International Journal of Education Humanities and Social Science

ISSN: 2582-0745
Vol. 4, No. 03; 2021

EXPLORATION OF MATHEMATICS TEACHERS' COMPUTER APPLICATIONS IN THE TEACHING OF EARTH GEOMETRY AT ORDINARY LEVEL

Maybin Kabaso[1], Emmanuel chinamasa[2] and Vincent Sinonge Kanyata[3]
[1]Mathematics Department, Loto Secondary School, Mwense District, Zambia
[2] Emmanuel Chinamasa, Chinhoyi University of Technology, Zimbabwe
[3]Mathematics Department, Luminu Secondary School, Chipili District, Zambia

ABSTRACT
This study exploredmathematics teachers' computer applications in the teaching of earth geometry at Ordinary Level in Zambian Secondary Schools. It is based on the premise that using technologies is not only very essential but also brings about improved mathematics teaching. The study was guided by a descriptive survey research design. Data was collected from a purposive sample of 35 mathematics teachers from six secondary schools in Mwense districts who were interviewed and their schemes of work as well as lesson plans analysed. This was complimented with the analysis of the National Mathematics Syllabus for Senior Secondary (10-12) and textbooks being used in secondary schools. The study found that teachers were not using computers and related software's in earth geometry teaching. However, teachers indicated that computers can display the globe as a three dimensional geometrical shape, downloaded lesson notes on earth geometry as well as audio videos can be effective. The study noted that students experienced difficulties with visualising three dimensional shapes. Computers were not used although teachers had wire models. Schools could not buy computers and related software's were due to financial constraints. Teacherslacked training in computer applications from colleges and universities. In addition, there is lack of consistent and clear ICT policies in schools specifically and Ministry of General Education generally. Among the strategies to improve computer applications in earth geometry teaching at Ordinary were the procurement of more computers, capacity building on computer applications in mathematics teaching and intensify School Based Continuing Professional Development in the usage of computers in mathematics teaching. The study recommends a college and university teachers' curriculum for teaching earth geometry using computers and related software's. New teachers' books for mathematics can be written to include activities that encourage teachers and students to use computers and related software's in their teaching and learning. School authorities can source modern ICT equipment, formulate and implement school ICT policies that are consistent with current technological trends to facilitate the increased integration of ICT tools in mathematics classroom generally and earth geometry specifically. Teachers' workshops on computer application in earth geometry can be mounted to cascade from province to school level.

Key Words: O-level mathematics teachers, earth geometry, computer applications.

1. INTRODUCTION
Mathematics is a basic science that serves a variety of other sciences Ilyas (2015). To this end, globally and Zambia in particular, the governments and their populace place a high premium on the teaching and learning of Mathematics in schools. Hence, Mathematics is a compulsory

ISSN: 2582-0745
Vol. 4, No. 03; 2021

school subject from early childhood, primary, junior secondary and senior secondary school's level (equivalent to pre-school to grade 12).

Due to global trends, all school curricula have been reviewed by the Zambian Curriculum Development Centre and implemented in 2014 to meet the challenges of primary and secondary education in the context of the countries vision 2030 for being a middle income country as well as to achieve the critical targets of the Sustainable Development Goals (SDGs). To realize these objectives, subjects at the secondary school level are grouped into four specialized categories of study namely: Literature and Languages, Social Sciences and Business Studies, Natural Sciences and Practical Subjects. Mathematics is one of the compulsory cross-cutting core subjects within the Natural Sciences category which every ordinary level student must pass in order to proceed to higher studies.

Changwe and Mwanza (2019) orate that Mathematics is one of the subjects that has a direct implication and application to all business related, science and engineering programmes in post-secondary school education programmes. Theirthreat points out that lack of people well-grounded in Mathematics entails lack of effective scientists, engineers and economists in any country. Notwithstanding the importance of Mathematics to science and technology as a roadmap to nation building and development, several studies done in Zambia by scholars such as Tembo (2013), Mwape and Musonda (2014), Kafata and Mbetwa (2016), Examination Council of Zambia (2012, 2016), Musonda et al (2018), Sakayombo (2018), Changwe and Mwanza (2019) as well as those studies done outside Zambia by scholars like Mutai (2010), Yara and Otieno (2010) and Mbugua et al (2012) have all indicated that students' performance in the subject have not seen any sound improvement over the years.

This problem of students' poor performance in Mathematics during internal and external examinations, have remained a source of concern to all stakeholders in education. Therefore, the problem has eaten deep into the foundation of the nation's technological advancement and its national development. Studies by Akinsola and Awofala, (2009), Abakpa and Iji, (2011), Tembo, (2013), ECZ, (2016), Musonda et al, (2018) and Changwe and Mwanza (2019) reveals that topics such as Earth Geometry, construction and loci, geometrical proofs, trigonometry, geometrical transformational and linear programming equip students with basic mathematical knowledge and skills to be matched with computer applications. They are basic requirements for all engineering and business courses in tertiary institutions which are now being done using computers. They continue to stress that students armed with this mathematical knowledge and these skills will be active players in technology and vocational areas that are the foundation of the meaningful economic development and transformation of any country.

Mathematics educators and researchers in Zambia have made significant efforts intended to identify the major problems associated with the teaching and learning of Mathematics in general and Earth Geometry in particular as a topic in the nation's schools. Kalumbi (2005) cites Sandman (1980) who attributes the poor performance to pupils' anxiety towards Mathematics, lack of self-esteem, enjoyment and motivation in Mathematics. Sakayombo (2018) cites language used in Mathematics teaching being difficult for some learners to understand making the subject being abstract.Sakayombo's (ibid) argument was in agreement with Davidson (1990)

ISSN: 2582-0745
Vol. 4, No. 03; 2021

who opined that a language deficit in the teaching of Mathematics entails or leads to a Mathematics deficit. Changwe and Mwanza (2019) cites high teacher to pupil ratio due to overcrowded classes, negative attitude and beliefs of learners toward the subject, lack of appropriate teaching and learning aids in schools and inappropriate acquisition of ethno mathematics amongst learners as factors leading to poor performance in Mathematics generally.

Zeroing in Earth Geometry teaching and learning, Tembo (2013) for example found that both teachers and learners had challenges in teaching and learning Earth Geometry respectively.Challenges ranged from inadequate knowledge of the topic on the part of the teachers to lack of resources in order to teach effectively. Teachers did not get adequate support in the area of geometry (Earth Geometry) in their teacher preparation programmes. As a result, teachers went into the field with the same challenges that they had when they were pupils themselves in school. Subsequently, teachers found it hard to explain or introduce some concepts in Earth Geometry to learners. Regarding students Tembo (2013) reports that students faced challenges that included poor grasp of Earth Geometry concepts, inability to visualize objects in three dimensions and comprehending the language or geometry terms used in geometry in general. According to students, these challenges were manifestations of poor teaching by their teachers of mathematics and being overwhelmed by the formulas. Musonda et al (2018) also found that the challenges faced by learners (as perceived by them) in understanding of Earth Geometry were attributed to incomprehensive teachers' guides. In addition, students felt there were too many formulas to memorize, no teaching aids used, lack of text books in schools and generally negative attitude of learners towards Mathematics as a whole.

From the foregoing findings by Tembo (2013) and Musonda et al (2018), it is clear that Mathematics teachers lacked pedagogical knowledge in Earth Geometry. Akintade, Ogbonnaya and Mogari (2013) also reported that some Nigerian Mathematics teachers lacked a pedagogical approach to teaching some topics such as latitude and longitude (Earth Geometry in Zambia) to their students. This assertion was consistent with Shulman (1986) cited by Akintade (2017: 4) who contends that when a teacher lacks the approach to teach a particular content, it becomes difficult for him/her to transform content knowledge into a form that students can easily understand. He concluded that the conventional (traditional) teaching methods adopted by subject teachers could be one of the reasons for students' inability to address latitude and longitude questions adequately during the examinations.

Changwe and Mulenga (2018) did a study at the University of Zambia (the oldest and largest university in Zambia) in which they analysed the Mathematics teacher education curriculum regarding whether or not student teachers had acquired the appropriate competences for teaching Mathematics in Zambian secondary schools. Among the key findings was that the Mathematics teacher education curriculum offered at UNZA did not adequately prepare teachers of Mathematics for effective teaching of classroom Mathematics. 80 percent of the participants who included lecturers of Mathematics content, lecturers of Mathematics education, student teachers of Mathematics who were in their final year of study (fourth year) and had done their school teaching experience as well as teachers of Mathematics who had gone the same teacher education programme at UNZA and were now actively teaching Mathematics in Zambian

ISSN: 2582-0745
Vol. 4, No. 03; 2021

secondary schools were all of the view that the Mathematical knowledge for teaching in the Mathematics teacher education curriculum was ignored greatly. Further, participants emphasized that the way the Mathematics teacher education curriculum was structured at UNZA made it very difficult for teachers to confidently and effectively teach secondary school mathematics topics such as Linear Programming, Geometrical Transformations, Construction and Loci, Mensuration, Earth Geometry and many others. In other words, Mathematics teachers lacked subject and pedagogical content in teaching some topics.

Despite the interventions such as Lesson Study (LS) introduced in 2006 as a form School Based Continuing Professional Development (SBCPD), subject association conferences such as Zambia Association for Mathematics Education (ZAME), students still get very low marks in Earth Geometry questions specifically in examinations internally and externally. Concerns regarding poor performance in Mathematics in general and Earth Geometry in particular is a clear sign that interventions are needed to improve the results. It is in light of this, that the study seeks to find ways computers and related softwares can be used teach Earth Geometry so as to enhance understanding of the topic with the view of improving the results in the topic and Mathematics generally.

1.1 Research problem

Mathematics is an important tool for national development and improvement of a person's intellectual competence in logical reasoning,spatial visualization, analysis and abstract thought. One of such a topic in the Zambian Ordinary Level Mathematics curriculum is Earth Geometry which is concerned with spatial visualization. However, successive reports of the Examination Council of Zambia (ECZ) indicate that the mean performance in the subject was 24.39% in 2016 and28.29% in 2017 (ECZ, 2017: 7). This performance isstill very poor because it is below 40%, the national average mean. The same report indicates that among the four common subjects (Biology, English, Mathematics and Science), the largest proportion of failing candidates was recorded in Mathematics at 41.33% (ECZ, 2017: 14).Earth Geometry in specificity, thesuccessive examiners' report showed that questions on Earth Geometry topic were very poorly answered. For example, the ECZ (2006) examiner's report showed that questions on Earth Geometry were either poorly done or very poorly done by most learners.

The Ministry of General Education (MOGE) has introduced a number of interventions such as In-service education training (INSET), Lesson Studies, Zambia Association for Mathematics Education conferences and involved International Corporation which was heavily involved in strengthening Science, Mathematics and Technology Education (SMASTE). Despite these interventions, the performance in Mathematics and Earth Geometry in particular has not improved much but remain poor. If this scenario remains unattended to, Ordinary Level students may continue getting poor Grades other than Credit or better. This might affect their educational progress to tertiary and higher education institutions since such institutions requires students to have obtained Credit or Better for many admission requirements. Further, the country (Zambia) may delay for further technological advancement and national development of the 21st century.

ISSN: 2582-0745
Vol. 4, No. 03; 2021

The performance in Mathematics and Earth Geometry might continue being very poor and this could be detrimental for technological advancement and national development of our country, Zambia. The use of computers in Mathematics teaching can bring about the lasting solution for the problem of poor performance in Mathematics and Earth Geometry in specificity. Although different scholars such as Tembo (2013), Chisembe (2017) and Simukoko and Sakala (2018) have recommended and used different teaching methods such as group discussions, class discussion, question and answer and use of Earth Model in enhancing understanding of Earth Geometry and improve performance, the use of computers can bring more significant difference from the previously used methods. There is limited literature on whether mathematics teachers are using computers and related softwares in mathematics teaching generally and earth geometry specifically. In fact, CDC (2013) suggested and encouraged the use of computer related software in Mathematics teaching and that Mathematics teachers were to encourage learners to use available Mathematics software. Further, academic researchers have given limited attention to rural secondary school teachers' views on challenges they face in teaching earth geometry using computers and related softwares. This study therefore contributes computer applications as a basis for improved pedagogical content in earth geometry teaching specifically and mathematics teaching generally.

1.2 Research questions

(1) What ways are you using computers and related softwaresin the teaching of Earth Geometry in Zambian secondary schools?

(2) What challenges Ordinary Level Mathematics teachers are facing in using computers and related softwares in Earth Geometry teaching in Zambian secondary schools?

(3) What strategies can be put in place to improve computer usage in Earth Geometry teaching in Zambian secondary schools?

1.3Study objectives

(1) Determine ways computers and related softwaresare being used in the teaching of Earth Geometry in Zambian secondary schools.

(2) Establish challenges Ordinary Level Mathematics teachers are facing in using computers and related softwaresin Earth Geometry teaching in Zambian secondary schools.

(3) Suggest strategies that can be put in place to improve computer usage in Earth Geometry teaching in Zambian secondary schools.

1.4 Significance of the study

This study explored how the teaching of Earth Geometry at O- level using computers can be improved. This study is vital due to the fact that majority of studies in Mathematics education have provided a bird's eye view of teaching and learning and not a detailed analysis of a topic like Earth Geometry more especially on the use of computers. This study, then, has provided

ISSN: 2582-0745
Vol. 4, No. 03; 2021

feedback to curriculum designers and textbook writers on Earth Geometry. Teachers are also expected to find it a useful source for their teaching methods (computers instructed teaching) on Earth Geometry.

2. LITERATURE REVIEW

Studies on Geometry Teaching and Learning and Opportunities for Computer Applications

Clements and Battista (1990) orates that the underlying concept in geometric thought is spatial reasoning which is the ability to see, inspect and reflect on spatial objects, images, relationships and transformations. As such the teacher is expected to ensure that his or her students visualize figures, shapes and planes that may not be very obvious to the student. Clements and Battista (1990) suggest that students' poor performance in geometry is due to low spatial reasoning which is unique and difficult to teach and learn without models. Therefore, this study intends to establish how the use of computers and related softwares can be used by teachers to teach the spatial reasoning part of geometry and Earth Geometry in particular.

According to Battista (2007) errors in the teaching and learning of Geometry and Earth Geometry in particular include:

(i) Conception errors, which affects perception since what one sees is affected by what one knows and conceives.

(ii) Diagrams with errors as data or representations. According to Chazan and Yerushlmy (1998: 70) "diagrams are aids for intuition and are not necessarily the objects of study themselves.' There is need therefore, for teachers to use accurate diagrams through the use of computers and related software's in the teaching process to enhance students' spatial understanding.

Musonda et al (2018) suggested that one of the factors that made Geometry learning difficult was the Geometry language which involved specific terminology unique to the African child's vocabulary. Some of the geometric terminologies in Earth Geometry which need comprehension include small circles, great circles, diagrammatically opposite, nautical miles and speed in knots. Such terminologies need particular attention and understanding before they could be used meaningfully. Further, Bishop (1986) and Lappan (1999) suggested that, the misuse of Geometry terminology could lead to misconceptions of geometric knowledge. These commend call for teachers to include language for geometric teaching skills. Thus, it is hoped that computers and related softwares provide an avenue that bridges the geometric language which contributes to poor performance among the students. Therefore, there is need to find out ways if any computers are being used in Earth Geometry teaching.

Chinamasa (2014) cites Jaji (1992) who postulates that English as a medium of instruction has an inhibiting factor. Jaji (1992) established that Form 2 pupils in Zimbabwe lack Mathematics reading skills and language. This is a critical factor for Earth Geometry questions which often are presented in word forms. Nziramasanga's (1999) report concurs with Jaji (1992) and suggested that Mathematics teachers should use the mother language to develop pupils' mathematical

ISSN: 2582-0745
Vol. 4, No. 03; 2021

concepts as a strategy for reducing conception errors. The critical issue in this case is the language used by teachers to develop understanding of Earth Geometry in their teaching. Therefore, it is hoped that this study will suggest ways on how computers can solve the language problem especially that we are in the 21st century where the use of technology such as computers and related softwares are highly encouraged.

The National Council for Teachers of Mathematics (NCTM) (1995) findings shows that the study of Algebra and Geometry is bound to change dramatically with the infusion emerging technology such as GeoGebra. GeoGebra is a cross plat-form Mathematics software that integrates Geometry and Algebra hence the name GeoGebra. According to NCTM (1995: 1), "Technology allows students to study algebra and geometry as the meaningful and related representations of functions, variables and relations rather than as an acquisition of skills in manipulating symbolic representations stripped of other meanings." These findings from NCTM (1995) suggest the need for teachers to use technologies such as computers and related softwares in the teaching of Geometry and Earth Geometry in particular to enhance understanding. Therefore, carrying out this study becomes pivotal because it will reveal whether or not mathematics teachers are using computers and softwares such as GeoGebra in Earth Geometry teaching.

Adedoyin (2012) also orates that the use of technology such as computers and related softwares in education generally provides the students with a more suitable environment to learn, creates interest and learning atmosphere, and helps increase their motivation. In the United States for example, the National Council of Teachers of Mathematics (2000:24)encourages teachers to use computers in the classroom and states that "computers are essential tools for teaching, learning and doing mathematics. They furnish visual images of mathematical ideas, facilitate organization, analyse data, and compute efficiently and accurately." The foregoing arguments by NCTM (2000) regarding the usefulness computer applications in Mathematics teaching gives this study a background to find ways teachers are using computers in Earth Geometry, challenges being encountered when using computers in Earth Geometry teaching and strategies that can be used to improve computer usage in Earth Geometry teaching.

Researchers such as Sanders (1998); Clements et al (2008) and Mwingirwa (2016) are advocating for the use of computer teaching and learning for Geometry and Earth Geometry in particular. Mariotti (2001) discusses Dynamic Geometry (DGEs) soft wares such as *GeoGebra, Dr Geo, Cabri*, and Geometer's *Sketchpad* contends. These DGEs are application soft waresthat were originally designed for teaching Geometry in secondary schools. These applications allow learners to discover patterns, to explore and to test conjectures by constructing their own sketches. This study is called upon to incorporate application computer soft wares in the teaching of Earth Geometry.

Hoyles and Jones (1998) pointed out that teachers tendency to teach Geometry by informing learners of the properties associated with planes or solid shapes, and then completing the exercises contributes to poor performance in geometry. Lecturing has limited attempts to encourage learners' thinking and reasoning skills. Hoyles and Jones (1998) suggest that students' poor performance in Geometry topics is due to teacher cantered approaches such as lecturing

ISSN: 2582-0745
Vol. 4, No. 03; 2021

method. Therefore, this study endeavours to establish how computer and related software applications in the teaching of Earth Geometry can makes students to fully participate in the teaching and learning process as opposed for lecturing pedagogy which is teacher centred.

Kalejaiye (2000) also contends that poor performance in Geometry is a result of teachers not involving learners in their teaching and the adoption of the rote learning style. Teaching by informing students' about geometric terminologies does not link class work and real-life situations. In fact students will not see its relevance. Thus, there is need for Mathematics teachers to involve students in the teaching of Earth Geometry to reduce conception errors. This could be achieved through the use of computers and related softwares, hence the current study.

According to Mullis (2000), in many Geometry classrooms today, teachers merely introduced learners to facts about Geometry and then drilled them with concepts in deductive reasoning. Students' were seldom given the opportunity to discover and conceptualize geometry on their own. Additionally, Hoyles and Jones (1998) argue that although the deductive method is central to Mathematics teaching, providing a meaningful experience for learners at school appeared to be difficult. However, Akanmu (2015) observed that technology such as computers and its products have great influence on what goes on in the classroom if effectively applied to education. He suggested that technology can prepare students to live, learn and work in the digital age if abstract concepts in mathematics and other science subjects are adequately handled with good illustrative material provided by teachers. If used properly, computers can be one of such technologies that can provide students good illustrative materials in the teaching and learning process of Earth Geometry specifically.

Geddes and Fortunato (1993) emphasized that quality of instruction was the greatest influences of the learners' acquisition of Geometry knowledge. To that end, Strutchens (2001) advised that instruction in Geometry should put emphasis on hands-on explorations, developing geometric thinking and reasoning, making conjectures and carrying out geometric projects. Computers and its related software's can be such technologies that provide students with hands on explorations.

Simukoko and Sakala (2018) carried out a study to investigate the impact of Earth Model in understanding of Earth Geometry by in-service Student Teachers at Mukuba University. The study indicated a 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, Simukoko and Sakala (2018) concluded that incorporating Earth Model in teaching Earth Geometry has a positive impact on in-service student teachers understanding of Earth Geometry. Further, the study also revealed that students 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. Additionally, the study suggested that the concepts of Geometry are abstract in nature and require more visualization tools to aid students' understanding. Computers can be such teaching aids that provide a more visualization to students. Computers enable three dimensional objects such as a sphere to be viewed in two dimensions for more clarity of Earth Geometry terms.

ISSN: 2582-0745
Vol. 4, No. 03; 2021

According to Bishop (1983) being able to "touch-see-do'' and interact with the objects of their learning promotes students' learning of geometry in a more imaginative and successful way. In the Theory of Multiple Intelligences, Gardner (1996) suggests that kinaesthetically inclined students learn best when actively involved with the objects on their learning. In this case, geometrical concepts require visual interpretations since many geometry problems are presented in a two-dimensional format. Indeed, computers and its related software's provide avenue for presentation of spherical objects into two dimensions.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study employeda qualitative descriptive survey in finding out ways the use computers and related softwares can enhance teaching and understanding of Earth Geometry in Zambian secondary schools. The use of surveys had the following advantages: (1) Verma and Mallick (1999:79) orates that the strengths of descriptive surveys required in this study include its ability to indicate prevailing conditions.(2) It enables the collection of primary data from a large population which cannot be observed directly. There are so many secondary schools now in Zambia which cannot all be reached out therefore a survey enables a small group (secondary schools in Mwense District) to be used from which the findings can be generalized to similar cases. Robson (1995) supports the idea by saying that survey methods may be adapted to collect generalizable information from almost any large human population. (3) Mustafa (2010) cited by Chinamasa, Nhamburo and Sithole (2014: 62) contend that the major purpose of descriptive survey is to describe the state of affairs as it exists. The researchers did not manipulate variables.(4) Descriptive surveys also use different methods of data collection to enhance method and data source triangulation. The study enabled the researchersto conduct face-to-face semi structured interviews and document analysis of the National Ordinary Level Mathematics Syllabus for Grades 10-12, teachers' schemes of work, lesson plans and approved mathematics textbooks on computer application in Earth Geometry teaching. (5) If the survey is properly conducted, the results are reliable and representative of a much wider population. (6) Surveys can be extremely efficient at providing large amounts of data at relatively low cost in a short period of time.

3.2 Population and sampling

Data for this study was collected from Ordinary Level Mathematics teachers who had taught Earth Geometry for atleast two yearsto Ordinary Level students in Mwense district of Luapula Province. National Ordinary Level Mathematics Syllabus for Grades 10-12, Ordinary Level Mathematics schemes of work, lesson plans and approved Mathematics textbooks will contribute to the data.

Purposive sampling was used to select 25 Mathematics teachers in selected secondary schools in Mwense district as well as documents for analysis. The 25 teachers were interviewed basing on questions that relates to the objectives of this study. The researchers considered this sample (25

ISSN: 2582-0745
Vol. 4, No. 03; 2021

mathematics teachers) adequate as it composed of a sample population considered to have rich information for the study.

3.3 Instruments

O-Level Mathematic teachers respondedto interview questions which sought ways of using computers in teaching Earth Geometry, establish challenges Ordinary Level Mathematics teachers are facing in using computers in Earth Geometry teaching and provide possible suggestions on strategies that can be put in place to improve computer usage in Earth Geometry teaching.

National Ordinary Level Mathematics Syllabus (Grades 10-12), Teachers schemes of work, lesson plans and approved text-bookswere analysed forcomputers and related softwares integrations in Earth Geometry teaching and learning.

The instrumentsused in this study therefore, were: a O-Level Mathematics interview guide (as the main instrument) as well as document analysis guide to improve validity and reliability of findings.

3.4 Data collection and Analysis

The researchers sought permission from the District Education Board Secretary's (DEBS) office in Mwense district and secondary school head teachers to gather data for the study from their schools. Assistance from colleagues who taught at sampled schools was sought for identifying and organizing Mathematics teachers who have taught Earth Geometry for at least two years for interviews. Oral interviews with Mathematics teachers were done to allow the researchersfor probing of participants' thoughtsconcerning ways computers are being used in teaching Earth Geometry, challenges faced by Mathematics in using computers in Earth Geometry teaching and strategies that can be used to improve computer usage in Earth Geometry teaching in Zambian secondary schools.

After oral interviews, the researchers analysed documents (National Ordinary Level Mathematics Syllabus, schemes of work, lesson plans and textbooks) on computer application in Earth Geometry teaching.

Data analysis was done on the basis of the themes that emerged from the study during oral interviews and document analysis. In other words, thematic analysis was used to analyse data. Further, qualitative answers were presented verbatim to maintain originality.

4. FINDINGS AND DISCUSSIONS

The data presented here was gathered from 25 Mathematics teachers who taught earth geometry for at least two years. Data was also gathered from National Ordinary Level Mathematics Syllabus (Grades 10-12), Teachers schemes of work, lesson plans and approved textbooks.

4.1 Usage of Computers and Related Softwares in Earth Geometry Teaching

ISSN: 2582-0745
Vol. 4, No. 03; 2021

To obtain responses to research question one of the study which stated as follows: *In what ways are computers being used in the teaching of Earth Geometry in Zambian secondary schools?*; Item 1 (a) and (b) from the teachers interview guide was designed to solicit responses to whether or not teachers used computers and related software's in earth geometry teaching. Part (b) wanted to find ways if any the computer and related softwares were being used in earth geometry teaching.

While teachers appreciated the important role computers and related softwares play in the teaching of earth geometry, all the teachers indicated that they did not use computers and any related software. One responded pointed out that:

No. I have not used computers and any related software before in my teaching.

Another one added:

I have not used it before. Where can I find time to use computers and related software's? It can't happen. All the teaching period can be wasted just to make computer connections. Besides some of us do not even know how to use a projector.

It was noted by respondents that they do not integrate computers specifically and Information and Communication Technologies (ICTs) in general in the teaching of earth geometry and Mathematics as a subject. This was unfortunate because the Senior Secondary School Mathematics Syllabus advocates for the use of computer related software for Mathematics teaching. Teachers were to encourage students to use available mathematics software.

The results from the interviews and document analysis (schemes of work and lesson plans)greatly indicated that there was no integration of ICT in the teaching of Mathematics generally and earth geometry specifically in the classrooms. However, the respondents and document analysis indicated that computers and related softwares can be used in the teaching of earth geometry in the following ways:

1. Displaying of the globe as a geometrical figure, thus making it slightly intuitive.
2. Download teaching notes on earth geometry.
3. Download audio videos on U tube and see how other teachers present earth geometry concepts.
4. Download audio videos, save them on a computer and show them to students.
5. Use of content free, mathematics specific software such GeoGebra on computers aid visualization and help make connections between algebra and geometry.

One respondent had the following to say:

There are a lot of things on internet. A teacher can watch videos online and see how earth geometry concepts are presented in simpler manner and simple local materials. What need to be done is to encourage Mathematics teachers to be using online materials. We are in the 21st century where almost everything has been digitalized.

ISSN: 2582-0745
Vol. 4, No. 03; 2021

Another one had the following to say:

Integrating computers and ICTs can be very welcome in earth geometry teaching. This is because the abstract models and language which we mathematics teachers usually use can become concrete. The retention of mathematics concepts becomes very high. We need to do something.

The researchers conducted also a textbook analysis on computer applications in the teaching of earth geometry selected mathematics textbook fromthe secondary school level of Zambia. The text books analysed included Progress in Mathematics Leaners Book Grade 12, Excel and Advance in Mathematics Learners Book 12, Longman Mathematics Learners Book 12 and Mathematics Syllabus: A Course for 10-12. It was found that these textbooks did not have materials or activities that could enable teachers use computers in their teaching as well as students in their learning. These textbooks have routine examples and exercises that make teachers to teach using conventional methods that are variance with the constructivist thought which encourages the active involvement of learners in the pursuit of knowledge (Schmidt, et al., 2007). Further, the implication of lack of activities that enable teachers and students use computers in their teaching and learning to a large extent might have made teachers to think as the source of knowledge and hence rely on traditional way of teaching.

4.2 Challenges faced by Mathematics Teachers in the Use of Computers and related Softwares in Earth Geometry Teaching

The second research question was: *What challenges Ordinary Level Mathematics teachers are facing in using computers in Earth Geometry teaching in Zambian secondary schools?* To this effect, one of the items on the teachers interview guide requested them to indicate challenges faced in using computers and related softwares in Earth Geometry teaching. The challenges faced were as follows:

1) Lack of competence on knowledge of suitable software,
2) Low availability of computers themselves,
3) Inadequate knowledge on how to use computers as a teaching aid,
4) Perceptions by teachers that use of computers waste a lot of time,
5) Inadequate knowledge on how to come up with computer programs,
6) Financial constraints,
7) Lack of a clear policy on ICT equipment uptake in schools,
8) Limited ICT infrastructure and tools and
9) Poor teacher training on integration of ICTs in Mathematics teaching.

Regarding challenges faced in using computers in Earth Geometry teaching, some of the sentiments of the teachers were as follows:

Regarding having limited ICT infrastructure, one teacher said:

I use computers just to type tests during test periods. Besides, our school has only one projector for all teachers in school. We are almost 30 teachers, so how can we use it. It

ISSN: 2582-0745
Vol. 4, No. 03; 2021

is non-starter.

Another one added:

I do not use computers in my mathematics teaching. Our school does not have basic infrastructure for internet and ICT tools.

With regard to financial constraints, one teacher had the following to say

Due to financial constraints our school has no capacity to procure more computers and buy bundles for internet connectivity. I think schools need to convince parents on the benefits of ICT to the learners.

Regarding ICT policy in schools, one teacher said the following:

The Ministry of General Education needs to relook at the policy that bars pupils from bringing smart-phones to school.This is because already pupils know a lot about this technology than even teachers. So why should we bar them from bringing them to school? What we should just do as teachers is to direct them towards the correct use of smart-phones. Let us show pupils how to go on internet and download Mathematics videos.

On the other hand, regarding teacher training, one teacher said the following:

How do you expect a teacher to integrate ICTs in his or her teaching when during his or her training that was not included? Our lecturer just used to mention ICTs but never integrated himself. So what do you expect? There is a problem in our Zambian colleges and universities.

Most of the respondents bemoaned the inadequacy or lack of ICT infrastructure and equipment in the schools, lack of clear policy guidelines to facilitate the easy uptake of some modern ICT equipment in the schools and poor teacher training has challenges they faced. Majority of the interviewees were of the opinion that MOGE and school head teachers needed to open up space and move with global trends by allowing students to bring these personal ICT gadgets in school. Additionally, lack of school policies on the uptake of some modern ICT tools in the school is a recipe for disaster and sadly most of the schools do not have a clear ICT implementation policy. Most of the respondents were of the view that teacher training in colleges and universities need to consider serious integration of ICTs in methodology courses. Instead of just mentioning ICT integration in their lectures, let them be practical and seriously integrate ICT. This will enable student teachers to also implement ICT in their teaching.

4.3 Strategies to Improve Computer and related Softwares usage in Earth Geometry Teaching

The third research question was: *What strategies can be put in place to improve computer usage in Earth Geometry teaching in Zambian secondary schools?* The

ISSN: 2582-0745
Vol. 4, No. 03; 2021

strategies provided by the respondents in improving computer usage in earth geometry teaching were as follows:

1) Procure more computers and projectors there by improving on access to computers and projectors in schools,
2) Capacity building on the suitable softwares to use when teaching specific topics such as earth geometry,
3) Specific and flexible ICT integration in teaching,
4) Support from head teachers and government on how to integrate computers in teaching,
5) Trainings on ways to integrate ICTs such as computers in Mathematics lessons,
6) Refresher courses on softwares to use in teaching Mathematics,
7) Intensification of School Based Continuing Professional Development on ICTs as pedagogy.

Analysis of the responses from the respondents clearly indicated that there was agent need for capacity building among mathematics teachers on how to integrate ICTs in their teaching process. Most of the teachers were teaching the way they were taught when they were pupils themselves. Teachers do not know the available mathematics software to use mathematics topics such as earth geometry. Further, teachers actually do not know at what point they can integrate computers and related softwares in their teaching. Teachers attributed their failure to integrate computers and related software to lack of exposure to such gadgets. Lecturers in colleges and universities rarely train teachers to use computers and other Information and Communication Technologies (ICTs) gadgets in mathematics. Instead of practically training student teachers how to integrate ICTs in mathematics teaching, lecturers just mention it and move on. Therefore, colleges and universities need to revisit their curriculum in mathematics education courses so that student teachers upon graduating will be well equipt with full knowledge on how to integrate ICTs in mathematics teaching generally and earth geometry specifically.

5. CONCLUSION

This study explored mathematics teachers' computer applications in the teaching of Earth Geometry. It was motivated by the fact that various interventions and methods such as lesson study, group discussions, earth model and many others have been tried. Despite such trial interventions and methods, the performance of students in earth geometry continued to be poor. From this angle, the use of computers and related softwares remained as the solution which can bring meaningful results in improving students' performance. The study found that teachers were not using computers and related softwares in earth geometry teaching. The teachers themselves indicated that they do not use computers in earth geometry teaching. Analysis of documents such as schemes of work, lesson plans and textbooks also clearly showed that teachers do not use computers in their teaching. Despite not using computers, the teachers indicated that computers and related softwares can be used in earth geometry teaching by helping displaying the globe as a geometrical figure, download lesson notes, download lesson audio videos and others. The study also found that

ISSN: 2582-0745
Vol. 4, No. 03; 2021

financial constraints, lack of policy on ICTs in schools and poor teacher training were some of the challenges that enabled teachers not to use computers and related software in their teaching of earth geometry. The study further found that capacity building and improvement in teacher trainings in colleges and universities could be some of the strategies to improve usage of computers in earth geometry teaching.

From the findings, the study concluded that poor teacher training and approved textbooks being used in Zambian schools contributed to the failure by teachers not to use computers and related softwares in earth geometry teaching specifically and mathematics generally.Teacher professional training in colleges and universities at the moment does not encourage student teachers to integrate ICTs in teaching. The softwares in mathematics that can be used in teaching are rarely mentioned and practically explained by lecturers of methodologies. This makes both pre-service and in service teachers not to use them. The textbooks also being used do not contain activities that could compel teachers to use computers and related softwares in their teaching. The examples in these textbooks only encourage using routine conventional methods.

6. RECOMMENDATIONS OF THE STUDY

Based on the findings of the study the following recommendations were made:

1) The universities and collegesthat train teachers should encourage lecturers to adopt the use of computers and related softwares in Mathematics.
2) Lecturers in universities and colleges should set aside time for teaching earth geometry using computers and related softwares. Let the lecturers indicate to students the available softwares for earth geometry teaching and practically demonstrate to students.
3) The new books for mathematics should be written which should have activities that encourages teachers and students use computers and related softwares in their teaching and learning.
4) School authorities should source modern ICT equipment, formulate and implement school ICT policies that are consistent with current technological trends to facilitate the increased integration of ICT tools in mathematics classroom generally and earth geometry specifically. The circular policy that bared students' from using phones especially smartphones should be revisited.
5) Ministry of General Education and School authorities need to establish and develop online support systems to sustain mathematics teachers' staff development initiatives that could be facilitated and accessed through ICTs.
6) Zambia Association for Mathematics Education (ZAME) should as a matter of urgency consider organize trainings and seminars in which various mathematics softwares available can be packaged and demonstrated practically.

7. RECOMMENDATIONS FOR FUTURE RESEARCH

ISSN: 2582-0745
Vol. 4, No. 03; 2021

The current study findings present a number of research needs.

1. Studies similar to the current one must be conducted in urban secondary schools in the country. This can help toassess if the findings of the current study can be generalized.

2. A study must be conducted on the effect of computer applications in the teaching of earth geometry in Zambian secondary schools.

REFERENCES

Changwe, R. andMulenga, I. M. (2018). Mathematics Teacher Education Curriculum at a University of Zambia. Student Teacher's Acquisition of Appropriate Competencies for Teaching Mathematics in Secondary Schools. *Multidisciplinary Journal of Languages and Social Sciences Education, 1(1), 207-242*

Changwe, R. and Mwanza, C. (2019).Reclaiming the Missed Opportunities in the Teaching of Mathematics in Zambia: Exploring the blame game on the Poor performance of learners in mathematics.*International Journal of Education and Research, 7(6), 43-50*

Chazan, D., and Yerushalmy, M. (1998).Charting a course for secondary geometry.*Designing learning environments for developing understanding of geometry and space*, 67-90.

Chinamasa, Nhamburo and Sithole (2014). Analysis of Students' Errors on Linear Programming at Secondary School Level: Implications for Instruction. In *Zimbabwe Journal of Educational Research, 26 (1), 54-72.*

Davidson, D.M. (1990). An Ethnomathematics Approach to Teaching Language Minority Students. In J. Sakayombo, Learners' Low Performance in School Mathematics: A Result of their Insufficient Acquisition of Ethnomathematics. *Zambia Journal of Teacher Professional Growth (ZJTPG), 4(1), 55-66.*

Examination Council of Zambia (2012).*School Certificate and General Certificate of Education Examiners' Reports October/November 2006 Examinations. Chief Examiners Report*

Examination Council of Zambia (2016).*2015Examinations Performance Review Report for Natural Sciences.* Lusaka:Examination Council of Zambia.

Ilyas, M. (2015). Pedagogical Content Knowledge (PCK): Type of particular Knowledge for Teachers to Effective Teaching (Case Study of Mathematics Teachers of international conference on Statistics

Kafata, F. and Mbetwa, K.S. (2016). An Investigation into the Failure Rate in Mathematics and Science at Grade Twelve (12) Examinations and its Impact to the School of Engineering: A case Study of Kitwe District of Zambia. *International Journal of Scientific and Technology Research, 5(6)*

ISSN: 2582-0745
Vol. 4, No. 03; 2021

Mbugua, K.Z., Kibet, K., Muthaa, M, G. and Nkonke, R.G. (2012).*Factors Contributing to Students' Poor Performance in Mathematics at Kenya Certificate of Secondary Education in Kenya: A case of Baringo County, Kenya.*Chuka University College.

Musonda, A., Chisembe, C., Sampa, R. and Musonda, F.F. (2018). Teaching of Earth Geometry at Secondary School in Zambia.*Journal of Education and Practice, (3) 17, 57-68*

Mutai, J.K. (2010). *Attitudes Toward Learning and Performance in Mathematics Among Students in selected Secondary Schools in Bureti District, Kenya.*M.Ed.

Mwape, J. and Musonda, A. (2014).An Investigation in the Teaching and Learning of Mathematics at Senior Secondary level in Solwezi District.*Research journali's Journal of Mathematics, 1(6).*

Mwingirwa, I.M. (2016). Feasibility of Using GeoGebra in the Teaching and Leaning of Geometry Concepts in Secondary Schools in Kajiado County, Kenya.Unpublished Thesis. Nairobi: Kenyatta University.

National Council of Teachers of Mathematics [NCTM] (2000).Principlesand Standards for School Mathematics. Reston, VA.

National Council of Teachers of Mathematics (2003). The use of technology in the teaching and learning of mathematics (Position Statement).Reston, VA: NCTM. Retrieved August, 20th, 2019 from http://www.nctm.org/about/content.aspx?id=6360.

Okafor, C.F. andAnaduaka, U.S. (2013). Nigerian School Children and Mathematics Phobia: How the Mathematics Teacher can help. *American Journal of Educational Research, 1(7), 247-251.*

Sakayombo, J. (2018). Learners Low Performance in School Mathematics: A Result of their Insufficient Acquisition of Ethnomathematics. *Zambia Journal of Teacher Professional Growth (ZJTPG), 4(1), 55-66*

Simukoko, G. and Sakala, W. (2018). The Impact of Earth Model in Understanding of Earth Geometry by In-Service Student Teachers: A Case of Mukuba University of Zambia. *Journal of Natural Sciences Research, 8(18), 1-14.*

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.

Yara, P.O. and Otieno, K.O. (2010).Teaching/Learning Resources and Academic Performance in Mathematics in Secondary Schools in Bondo District of Kenya.*Asian Social Science, 6(12), 126-132.*