method mentioned was Group discussion which was accounted for 40% and reason given was that, learners will work collaboratively in groups hence discover new things. The second method which was suggested was Group work which was accounted for 34.28% and that learners learn well on their own. Demonstration method was mentioned which accounted for 25.7% and the reason given was, it is practical with the aid of the model. The other method was Discovery which accounted for 22.85% and the reason given was, learners will be able to research or discover things on their own and enhancing understanding earth geometry. Question and Answer method was accounted for 14.28% and the reason given was, it is to check the understanding. Project method was also mentioned which accounted for 8.57% and the reason given was, learners ask to make the model will be difficult to forget. The last one mentioned was Teacher exposition or explanation which was accounted for 8.57% as well and the reason given was, learners can follow through.

4.5.3 The third question states:

Suggest the measures to be undertaken in order to improve the teaching of earth geometry?

Below are some of the measures that in-Service Teachers suggested;

(i) Earth model should be used correctly as teaching aids.
(ii) Involve learners to explain what they are seeing and participating in making models.
(iii) Teacher to be conversant with the lesson and prepare in advance.
(iv) Complementing continuous professional development meetings in schools.
(v) Use of different teaching methods.
(vi) Relate lessons to real life situations.
(vii) Computer simulation of earth model application and mathematics laboratory.
(viii) Schools to be availed with examination report.

The above suggestions were then used as codes and with the help of qualitative data analysis software, QDA miner version 4.0, percentage with which each one appeared in the transcript were computed. It was discovered that 71.4% suggested for (i) and 28.57% suggested for (ii). The response for (iv) was 20% and 14.28% was for (iii). The response for (v) was 11.43% while both the sixth and seventh suggestions each accounted for 5.7% of the total number of responses. The last which is (viii) accounted for 2.85%.

5. DISCUSSION OF THE FINDINGS

The discussion of the findings focused on how the three research questions were addressed.

5.1 Impact of using earth model in understanding Earth Geometry

The use of earth model can enhance understanding of earth geometry in mathematics at Mukuba University. The suggestion was that learners are able to visualise the earth and they don't forget the concept easily and accounted for 77.14%. The other suggestion was that the earth model enhances the attention for the learners resulting in understanding of earth geometry and accounted for 25.7%. Furthermore, the learners develop interest and grasp the concept easily and the response was 34.28%. At this stage of learning Earth Geometry, learners need experiences that incorporate concrete operations and abstraction. This is in support of Piaget's theory which centered on the process of assimilation and accommodation of information into the schema of the learners. The theory stresses the importance of human interaction and physical manipulation in the acquisition of knowledge. This is in agreement with the study conducted by Tembo (2013), which suggests that the teaching of geometry should be sequential and that no level should be bypassed. Many teachers, however, inappropriately believe they are applying Piaget's theory when they merely show objects to learners instead of letting them manipulate the objects and make their own mathematical connections. Earth geometry is one area of Mathematics which requires models in teaching it in order to help learners establish and interpret mathematical connections. The theories demand that teachers should provide concrete models in their instruction in Earth Geometry and the sequential order must be followed to ensure that no level is skipped in teaching Earth Geometry. So lack of teaching aids can make it difficult for the learners to visualize the spherical nature of earth in three dimensions.

5.2 Teachers' Responses on the best methods that can be used in teaching earth geometry

The focus is on the best methods that can be used in teaching and learning earth geometry. Learner centred teaching methodology was found to dominate the best teaching. One of them was group discussion which was accounted for 40% and reason given was that, learners will work collaboratively in groups hence discover new things. This is supported by Hsiung (2012) who argues that students who work together exhibit high academic achievement. The second method which was suggested was Group work which was accounted for 34.28% and that learners learn well on their own. A more effective way of managing large classes would be to make use of group work. According to Smith (2010), group work can be used to better engage students in academic content. Demonstration method was mentioned which accounted for 25.7% and the reason given was, it is practical with the aid of the model. The other method was Discovery which accounted for 22.85% and the reason given was, learners will be able to research or discover things on their own and enhancing understanding earth geometry. Question and Answer method was accounted for 14.28% and the reason given was, it is to check the understanding. Project method was also mentioned which accounted for 8.57% and the reason given was, learners ask to make the model will be difficult to forget. The above mentioned methods were categorized as learner centred. The last one mentioned was Teacher exposition or explanation which was accounted for 8.57% as well and the reason given was, learners can follow through. This method can be referred to teacher centred method. These findings are not related with the findings of Tembo (2013), which noted that the majority 31(43.1%) of the teachers stated that the lecture method was a suitable approach in teaching Earth Geometry. According to the researcher, Class discussion together with question and answer are the best methods in the sense that some learners do not participate in group discussion but during class discussion and question and answer, the teacher can try to involve as many learners as possible. However, this is at variance with modern education which focuses on teaching skills required to survive in the modern world of science and technology. On the other hand, those who used learner centred methods of teaching indicated that they preferred those methods of teaching because of the following reasons; (i) enhancing hands on activities, (ii) they involve leaners, which helps them to grasp the concepts quickly, (iii) it is easy for learners to remember what they see, (iv) for easy interaction among leaners and with the teacher, and (v) to learn about the views of leaners. Group discussion was one of the most cited teaching methods under learner centred teaching methodologies. In this respect, it suffices to state that these categories of teachers who employ learner centred teaching methodology are in line with the dictates of modern teaching of mathematics and science. For instance, Land and Hanna fin (2000) indicated that some core concepts of student-centred learning and instruction are: (a) creating multiple experiences for knowledge construction; (b) creating authentic and complex sociocultural learning environments to mediate learning. Additionally, according to Heggart (2016), it seems obvious that, if you are going to teach a subject, then you should really know a lot about the subject. According to Constructivist theorists, learners discover knowledge when they perform hands-on activities, implying that if the teaching materials in a school are not used for their intended purpose, learners have no opportunity to discover knowledge.

5.3 The measures to be undertaken in order to improve teaching of earth geometry

The focus is on measures to be undertaken in order to improve teaching and how teachers handle content and pedagogical issues during the teaching process. Suffice to say that 71.4% of the in-service student teachers suggested the use of Earth model should be used correctly as teaching aids in mathematics. This was followed by Involving learners to explain what they are seeing and participating in making models which stood at 28.57%, while 14.28% of the respondents pointed out that Teachers should to be conversant with the lesson and prepare in advance. Teachers should be encouraging learners to study hard and give them as many questions as possible for practice. Studying hard requires an element of self-directed and self-regulated learning, which according to Ainley and Patrick (2006), who presented evidence which showed students' state of interest can lead to mastery of tasks and high achievement. In the same vein, teachers without preparing to teach maybe due to the teachers' poor subject content matter knowledge or indeed poor pedagogical knowledge or both (PCK). Lack of pedagogical content knowledge by the teachers may lead to learners having challenges in teaching earth geometry, because they may not be competent to handle both the content matter, or may not have the requisite pedagogical knowledge to put the content matter in a form for pupils' easy learning. This may be the reason why pupils revealed in Chisembe (2017) that some teachers skip certain topics. The adverse effects such practices have on pupils' performance cannot be over emphasized. 20% of the respondents indicated that continuous professional development meetings in schools should be encouraged by school administrators. It's quite unfortunate to learn that even some new teachers from colleges and universities are quite blank about certain new topics. This can only be sorted out if universities and colleges can incorporate the new topics in their curricula. It can also be overcome by allowing one teacher who knows the topic to teach while others observe or through Continuous Professional Development (CPD) meetings. Other measures should undertake by school administrators is to improve the performance of pupils in their respective schools should include; homework policy, remedial policy, interclass quiz, monthly tests, period wise registers and intensifying club activities such as Junior Engineers, Technicians and Scientists (JETS). In addition, some school administrators should ensure that pupils who fail end of year tests were not allowed to progress to the next grade. Schools to be availed with examination report. Lastly the respondents suggested the use of different teaching methods which was accounted for 11.43%. A comparison of lecture combined with discussion versus active, cooperative learning methods by Morgan, Whorton, & Gunsalus (2000) demonstrated that the use of the lecture combined with discussion resulted in superior retention of material among students.

5.4 Challenges faced by in-service student teachers on Earth Geometry

According to Appendix 2 on post- test, the study revealed that some in-service student teachers encountered difficulties in answering well question 3 and 4. Question 3 was about the shortest distance between points and question 4 was about surface area between two meridians, these questions involved analysis, deduction and rigor. Probably, because of the failure by the leaners to attend to the full dictates of specific questions, or indeed failure to communicate answers using the subject Language terminologies may be surprised that they had failed the seemingly simple examination. This challenge can be alleviated when teachers elaborate the restricted code of a subject during lessons (Bernstein, 1971). Further, the teacher should teach pupils how to communicate their responses to examination questions. This entails that student teachers' challenges in Earth Geometry were at level 2, 3 and 4 of old version of the Van Hiele model. Suffice to say that, serious limitations by almost all the in-service student teachers who took part in the study were noticed at these levels. The study concluded that three quarters of the in- service student teachers who were involved in the study operated at level 1, level 2 and level 3 of the Van Hiele model. It can therefore be argued that the difficulties that in-service student teachers encountered when trained were passed on to the classroom. The major source of the difficulties that teachers encountered in teaching Earth Geometry was the institution of training and more especially institution which have not include classroom new topics in their course outline. In this case it is important that those tasked with the responsibility of teacher training institutions should address the challenges encountered by the teachers to avoid their reoccurrence in the classroom. In line with this finding, the ECZ mathematics examiners' report (ECZ, 2006) advised ZAME to address the challenges encountered by teachers in teaching Earth Geometry because of the poor performance which was noted at the end of the year in school certificate results. This was the case as questions on Earth Geometry were either poorly done or very poorly done by most learners (ECZ, 2006) because of the challenges that teachers encountered in teaching Earth Geometry.

The researcher conducted also a textbook analysis on earth geometry selected mathematics textbook from the secondary school level of Zambia. It was found that textbooks were lacking a concept of surface area between two meridians and detailed about shortest distance between two meridians. The implication of lack of quality textbooks to read or study is that learners to a large extent cannot search for knowledge by reading on their own, but only rely on the teacher as the source of knowledge. This is it variance with the constructivist thought which encourages the active involvement of learners in the pursuit of knowledge (Schmidt, et al., 2007). This is in line with the submission made by Tembo (2013) that some newly introduced topics especially earth geometry and computer in mathematics were challenging to teachers. He indicated that even those new graduates from universities do not seem to be well grounded in the said topic. The teacher should ensure that learners learn meaningfully by putting learners at the Centre of the learning process. However, it involves developing explanations that are meaningful and making sense to others (Clements & Battista, 2000). Strutchens (2001) advised that instruction in geometry should emphasise hands-on explorations, developing geometric thinking and reasoning, making conjectures and carrying out geometric projects. This can enable leaners to unlearn, relearn, and learn the correct mathematics content and processes (Toffle, 2009), when coupled with immediate feedback such as marking of tests and class exercises. In this regard, the results of the present study are line with the observation made by Tembo (2013) which suggested that the use of the globe and suitable teaching aids to be among the solutions to some challenges teachers face in teaching earth geometry. The researcher also suggested that using teaching aids in geometry can help leaners learning how to learn (Novak, 1984). Similarly, the results are also in line with Zemene (2015) who examined the roles of models on students' conceptual understanding of geometry in Addis Ababa University in Ethiopia. The data were collected using pre-test and post-test and analysed using a t-test. The result indicated that the use of models in teaching geometry has significance in geometry classes. From the results obtained; a number of implications can be forwarded in the interest of improving earth geometry teaching in the classroom. Also, the significant differences in earth geometry achievement of the experimental group as compared to the control group indicate that the earth model shows promising potential of teaching earth geometry at Mukuba University. The result of this study is consistent with the Sanders (1998) study which reported that the addition of dynamic geometry software in geometric construction had increased her students' interest in geometry as well as enhancing their understanding. This observation can therefore encourage classroom teachers and even curriculum developers of the potential of the earth model as effective tool in learning and teaching earth geometry.

6. KEY FINDINGS

i. The mean for the experimental and control group pre-test scores were statistically insignificant. This implied that the control and experimental group started at the same level. No group was superior to the other.
ii. The mean for the experimental and control group post test scores were statistically significant. The fact that the control and experimental group started at the same level, then the difference that was observed between the post- test scores of the two groups was due to the treatment. The experimental group outperformed the control group. The use of Earth model was, therefore, more successful than Conventional method.
iii. The questionnaire findings showed that students had positive attitude towards the use of Earth model.

7. CONCLUSION

This study compared the impact of earth model strategy to the conventional method strategy. A statistical difference was observed between the experimental and control groups. The experimental group performed better than the control group. The results showed that earth model was a better teaching aid when teaching earth geometry to undergraduate students. Earth model, therefore, helped students learn meaningfully. Meaningful learning takes place when we grasp the interrelationship between two or more ideas, old and new. This study also showed that students had positive behavior towards earth model. The highest best method mentioned was Group discussion which was accounted for 40% and reason given was that, learners will work collaboratively in groups hence discover new things. Students indicated that they used earth model for relating new information to the old. Finally, this study showed that using earth model when teaching the learners can enhance the understanding of Earth Geometry.

7.1 Recommendations of the study

Based on the findings of the study the following recommendations were made:
1. The University must encourage lecturers to adopt the use of earth model in Mathematics.
2. Lecturers must set aside time for teaching earth model to student.
3. Subject associations such as the Zambia Association for Mathematics Education (ZAME) and School managers, should consider this as a matter of agency to send serving mathematics teachers for training and seminars or continuous professional Development (CPD) meetings for effective teaching of mathematics and geometry in particular.
4. The new books for mathematics must be written which should cater more on shortest distances and surface area between two meridians on Earth Geometry.

7.2 Recommendations for Future Research

The current study findings present a number of research needs.
1. Studies similar to the current one must be conducted in other Universities in the country. This can help to assess if the findings of the current study can be generalised.
2. A similar study must be conducted to the pre-service students in colleges and Universities and also to pupils in secondary schools.

8. REFERENCES

Adolphus, T. (June 2011). Problems of Teaching and Learning of Geometry in Secondary schools In Rivers state, Nigeria. Int.j. Emerg. Sci., 1(2), ISSN: 2222-4254, 143-151.

Ainley, M.,& Patrick, L. (2006). Measuring self- regulated learning processes through tracking patterns of student interaction with achievement activities. Educational psychology Review, 18, 267-286. Doi:10,107/51064-006-9018-z.

Ali, I., Bhagawati, S. & Sarmah, j. (2014). Performance of Geometry among Secondary school Students of Bhurbandha CD Block of Morigaon, District, Assam, India. International Journal of innovative Research & Development, Vol. 3, No. 11.

Baki, A. (1998). " Balance of Conceptual and procedural Knowledge in Mathematics Education." In Mathematics Symposium for the 40th Anniversary of Ataturk University. Erzurum, Turkey, Special Number. Pp. 259-263. Bankov, K. (2013). Teaching of Geometry in Bulgaria. European journal of Science and Mathematics Education, Vol, No. 3.

Battista, M.T. (2007). The development of geometric and spatial thinking. In F.K. Lester (Ed), second handbook of research on mathematics teaching and learning (pp 843 – 908). Charlotte, N.C : Information Age Publishing.

Battista, T.M., & Clements, H.D. (2000). Geometry Instruction. In L.S. Grinstein and I.S. Lipsey (Eds.) Encyclopedia of Mathematics Education, London: Routledge Falwer.

Bhagat, K.K.& Chang, C.Y. (2015). Incorporating Geogebra into Geometry learning. A lesson from india. Eurasia journal of Mathematics, Science and Technology Education, 11(1): 77-86.

Bernstein, Basil. (1971). Class, codes and control: Theoretical studies Towards a sociology of language. London: Routledge & Kegan paul. Pp125-126, 127, 151, 143, 151-15211world cat.

Boyer, M. M.(2013). Underwriting apophenia and cryptids: Are cycles statistical figments of our imaginations?

Brown, J. D. (2011). Questions and answers about language testing statistics: Likert items and scales of measurement? University of Hawaii: Manoa.

Chisembe, C.(2017). Challenges Encountered by Secondary school Teachers and pupils in Earth Geometry. Unpublished Masters Dissertation, Copperbelt University. Zambia.

Cohen, J. (1988). Statistical power Analysis for the Behavioral Sciences. Hillsdale, NJ: Erlbaum.

Curriculum Development Centre, (2013). Mathematics High school syllabus Grades 10-12, Lusaka.

Examination Council of Zambia. (2004). School Certificate and GCE mathematics Examiners Report, Lusaka.

Examination Council of Zambia. (2006). School Certificate and GCE mathematics Examiners Report, Lusaka.

Examination Council of Zambia. (2008). School Certificate and GCE mathematics Examiners Report, Lusaka.

Examination Council of Zambia. (2015). School Certificate and GCE mathematics Examiners Report, Lusaka.

Examination Council of Zambia. (2016). School Certificate and GCE mathematics Examiners Report, Lusaka.

Field, A. (2009). Discovering Statistics using SPSS (3rd edition). SAGE, New Delhi.

Glenda. A, and Margaret. W.(2009) Effective pedagogy in mathematics. International Academy of Education and International Bureau of Education.

Hannan, A. (2007). Interviews in education research. www.edu.plymouth.ac.uk.

Heggart. K. (2016). How important is the subject matter knowledge for a teacher. Sydney, Australia. Community @edutipia.org.

IBM. (2011). IBM SPSS Statistics 20 Brief Guide: IBM Corporation.

Institute for Digital Research and Education (IDRE) (2014). Annotated SPSS Output: t-test.

Jones, K. (2002), Issues in the Teaching and Learning of Geometry. In: Linda Haggarty (Ed), Aspects of Teaching Secondary Mathematics: perspectives on practice. London: Routledge Falmer. Chapter 8, pp 121-139. ISBN: 0-415-26641-6.

Jones, K. (2000). Teacher Knowledge and Professional Development in Geometry. Rowland, T (Ed), Proceedings of the British Society for Research into Learning Mathematics, Vol. 20, No.3

Kalejaiye, A. O. (2000). Teaching Primarily Mathematics, Hong Kong: Longman Asia limited.

Kirby, J.R., & Schofield, N.J. (1991). Spatial cognition: The case of map Comprehension. In G. Evans (Ed), Learning and teaching cognitive skills. Retrieved on 12 February, 2012, from http://trove.nla.gov.au/work/153175245?versionId=166932396

Knight,K. C. (2006). An investigation into the change in the VanHiele level of understanding geometry of pre-service elementary and secondary mathematics teachers.

Kombo, D.K. and Tromp, D.L. (2006). Proposal and Thesis writing, Nairobi: Pauline's publications Africa.

Land, S. M., & Hanna fin, M. J.(2000). Student-centered learning Environments: Foundations, Assumptions, and Design.

Larson, R.E., Laurie, B.,& Lee, S. (1995). Geometry: An Integrated Approach, Toronto: D.C. Heath and Company.

Lim, C. S., and Hwa, T. Y. (2007). Promoting Mathematical thinking in the Malaysian classroom: Issues and challenges. Centre for research on international cooperation in Educational Development (CRICED), University of Tsukuba.

Masaiti, G. and Manchishi, P. C. The University of Zambia Pre-service Teacher Education Programme: Is it responsive to Schools and Communities' Aspirations? European Journal of Educational Studies 3(2),2011

Mayberry, J. (1983). The Van Hiele levels of geometry thought in undergraduate pre-service teachers. Journal for Research in Mathematics Education. 14(1), 58-69.

Ministry of Education. (MOE). (1996). Educating our Future: National Policy on Education. Lusaka, Ministry of Education.

Ministry of General Education, (2013). Teachers' Curriculum Implementation Guide. ZESSTA, Lusaka, Zambia

MOGE. (2016). Annual Report for 2015. Ministry of General Education: Lusaka.

Morgan, R., Whorton, J., & Gunsalus, C. (2000). A comparison of short term and long term retention: Lecture combined with discussion versus cooperative learning. Journal of instructional psychology, 27(1), 53-58.

Noraini, I. (2009). The impact of using Geometers' sketchpad on Malaysian students' achievement and Van Hiele Geometric Thinking. Journal of Mathematics Education, vol.2, No. 2 pp 94 – 107.

Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. New York: Cambridge University press.

Pallant, J. (2005). SPSS survival manual: A step by step to Data analysis using SPSS for windows (Ver 12). Sydney: Allen & Unwin.

Sanders, C. V. (1998). Geometric Constructions: Visualizing and Understanding Geometry. Mathematics Teacher, 91, 554 -6.

Schwartz, J.E. (2008). Elementary Mathematics Pedagogical Content Knowledge: Powerful Ideas for Teachers, Washington: Pearson Education Inc.

Tembo, O.F. (2013).The perception of teachers and pupils regarding the teaching and learning of earth geometry. Thesis report Submitted to UNZA for Master's Degree in Mathematics.

Toffle, A. (2009). Rethinking the future.

Van Hiele, P.M. (1999). Developing geometric thinking through activities that begin with play. Teaching children Mathematics, 5(6), 310-316.

Zemene, M. (2015). Roles of models on students conceptual Understanding of Geometry in Addis Ababa University. Addis Ababa, Ethiopia.