Factors Affecting Poor Academic Performance in Earth Geometry at School Certificate Level: A Case of Three Selected Secondary Schools in Mansa District

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***Abstract*: - Most research in Mathematics education concentrate on factors affecting performance in mathematics in general, little research considers factors affecting performance in Earth Geometry. Thus, this study investigates factors affecting poor academic performance in earth geometry at school certificate level. This was a case of three selected secondary schools in Mansa District of Luapula province. Sixty six grade twelve pupils were randomly selected to participate in the study, and sixteen mathematics teachers were also purposively selected to form the sample population. The collected data was analyzed using SPSS (version 20), which allowed for simple frequency counts and percentages and data from interviews were analyzed thematically. The results might be so useful to policy makers, the government, teachers of mathematics, and teacher training colleges and universities in coming up with policies that enhances conducive teaching and learning of Earth Geometry. The study established that the topic had many formulae, the topic was not well taught due to teachers aiming at finishing covering the syllabus, and the topic lacked practical examples from local communities. The findings further revealed that there was need to introduce basic Earth Geometry at junior level and relevant text books needed to be supplied in schools. An implication for policy makers is that inclusion of formulae on the topic in the Examination Council of Zambia examination paper would reduce miss application of formulae.**

Key words: **Mathematics Education, Earth geometry, poor academic performance, case study, Zambia.**

I. INTRODUCTION

The knowledge of mathematics is an essential tool in our society (Baroody, 1987). It is a tool that can be used in our daily life to overcome the difficulties faced (Bishop, 1996). Due to this mathematics has been considered as one of the most important core subject in the Zambian school curriculum (MoE, 1996). More mathematics lessons are likely to be taught in schools and colleges throughout the world than any other subject (A. Orton, D. Orton, & Frobisher, 2004). However, the standard tests and evaluations reveal that pupils do not perform to the expected level. The pupils' under achievement in mathematics is not just a concern for a particular country, but has become a global concern over the years (Pisa, 2003).

The senior Zambian mathematics syllabus contains many topics such as Statistics, Probability, Transformation, and Earth Geometry. Of particular interest to this study is Earth Geometry. The word 'geometry' comes from two ancient Greek words, one meaning earth and the other meaning to measure. These Greek words, as well as the word 'geometry', may themselves be derived from the Sanskrit word 'Jyamiti ' (in Sanskrit, 'Jy a' means an arc or curve and 'Miti' means correct perception or measurement). The origins of geometry are very ancient, it is probably the oldest branch of mathematics, with several ancient cultures such as Indian, Babylonian, Egyptian, and Chinese, as well as Greek, developing a form of geometry suited to the relationships between lengths, areas, and volumes of physical objects. In these ancient times, geometry was used in the measure of land or, as we would say today surveying, and in the construction of religious and cultural artefacts. Examples include the Hindu Vedas and the ancient Egyptian pyramids (Jones, 2002). The British mathematician, Sir Christopher Zeeman stated that geometry comprises those branches of mathematics that exploit visual intuition (the most dominant of our senses) to remember theorems, understand proof, inspire conjecture, perceive reality, and give global insight (Royal Society/JMC, 2001).

Having looked at the origin of Geometry, it is imperative to focus attention on the importance of Earth Geometry. Geometry is a wonderful area of mathematics to teach. It is full of interesting problems and surprising theorems. Geometry appeals to our visual, aesthetic and intuitive senses (Van Hiele ,1959). It is therefore a topic that captures the interest of learners, often those learners who may find other areas of mathematics, such as number and algebra, a source of bewilderment and failure rather than excitement and creativity. Teaching and learning geometry well can mean enabling more learners to find success in mathematics. It

involves knowing how to recognise interesting geometrical problems and theorems, appreciating the history and cultural context of geometry, and understanding the many and varied uses to which geometry is put, as well as appreciating what a full and rich geometry education can offer to learners (Jones, 2002).

The Royal Society/JMC (2001) report suggested the following as aims of teaching geometry to learners:

- To develop spatial awareness, geometrical intuition and the ability to visualize.
- To provide a breadth of geometrical experiences in 2 and 3 dimensions.
- To develop knowledge and understanding of and the ability to use geometrical properties and theorems.
- To encourage the development and use of conjecture, deductive reasoning and proof.
- To develop skills of applying geometry through modeling and problem solving in real world contexts.
- To develop useful ICT skills in specifically geometrical contexts.
- To engender a positive attitude to mathematics.
- To develop an awareness of the historical and cultural heritage of geometry in society, and of the contemporary applications of geometry.

According to Volderman (1998) geometry provides a more complete appreciation of the world we live in. For instance, Earth Geometry's focus on spherical geometry is important in the sense that it enables learners gain knowledge of how to locate different places on planet earth. It also enables learners to comprehend that differences in longitudes of different places brings about differences in time. The study of geometry contributes to helping learners develop the skills of visualization, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument and proof.

Previous studies on performance of learners in Earth Geometry showed that both learners and teachers have difficulties in learning and teaching concepts (Ozerem, 2012; Sunzuma, Masocha, and Zezekwa, 2013;Jacques and Fabien, 2015; Jones, 2002). Tembo (2012) stated that the dismal performance in the topic had been attributed to a number of the following factors:

- Competitive structured classrooms.
- Specialized mathematical language.
- The quality of text books.
- Lack of teaching and learning materials.
- Negative attitude towards mathematics.
- Unsuitable teaching methods.
- Social background factors.

Performance in mathematics in many countries has been low (Delamont, 1992). In Kenya for instance, the performance of learners at Kenya Certificate of Secondary Education in Mathematics had been below average (K.N.E.C, 2008). In recognition of the value of mathematics, the Ministry of Education, Science and Technology (MOEST) in Kenya made mathematics a compulsory subject in both primary schools and secondary schools (Costello, 1991). In Zambia however, the experience was not different from other countries. Pupils as well performed poorly in mathematics (MESVTEE, 2013). Chief examiners report for Mathematics paper two (2017; 60) reveals that the question on Earth Geometry was not very popular and majority of the candidates who attempted it did not do very well.

Against this background, the purpose of this study is therefore to investigate factors affecting poor performance in Earth Geometry at school certificate level in some selected schools in Mansa District. More specifically, this research has four objectives:

- To find out difficulties teachers experience in teaching Earth Geometry in secondary schools.
- To find out difficulties learners experience in learning Earth Geometry in secondary schools.
- To investigate the causes of the teaching and learning difficulties.
- To establish possible ways to minimise teaching and learning difficulties experienced by teachers and learners respectively.

The findings from this research are expected to assist Policy makersin coming up with policies that enhances conducive teaching and learning, the government and other agencies to formulate future initiatives in teaching, curriculum and teacher development, and teacher training colleges and universities in identifying areas in the training programs that might need change. Findings will also assist teachers of mathematics in improving teaching methodologies. The study was conducted in Mansa district of Luapula province, and three selected secondary schools were targeted. The units of analysis are the individual grade twelve pupils and mathematics teachers.

The rest of the article is structured as follows: first the literatures review and methodology are presented, and this will be followed by presentation of findings, discussion, conclusion, and recommendations.

II. LITERATURE REVIEW

The general aim of mathematics is stated as making an individual acquire the mathematical knowledge needed on daily basis. However, to acquire mathematical concepts, one should be able to visualize the diagrams. This part covers the following areas: teaching and learning of geometry, strategies that enhance quality of teaching and learning of Earth Geometry in secondary schools, theory of learning Earth Geometry, and relevance of teaching Earth Geometry in secondary schools.

2.1. Teaching and learning of geometry

Earth Geometry comprises a branch of mathematics that exploit visual intuition (the most dominant of our senses) to remember theorems, understand proof, inspire conjecture, perceive reality, and give global insight (Royal Society/JMC, 2001). According to Atiyah (2000) geometry provides a culturally and historically rich context within which to do mathematics.

Jacques and Fabien (2015) stated that for students from 5 to 8 years old, the spatial and geometrical learning concern mainly the control of its relations to real space, the recognition of objects and shapes, and their representation by drawings using straight lines.

Curriculum Development Centre (2000) stated that Mathematics based learning should be done according to three aims, that is, learners acquiring mathematical concepts, understanding mathematical operations, and to help learners make connections with the concepts and operations. However, the teaching and learning of mathematics in schools according to Davar (2012) is still dominated by teacher-centred and textbook oriented approach. There is minimal use of visualisation tools such as the dynamic geometrical tool and graphing tools in mathematics classroom. One of the reasons is because of the teachers' attitude and beliefs about mathematics and the use of these visualization tools. Another reason is because of limited skills of using these tools (Tembo, 2009).

In order to effectively teach geometry to learners of any age or ability, it is important to ensure that students understand the concepts they are learning and the steps that are involved in particular processes rather than the students solely learning rules (Schwartz, 2008). More effective teaching approaches encourage students to recognise connections between different ways of representing geometric ideas and between geometry and other areas of mathematics.

Kalejaiye (2000) states that poor performance in geometry is as a result of teachers who do not involve learners in their teaching and who adopt the rote learning style. Geometry teaching should have a connection between class work and real situations, as this enables learners to see the relevance of the topic. The document National Council of Teachers of Mathematics(NCTM) (2000) recommended that geometric topics be introduced and be applied to real world situations whenever possible. Learners fail in mathematics because of rarely getting help in their learning process. If they achieve academic success on certain mathematics exams, they think that there were instability factors, such as luck. Otherwise, failures are based on some uncontrollable factors, such as knowledge of mathematics foundations and loss of interest in the subject. Learners' self-confidence can be enhanced through guiding them to improve learning skills and correct negative attribution (Slavin, 2003). Chifwa (2015) stated that the most cited reasons for learner's poor grasp of the topic (Erath Geometry) were attributed to learners' negative attitude towards mathematics, teachers' failure to inspire learners and to explain concepts clearly, and lack of teaching aids which made it difficult for the pupils to visualize the spherical nature of earth in three dimensions.

Among some methods that could enhance teaching and learning of earth geometry is the Lecture method, which is one of the teacher centred methods of teaching. Davar (2012) and Ministry of Education, Science, Vocational Training and Early Education ([MESVTEE], 2014) mentioned that lecture method can be used when teaching a large number of students. Demonstration is another teacher centred method that can be used in teaching Earth Geometry. Muzumara (2008) defined demonstration as a repetition of a series of planned activities which are designed to illustrate a certain phenomenon or event. A discussion which is an exchange of opinions or ideas is one of the student centred teaching methods that can also be used in teaching Earth Geometry.

Slavin (2003) addresses four helpful general principles for supporting learners with a tendency to accept failure: (1) Accentuate the positive. As a teacher, understand the learners' strengths and use these to develop their confidence, (2) Eliminate the negative. Teachers ought to deal with the learner's weaknesses tactfully. Talk to the learners and develop a plan to improve learning, (3) Go from the familiar to the new, using advanced organizers or guided discovery; and (4) Create challenges in which students actively create problems and solve them using their own knowledge and skills.

2.2. Strategies that enhances quality of teaching and learning of Earth Geometry in secondary schools.

There are many factors that contribute to the quality of teaching and learning of Earth Geometry in secondary schools, such as the availability of adequate teaching and learning materials, teacher qualifications, contact time between pupil and teacher and also motivation of teachers. Poor state of classrooms and facilities such as laboratories, workshops and other infrastructures could affect the quality of education delivery (Educational Statistical Bulletin, 2005). Other factors include teaching methodologies, assessments, planning and resource management, physical environment, co-curricular activities, continuing professional development (CPD), subject associations, and research.

Teaching methods are chosen on the basis of fitness for a particular purpose (Petty, 2009). The teacher first has to clarify the purposes of the lesson and then choose activities which will achieve these purposes. Anderson (1994) stressed that student learning achievement may heavily depend on the teacher's instructional planning, teaching method selection, and on a variety of learning activities. It is important that teachers use a variety of teaching methods and techniques in order to cater for the range of learning needs. Teachers should as well use methods that encourage learners to reflect, think and do rather than reproduce from rote learning.

Nwokoukwu (1979) classified teaching techniques into two groups, namely, the group techniques and the individualised techniques. The group techniques include discussion, demonstrations, field trips, and role playing. The individualised techniques include supervised study, experiments and independent study. Similarly, Henson (1988) calling them "strategies," mentioned others including lecture, tutoring, inquiry learning, questioning, discovery learning, and simulation games. Phipps et al. (1988) added teaching facilities, computers and audio-visual aids to the teaching strategies in secondary schools. West and Osborne (1995: 260) stated that students' thinking skills and problem solving abilities can be developed by teaching activities, especially by the selection of an appropriate teaching approach.

Learning aids are devices or mechanisms designed to make learning more effective, efficient, and satisfying, while simplifying and organizing complex content and connecting new ideas to old ones. Furthermore they are built to focus the learners' attention on what is being taught, ease learning, produce recall, foster transfer, and speed instruction (Yelon, 1996).

Assessmentis an important tool in the teaching and learning experience, and is used to determine whether teaching and learning have taken place or not. Using assessments in the classroom enhances learners' achievement levels, it is based on the idea that learners will improve if they understand the aim of the assessment and where they are in relation to this aim, and how they can achieve it.

Since Outcomes-Based Education encourages the parents to take an active part in the teaching and learning process, it is imperative therefore that from time to time, parents/guardians are encouraged to take interest in the education progress of their children. This can be done, for example, by looking at the work their children do at school and by interacting with teachers and school management (curriculum development centre, 2013).

Mohan (2012) defines a lesson plan as an outline of the important points of a lesson arranged in the order in which they are to be presented to learners by the teacher. Planning is important in the work of a teacher as this works as a guide for the effective delivery of lessons and other activities in and outside the classroom. Furthermore, Jones (1998), Muzumara (2008) and Mohan (2012) considered lesson planning as a creative process which provides a framework for purposeful teaching and learning.

Learning institutions should use and manage teaching and learning resources prudently in their institutions. The institutions should expose learners to a variety of teaching and learning resources that they can use in the teaching-learning process. Learning institutions should ensure that they put in place the right numbers with correct academic and professional qualifications for teaching and non-teaching staff. This will help in the effective teaching and learning (CDC, 2013).

Nwokoukwu (1979) advocated concerning the physical environment that learning institutions should have appropriate infrastructure such as classrooms, lecture rooms/lecture theatres, tutorial rooms and specialised rooms, laboratories, workshops and resource rooms. This infrastructure should be well stocked with adequate equipment and materials needed for effective teaching and learning.

The National Council of Teachers of Mathematics (NCTM) (2000) stressed that teachers and teacher-educators are key players in any education system and should regularly attend Continuing Professional Development (CPD)programmes. This helps in updating pedagogical approaches and assessment procedures.

Subject Associations are professional bodies that are mandated to participate in the effective implementation and teaching of mathematics (CDC, 2000). To this effect, subject associations are expected to play a complementary role in suggesting solutions to challenges encountered during the teaching and learning process.

Research is an important intervention at all levels of education. There is need to find out what obtains and what needs to be adjusted or changed completely to suit the obtaining situations. Educational surveys should form part of research work to alleviate challenges in the teaching and learning of mathematics in secondary schools (CDC, 2013).

2.3. Theory of learning geometry

Van Hiele (1959) advanced a model which suggests that learners advance through levels of thought in geometry. The levels are characterised as visual, descriptive, abstract/relational, and formal deduction. At the first level, learners identify shapes and figures according to their concrete examples. At the second level, learners identify shapes according to their properties, and here a learner might think of a rhombus as a figure with four equal sides. At the third level, learners can identify relationships between classes of figures, for example, that a square is a special form of rectangle, and can discover properties of classes of figures by simple logical deduction. At the fourth level, learners can produce a short sequence of statements to logically justify a conclusion and can understand that deduction is the method of establishing geometric truth. According to this model, progress from one level to the next is more dependent upon teaching method than on age. The model further suggests that it is not possible for learners to bypass a level.

2.4. Relevance of Teaching Earth Geometry in secondary schools.

The study of Earth geometry contributes to helping students develop the skills of visualisation, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument and proof. Geometric representations can be used to help learners make sense of other areas of mathematics, such as, fractions and multiplication in arithmetic, the relationships between the

graphs of functions (of both two and three variables), and graphical representations of data in statistics. Spatial reasoning is important in other curriculum areas as well as mathematics, such as science, geography, art, and design and technology (Chifwa, 2015; & Royal Society/JMC, 2001).

According to the National Council of Teachers of Mathematics (2000) the major goals of secondary school geometry are to develop mathematical reasoning abilities and to promote a deeper awareness of the real world. To help learners achieve this goal, reasoning in relation to shapes should be aided by coordinate and transformation techniques as well as the traditional synthetic techniques such as flip, turn and sliding of an object.

III. METHODOLOGY

3.1 Sampling

The target population for this study were mathematics teachers and grade twelve pupils in Mansa District of Luapula Province. Grade twelve pupils were chosen because they had covered the topic and were in a better position to provide information needed to answer the research questions. The units of analysis were the individual grade twelve pupils and mathematics teachers. Purposive sampling method was used in order to choose participants who would provide the best information to answer the research questions (White, 2005 and Creswell, 2003). Schools were purposively sampled so as to include a boarding secondary school for boys (Catholic school), a co-secondary boarding school (government school), as well as, a day secondary school (government school). Schools were chosen on the basis of easy accessibility by the researcher. Grade twelve pupils were sampled as follows: Numbers were written on pieces of paper and were assigned to all grade twelve pupils at a particular school and put in a box, the box was shaken thoroughly to mix the contents. Numbers of pupils who were to participate in the study were picked from the box by hand, and twenty two pupils were selected from each secondary school. Fort three male pupils and twenty three female pupils comprised a sample. Sixteen Mathematics teachers were purposively selected from three schools on the basis of availability, willingness to participate in the study, and those who had taught the topic to the pupils before. Eleven male teachers and five female teachers were selected. Therefore, the study sample consisted of sixteen mathematics teachers drawn from three secondary schools, namely, Mansa secondary school, St Clements secondary school, and Mutende Day secondary school, and sixty six grade twelve pupils were also drawn from the same three secondary schools.

3.2 Data collection procedure

Polit and Hungler (1999: 267) define data as information obtained in a course of a study.

Using an introductory letter from Copperbelt University, the researcher was permitted to conduct the research in the District by the office of the Provincial Education Mansa through endorsing on the introductory letter. The researcher further sought permission from head teachers and heads of mathematics departments at selected secondary schools. Permission was granted to carry out research in the three schools, and with the assistance from heads of departments, pupils and teachers were mobilized to participate in the study.

In this study, data was collected by using semi-structured interview schedules, self-completion questionnaires, and document analysis. The contents of the interview guides and questionnaires were derived from the research questions, as this would enhance the researcher to capture data relevant to the study's objectives and research questions.

Questionnaires were administered by the researcher with the assistance of the heads of departments to the pupils and teachers and were collected upon completion. No incentives were provided to respondents to complete the questionnaire. Interview guides were prepared for both mathematics teachers and grade twelve pupils, and depending on their wish as to whether to be interviewed or to complete the questionnaire. Three teachers (one female and two males) chose to be interviewed, and eight pupils (three girls, and five boys) also found interviews more convenient to them, therefore, they chose to be interviewed. Data collected through questionnaires administered to learners and teachers, addressed four research questions. Some questions that appeared in the questionnaire for learners also appeared in the questionnaire for teachers, and this was for the purpose of providing adequate information addressing the research questions, regarding factors affecting academic performance in Earth Geometry.

IV. RESULTS

This part presents the findings of the research from the questionnaires and the interviews undertaken as answers to factors that contributed to learners' poor performance in Earth Geometry. Quantitative summery has been given for each questionnaire item. Fifty eight learners completed the questionnaire, of which 38 (65.5%) were males and 20 (34.5%) were females. Thirteen teachers, 9 (69.2%) males and 4 (30.8%) females also completed the questionnaires.

On the other hand, three mathematics teachers (one female and two males), and eight grade twelve pupils (three girls and five boys) were interviewed.

4.1 Difficulties learners experienced in learning Earth geometry

The responses were coded and percentage for each response was computed. The responses advanced by learners are summarised as follows:

- Calculation of speed.
- Calculation of the shortest distance.
- Calculation of distance along the circles of longitude and latitude.
- Generally the whole topic is difficult.

- Identification of longitudes and latitudes.
- Location of points on the globe.
- Distinguishing between small circles and great circles.
- Calculation of time

The findings indicated that learners had difficulties almost in the whole topic. The total number of responses was 92. It was noted that the larger percentage of responses out of 92 responses was reported under the sub-topic 'Calculation of the shortest distance' which accounted to 20 (21.7%) responses. 'Calculation of distance along the circles of longitude and latitude' proved to be the second difficult sub-topic indicated by 13 (14.1%) responses. 12 (13.0%) responses indicated that they had difficulties in both 'distinguishing between small circles and great circles' and 'calculation of time'. 11(12.0%) responses also indicated having difficulties in 'Location of points on the globe'. Furthermore, 10 (10.9%) responses showed that they had difficulties in calculation of speed. 8 (8.8%) responses indicated difficulties in identifying longitudes and latitudes. Finally, 6 (6.5%) responses indicated that generally they had difficulties in the whole topic. To gain more insights on learners' difficulties in Earth Geometry from teachers' perspective, question 17 in teachers' questionnaire was included and responses were not very different from the ones given by pupils, except that point (ii) received 7 (25%) out of 28 total responses, and pupils' failure to visualize sketches in three dimension was another difficult which had 2 (7.1%) responses.

4.2 Causes of learning difficulties experienced by learner

Table 1: Causes of learning difficulties encountered in Earth Geometry.

Perceived causes	Responses (n=102)	
	Frequency	**Percent**
The topic has many formulae	15	14.7%
Teachers were not well qualified to teach grade 12	5	4.9%
Lack of seriousness by pupils through missing lessons	9	8.8%
Lack of seriousness by qualified teachers when teaching	6	5.9%
Topic not well taught due to teachers aiming at finishing the syllabus	18	17.6%
Topic was only taught in grade twelve	3	2.9%
Teachers teaching without the teaching aid (e.g the globe)	6	5.9%
Poor explanation by the teachers	9	8.8%
Lack of practical examples from our community	5	4.9%
ECZ Examination questions were phrased differently from what teachers were giving during lessons	4	3.9%
Cant visualize sketch in three dimension	6	5.9%
Difficult language was used	6	5.9%
Lacking exposure to ECZ past papers	7	6.8%
Have not learnt the topic because they came on transfer	3	2.9%
Total	**102**	**100.0**

The majority of learners indicated that the topic was not well taught due to teachers aiming at finishing the topic as opposed to learners understanding of the concepts, this was indicated by 18 (17.6%) responses out of the total 102 responses, and 3 (2.9%) learners indicated that they never learnt the topic because they came on transfer and found that the topic had already been covered.

4.3 Factors to be considered in overcoming learning difficulties in Earth Geometry

Table 2 gives details of what should be done to overcome the learning difficulties pupils face in Earth Geometry.

Table 2: Factors to consider in overcoming learning difficulties in Earth Geometry

Explanation	Responses (n=84)	
	Frequency	**Percent**
Formulae to be provided at the first page of the ECZ examination paper	4	4.8 %
Supply teaching aids in schools e.g globe	7	8.3%
Reduce number of sub-topics so as to reduce on the number of formulae	7	8.3%
Only well qualified teachers to teach grade 12	6	7.1%
Teachers to aim at making learners understand the concept and not at finishing the syllabus	10	11.9%
Giving more class exercises, home works and assignments	6	7.1%
Teachers to revise from the ECZ past papers with pupils upon finishing teaching the topic.	5	5.9%
The topic to be taught in every senior grade	7	8.3%
Simple and clear language to be used	4	4.8%
Teachers to be using teaching aids	3	3.6%
Teachers inculcating positive attitudes in pupils towards loving the topic	1	1.2%
Encourage team work	8	9.5%
Pupils to be putting in more efforts	9	10.7%
Topic's objectives to be clearly stated	3	3.6%
Provide more text books that contain the topic	4	4.8%
Total	**84**	**100.0**

It can be noted from Table 2 that out of the 84 responses, a comparatively larger number of responses, 10 (11.9%) responses stated that teachers ought to aim at making learners understand the concept and not at finishing the syllabus. These were seconded by 9 (10.7%) responses which indicated that learners had to put in more efforts when learning the topic. Teachers needed to inculcate positive attitudes in learners towards loving the topic, this was indicated by 1 (1.2%) response.

4.4 Causes of teaching difficulties faced by teachers

The study also sought to find out from the teachers the reasons why they faced difficulties when teaching Earth Geometry. Table 3 shows responses from teachers.

Table 3: Causes of teaching difficulties faced by teachers.

Causes	Responses (n=15)	
	Frequency	**Percent**
Negative attitude of learners in Earth Geometry	3	20%
Lack of teaching resources and books	4	26.7%
Teachers did not learn the topic when trained	2	13.3%
Lack of basic knowledge in learners	1	6.7%
Lack of seriousness by learners	5	33.3%
Total	**15**	**100.0**

It can be noted from table 3 that 5 (33.3%) responses indicated lack of seriousness by learners. 4 (26.6%) responses attributed teaching difficulties to lack of teaching resources and books. Meanwhile, 3 (20%) respondents indicated that negative attitude of learners in Earth Geometry was the contributing factor. 2 (13.3%) respondents showed that some teacher never learnt the topic from the institutions they were trained, and 1 (6.7%) response indicated that learners also lacked prerequisite knowledge.

Despite teachers facing challenges in teaching the topic, the following relevance of the topic were suggested by both learners and teachers: it helps in calculation of distances between places, broadens knowledge of the earth and its measurements, understanding world time differences, and broadens the understanding of mathematics at large.

V. DISCUSSION

This study investigated factors that affect poor academic performance at school certificate level. The findings have been discussed according to the research objectives.

5.1 Difficulties pupils experienced when learning Earth Geometry and causes

The study revealed many difficulties that learners encountered in learning Earth geometry. Among the difficulties are: Calculation of speed, calculation of the shortest distance, calculation of distance along the circles of longitude and latitude, identification of longitudes and latitudes, location of points on the globe, distinguishing between small circles and great circles, and calculation of time. Many teachers had an average of 71 to 75 pupils in classroom. This was a challenge to learners as they lacked personal attention from teachers during lessons. Another difficult revealed by the study was the language. Pupils find some terms very difficult and confusing to understand. This is due to the inability of some teachers to explain the different terms found in Earth Geometry. Bishop (1986) stated that geometry language was a pertinent problem with many learners and this was their weakness. It can therefore be argued that Earth Geometry has its own terminologies which must be understood before an attempt to solve a problem.

It was also discovered that pupils had difficulties in drawing and visualizing the diagrams in three dimensions. This is usually because teachers did not teach pupils how to draw diagrams in three dimensions. Kor (1995) recommended more visual activities in the classroom to help learners understand geometric concepts. It could therefore be helpful for learners if geometry lessons could be carried out with hands-on activities.

The study also showed that the topic was not well taught due to teachers aiming at finishing the syllabus as opposed to making pupils understand the concepts. Pupils complained that teachers usually ignored slow learners and concentrated on fast learners. This attitude of teachers usually contributed to some pupil's poor performance. This is also shown by Orzechowska (1975) who argued that students differ in the time required to learn any particular topic. He goes on to say that in the majority of our classrooms the work is usually covered at the apparent speed of the average learner. This is evidenced by the methods which teachers indicated they were using in teaching the topic, that is, the lecture method and teacher exposition method. These methods do not fully engage learners in discovering and developing concepts on their own. This view was supported by Gardner in (Campbell & Dickson, 1996). In his Theory of Multiple Intelligences, Gardner suggested that some learners were kinesthetically inclined, meaning that they learn best when actively involved with the objects on their learning. Another difficult which came through was that pupils considered some teachers not to be qualified to handle certain topics like Earth Geometry. Despite the majority of teachers having been in the service for more than ten years, it was clear that most of them never learnt the topic from institutions they were trained. Learners' lack of basic geometric concepts and teachers teaching without using teaching aids, such as the globe were other identified difficulties. Hershkowitz (1989) argued that visualization was a necessary tool in geometry concept formation. The study also established that learners were not exposed to Examination Council of Zambia past papers, and that the topic had many formulae.

5.2 Difficulties teachers experienced when teaching Earth Geometry and causes

The study revealed that teachers experienced a number of participation and motivation related problems among learners. Some learners were lazy and did not take their learning process so seriously, as a result, learners could miss lessons which made it so difficult for them to connect concepts. In turn, that led learners to only memorize concepts as opposed to understanding concepts. Jones (2002) argued that geometry learnt by memorizing geometric properties rather than by exploring and discovering the underlying properties was limited, superficial and short-lived. Teachers encountered difficulties in learning Earth Geometry at the institution they were trained. Some of the difficulties were calculating the shortest distance between points, calculation of distance along the circle of latitude and great circle, and deriving the nautical

mile concept. It can be argued that these same difficulties were passed on to the pupils.

5.3 What could be done to minimize the learning difficulties pupils experienced in Earth Geometry?

In order to address the language learning difficult pupils experienced in Earth Geometry, teachers of mathematics should discuss the various meanings and interpretations of words and phrases that occur in Earth Geometry with learners in class. This finding is consistence with Haambokoma (2007) and Hashweh (1987) that the extent of mastery of the topic has a major influence on the quality of explanation a teacher can give to students.

Learner's inability to do their homework may have a negative effect on their academic achievements. In order to encourage learners to do their homework and assignments, teachers should mark the homework and assignments regularly and talk to parents to encourage their children to do their homework. Learning materials such as textbooks, audio visual aids and others should be supplied in schools and should have certain qualities if teaching and learning is to be extremely effective. In the same line, teachers should give adequate explanations to learners by relating Earth Geometry to real life situations.

Thorough assessment of learners' performance should be stressed. This is in line with Das (2007) who believes that assessment is a key in assisting pupils to revise perceived difficult topics. The study also revealed that the syllabus must be made short so as to enable their teachers to complete it within the stipulated time. This is in line with Haambokoma et al (2002) who observed that the overloaded syllabus does not give adequate time for teachers to engage pupils in practical work.

The study further revealed that the formulae on the topic Earth Geometry should be given on the first page of the final mathematics examinations for Examination Council of Zambia, and that basic geometric concepts be introduced in junior grades or other senior grades as this would enable learners to have relevant basic geometric knowledge. Teachers should teach pupils how to answer examination questions, and expose them more frequently to examination past papers. This is consistent with Meyer (1988) who described examinations as a critical factor in influencing effective learning.

5.4 What could be done to minimize the teaching difficulties teachers experienced in Earth Geometry

According to Carkhuff (1981) teaching is the opportunity to help others to live their lives fully, which means teachers help to give to the learners lives through their physical, emotional, intellectual and social growth. Anderson (1994) concluded that learner's outcomes may heavily depend on the teacher's instructional planning, teaching,method selection, and having a variety of learning activities.

Teachers need support and training to use strategies that are more active and learner-centered, as well as developing learners' competencies in reading mathematical terms. Teachers also need training in designing questions that can engage in higher levels of thinking and reasoning. Learners should be engaged in group works that engages them to discover concepts on their own. This is in consistent with the findings of Johnson et al (1994) who confirmed that cooperative learning has the potential to improve the quality of learning.

Large class size has been identified as a challenge in effective teaching of Earth Geometry to the learners, as this inhibits adequate teacher-learner attention. Organizational issues must also be considered in promoting effective teaching of Earth geometry. In this area questions such as efficiency of administrative support, the type and influence of leadership, class size and the teacher pupil ratio and the administrative structure of the mathematics department need to be considered. This is in line with Haambokoma, (2007) who emphasized the need to provide management training to heads of departments in Zambian high schools. Mashambe, (1973) also advised that in order that different factors work in harmony to bring about maximum learning, there must be a good organization of staff, pupils, finances and curriculum. The study also revealed that teachers can improve in their teaching methodologies through the Continuing Professional Development (CPD) meetings. Promotion of CPD for teachers of mathematics should be emphasized because training and professional development of teachers underpins what can be accomplished in a school (MoE, 1996).

It is important to note that the findings of this study would not be generalized to all secondary schools in Mansa District, due to a small sample, however, the study would provide general evidence on teaching of Earth Geometry in ordinary mathematics.

VI. CONCLUSION

Generally, the study highlighted a number of difficulties experienced in Earth Geometry from both teachers' and learners' perspective, and these included: visualisation of figures in 3-dimension, calculation of the shortest distance, calculation of distance along the circles of longitude and latitude, lack of basic geometric concepts, inadequate teaching and learning materials and bulky topic leading to having many formulae. In trying to minimise the experienced difficulties, the following factors were highlighted: formulae to be provided at the first page of the ECZ examination paper, provide more text books that contain concepts on the topic, simple and clear language to be used, introduction of basic Geometric concepts at junior level or other senior grades apart from just grade twelve, and intensification of Continuing Professional Development meetings (CPD). The results of this study echo those that have been carried out in other parts of the country and world at large, meaning geometry is one of the important areas of Mathematics.

VII. RECOMMENDATIONS

In view of the findings and conclusions, the following recommendations are proposed:

- The Ministry should encourage the Teacher Education Institutions to encourage student teachers in the use of pupil centered methodology in most of their teaching time to arouse interest and positive attitude in the learning of Mathematics.
- The Ministry should supply adequate Mathematics textbooks and other teaching and learning aids to Secondary Schools.
- There is need to control enrolment so that assessment of pupils is improved.
- There is need to introduce basic concepts in Earth Geometry in junior or other senior grades.
- Formulae on the topic to be provided on the first page in the final mathematics examinations for ECZ.
- This study recommends that internal monitoring of lessons by mathematics HODs should be intensified.

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