BINDURA UNIVERSITY OF SCIENCE EDUCATION

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An investigation into the effect of ICT in the teaching of Geometry at ordinary level. A case study of schools in Chiredzi District in Masvingo Province, Zimbabwe.

A Prospectus Submitted in Partial Fulfilment of the Requirements for the Bachelor of Science Education Honors - Mathematics (HBScEd-Mt)

BY

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Release Form

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Declaration

This research has not been presented at any other university to the best of my knowledge

Elvis Baloyi

Dedication

This research project is dedicated to my beloved wife Cecilia Muzvi, our beautiful daughters Vanessa. E Baloyi and Sandra. N Baloyi and to our son Elvis. L Baloyi. To God be the glory.

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The conduct of this study would not have been possible without the involvement of a number of people and institutions that accorded me assistance, guidance and support. First is the work of academic guidance accorded to me by my able supervisor and lecturer, Doctor Kazunga C, whose input and critique was invaluable throughout the course of the research study process. Secondly is the preparation for the task by all my lecturers at Bindura University of Science Education, especially the Library Staff. Many thanks also go to all my classmates.

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Abstract

Information and Communication Technology (ICT), plays an intrinsic role in facilitating the dissemination and acquisition of knowledge in all spheres of life and more-so in education, in particular, in subjects such as Mathematics and Science being some of the most dreaded subjects. There are areas in Mathematics such as Geometry that require the use of ICT to present good diagrams which will in turn appeal to the learners and help them develop love for the subject. However, the impact of ICT in the teaching of Geometry has been very minimal as a curriculum thrust. In Zimbabwe, traditional teaching methods which are teacher centered and less interactive continue to dominate classroom lesson delivery especially in Mathematics. This research study sought to investigate the effect of ICT in the teaching of Geometry in Mathematics through analyzing the determinants of ICT integration with a view to suggest strategies to be employed to enhance integration of ICT in the teaching of Geometry. The study adopted a descriptive survey design where qualitative and quantitative data was collected. Using purposive sampling method, primary data was collected using questionnaires for Mathematics teachers and interviews for the Heads of Department (Mathematics HODs), that had been pretested to ensure reliability and validity. Thirty mathematics teachers and HODs were chosen as the sample for the study of which twenty-six responded to the questionnaire. The data collected was analyzed using a combination of statistical computations and presented through graphs and tables. Interpretation was done using texts for clarity. The research proved that ICT if used properly has a great potential to motivate students, improve pass-rate and simplify the teaching and learning of Geometry at ordinary level. It also highlighted need to hold regular workshops to upgrade teachers on modern pedagogical practices whose thrust is more learner centred and promote ICT in schools. Mathematics teachers are encouraged to capitalise on the inherent love of technology and inquisitiveness inborn in learners to adopt ICT to teach especially conceived difficulty topics such as Geometry.

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List of Abbreviations and Acronyms

ICT…….. Information and Communication Technology

HOD…… Head of Department

CHAPTER 1

1.0 Introduction

The chapter presents an introduction to the study. It provides an abstract analysis of the problem, the objectives to be attained in carrying out the research, the significance of the research project, its objectives, delimitations and limitations of the study. The chapter includes definition of key terms used in the research and a summary of the chapter.

1.1 Background of study

The place of technology in education is unquestionable. In this information age and our need to join the global village, the researcher having realised how Geometry remains a thorny area for most pupils, has decided to investigate the degree to which the integration of ICT has impacted on the teaching of Geometry at ordinary level. The researcher also wants to help teachers and pupils alike to integrate the use of technology such as computers which can plot and draw better and much more accurate graphs in vivid colour and 3D presentation to give a clearer picture than hand drawn sketches. Having noticed how work presentation influences attitudes towards Geometry, the researcher is of the opinion that using such attractive and interesting technology can instill love for Geometry in pupils resulting in higher pass-rates at ordinary level Mathematics and more.

According to Dhakal, P. (2018), technology is essential in teaching and learning Mathematics since it has a positive influence students' learning. As Dhakal, P. (2018), correctly point out, the attitudes of the teachers play an important part in influencing how they will use and adopt ICT in their classrooms. Some of these attitudes are a sign of poor ICT literacy on the part of the teacher.

Research on the integration of ICT in the teaching of Geometry has examined the effectiveness and impact of software packages such as, Maple, SPSS and GeoGebra on achievement and also on computers graphing (Arvanitaki, M & Zaranis, N, 2020). The findings of the studies support computers in Mathematics teaching and learning. Verbruggen, S & Depaepe, F & Torbeyns, J. (2021), researched on the effect of spreadsheet and dynamic Geometry software on achievement in Geometry and their findings indicate that using ICT effectively in teaching and learning greatly enhance students' mastery of Geometry. Arvanitaki, M & Zaranis, N, (2020), also discovered that students who had computers at home had higher Geometry scores. Seeing this, Arvanitaki et al. (2020), suggested that schools integrate mathematical content and technology in a way that will allow students to enjoy mathematical discoveries.

Even though there are many factors such as poor pedagogy, student's attitudes, lack of resources, that may result in poor performance of students at Geometry, one of the major cause might be the integration of ICT which if properly incorporated could make easier the teaching of such topics as Geometry, which is dreaded by teachers and students alike. Against this background, this study investigates the effect of using ICT in the teaching and learning of Geometry in order to gain insight into the problems noted in the curriculum implementation.

1.2 Statement of the problem

Given the scenario cited in the background, there was a need to look closer into the teaching and learning of Geometry through use of ICT to establish what exactly the teachers find to be difficult and also the factors causing such difficulties experienced.

The fact that Mathematics is perceived as the most difficult subject at ordinary level suggests that it contributes significantly to the poor achievement of students in sciences at this level. It is important to establish the causes of these difficulties in teaching and learning this subject and in particular in the Geometry area.

1.3 Objectives of the study

This study is carried out to:

a) examine the levels of preparedness of the teachers in adopting ICT in the teaching of Geometry at ordinary level

b) assess the effect of ICT in the teaching of Geometry at ordinary level.

c) determine factors affecting the integration of ICT to teach Geometry at ordinary level.

1.4 Research questions

Given the background, there is need to look closer into the impact of ICT and how it is being integrated in teaching Geometry. In order to do so, the following research questions will be answered during and after the study:

a) How much are the teachers prepared in adopting ICT in the teaching of Geometry at ordinary level?

b) What is the effect of using ICT in the teaching of Geometry at ordinary level?

c) What are factors affecting the integration of ICT to teach Geometry at ordinary level?

1.5 Significance of the study

The findings from this study benefits Mathematics teachers by highlighting problems experienced by other teachers and students in the teaching of Geometry. The study report also provides a forum for sharing experiences. Mathematics teachers need different professional views and experiences. This enables them to compare their teaching methods and also to be continuously updated by the new findings on the impact of ICT in the teaching of Geometry.

The researcher would need to be furnished with information on the ground so as to design some intervention strategies in order to curtail the factors that affect teaching of Geometry using ICT. The researcher will disseminate the findings through journal publications. Although the study will be conducted in Zimbabwe, the recommended intervention strategies can be applied in any other locality.

1.6 Definitions of terms

a) **Effect**

According to the Concise Oxford Dictionary (eleventh edition), effect means a marked impact or influence on something. This refers to the degree of influence that technology has dealt in the education system as regards the teaching of Geometry. Impact evaluation is an assessment of how the intervention being evaluated affects outcomes, whether these effects are intended or unintended.

b) **Information and Communication Technology (ICT)**

The scientific, technological and engineering disciplines and the management techniques used in information handling, processing and disseminating; their applications; computers, networking and communication and their integration with men and machines; and associated social, economic and cultural matter (British Computer Society).

This implies that ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software,

satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries.

1.7 Delimitations of the study

The study investigated teachers' perception on the effect of ICT in the teaching and learning of Geometry at ordinary level. It explored teaching methods and instructional materials used by the teachers. Other variables such as students' socioeconomic status and stereotypical attitudes towards Geometry among others were not included in the study. The study was confined to schools in Chiredzi district in Masvingo Province of Zimbabwe due to time and financial constraints. Teachers targeted by the study were those who teach Mathematics at ordinary level (Form 3 and Form 4).

1.8 Limitations of the study

Several limitations of the study require cautious interpretation of the findings. The researcher will exercise caution when interpreting the findings to accommodate alternative explanations. Limited generalization of the findings to other population will be considered.

There are few, if any, similar studies that have been conducted in Zimbabwe to compare the findings of this study. There are also financial limitations in regards to travel expenses, printing, photocopying and distribution of questionnaires. Environmental factors such as prevailing climatic conditions such as heat and geographical factors such as distances learners travel to school, are not considered in the study. Due to this, a sample was taken to represent the total population of the study.

1.9 Ethical considerations

It is imperative to consider a range of ethical issues when conducting a research. The researcher will uphold receptiveness to teachers' ideas and openness to listening for their messages. The researcher will ensure honesty with all the respondents, so that they know if confidentiality would ever be broken and what the parameters are. The researcher will consider the likely consequences of collecting and disseminating various types of data and will guard against predictable misinterpretations or misuse. Exaggeration of the accuracy or explanatory power of the data will be avoided.

1.9.1 Chapter summary

The chapter outlined the background of the problem of the study and gave a statement of the problem. The objectives of the study, the delimitations and limitations of the study were also discussed. It gave the direction of the study and also dealt with ethical considerations assuring confidentiality of data treatment.

CHAPTER 2: Literature Review

2.0 Introduction

One cannot talk about the integration of ICT in the teaching and learning of Geometry without talking about the curriculum and its implementation. Researchers in developed countries have shown that the quality of curriculum implementation in the classroom has effects on academic achievements of the students (Verbruggen, S & Depaepe, F & Torbeyns, J. 2021; Yanuarto, W & Maat, S & Husnin, H. 2021), highlighted several factors that are related to successful curriculum implementation which include: textbooks and other reading materials, instructional materials, instructional media like radios, active teaching and learning approaches, individual work, clearly presented lessons and library facilities

Maharjan, M & Dahal, N & Pant, B. (2022), evidenced that cooperative learning approaches have positive effects on learner academic achievements. Researchers in the developing world, particularly in Southern Africa, have shown their interest in how the curriculum is being implemented in their countries (Farley, S., Gerard, A., Sayre, M. and Carter, J. 2015). Also, poor ICT competence coupled with lack of confidence as well as lower motivational levels seem to impede teachers from properly integrating ICT in their teaching, (Drijvers, P. H. M., Monaghan, J., Thomas, M., & Trouche, L. 2015).

2.1 Factors Affecting the Integration of ICT in the Teaching of Geometry

2.1.0 The Curriculum

Farley, S., Gerard, A., Sayre, M. and Carter, J. (2015). outlined the three curriculum components as:

(i) the intended curriculum which is drawn up in form of syllabuses, policy statements, teaching materials etc.

(ii) the implemented curriculum which is what the teacher tries to do in the classroom and

(iii) the attained curriculum which is what learner has actually learnt.

Farley, et al (2015), after having discovered that many teachers have difficulties in interpreting the national syllabus, highlighted that the vital part of the curriculum development is the transition from the intended to implemented curriculum. To fortify this idea, Rana, N. (2013), argued that, no matter how good the curriculum is on paper, it becomes worthless if the whole spirit of curriculum is lost in the transition into actual process. This was supported by Maharjan, M & Dahal, N & Pant, B. (2022), who argued that translating the theories into practice in classrooms has always turned out to be problematic.

Nyakowa, L. S. (2014), discovered that there are disparities between the intended and the implemented curricula. Luneta, K. (2015), found that teachers have difficulties in interpreting the national syllabus. Successful curriculum implementation is dependent upon a variety of factors. Nyakowa, L. S. (2014), states that the school climate, material provisions, school administration, qualifications of the teacher, teacher training, teacher experience, teaching methods, age and gender have an effect on teacher effectiveness.

A review of these studies leads to an understanding of ICT integration as a complex and multi-layered phenomenon which needs to include a survey of infrastructure as well as more intangible measures of pedagogy. Some of the conditions necessary for successful ICT integration include administrative and parental support, physical upgrading of the learning environment and introduction of teacher upgrade workshops on ICT to ensure that the teachers stay abreast of the latest approaches being used with positive results.

ICT enhances educational quality by boosting learner motivation, engagement and participation, by also enabling basic skills acquisition and by enhancing teacher content mastery through maximized research and the sharing of information with their peers. Polly, (2011) points out that ICT helps transform the learning environment from teacher centered to a more learner centered one. Balanskat, (2006) claims that use of ICT in teaching generally impacts more on the pupils' higher order thinking skills and also facilitate competence development through teamwork as well as individual learning. ICTs such as internet connected computers give rise to a variety of new ways of teaching and learning on top of the traditional ways thus enabling teachers to deliver their lessons in a fresh and attractive way.

2.1.1 Age and experience of the teacher

In the teaching profession, age is normally linked with experience and seniority of a teacher (Nyakowa, L. S. 2014), posits that at the end of primary and in secondary schools, older teachers are more successful than younger ones. He found that there are also some complimentary factors such as availability of equipment and materials at schools which attracted senior teachers.

Tripathi, H. (2016), being interested with experience of school heads, found that the more experience school heads are, the better their levels of performance in their administrative duties. Focusing on practicing teachers, (Nyakowa, L. S. 2014), argues that teachers experience is important at both Primary and Secondary Schools. However, Adegoke, A. I. (2016) thinks the contrary in terms of teacher effectiveness. He says that newly trained teachers have much to offer and that longer experience may erode teacher effectiveness, especially in the face of changing curricula, methodology and examination requirements.

2.1.2 Teachers' Qualifications

There seems to be a unanimous agreement between authors about the existence of a positive relationship between qualifications and teacher effectiveness (Rana, N. 2013). After finding that most teachers being investigated lacked content and professional knowledge and skills to effectively evaluate and change their teaching behaviors in the light of classrooms needs, Saha, R. (2016), concluded that there is need for teachers to have the professional skills to reflect on their decisions in an intellectually useful manner so as to be able to evaluate pupils' learning and their

own instructional moves. After the studies on primary schools, Koparan, T., and Yılmaz, G. (2015) argues that a teacher who lacks knowledge of content and lacks confidence in presenting it might not be in a position to teach mathematics effectively and successfully, let alone Geometry.

Teacher professional development is at the core of any educational program success. Tripathi, H, (2016), after carrying out a quantitative study on the factors that facilitated teacher skill and morale and observed pupil learning through ICT found out that professional qualification was crucial to the extent of which ICT was integrated in the classroom.

Another vitally significant discovery they made was that most teacher training programs seem to concentrate on basic ICT literacy skills at the expense of the integrated use of ICT in teaching. The same notion of ICT literacy over integration is be-mourned by Schaffer and Richardson (2004), who decry that despite the thrust to use ICT in schools, very little training is given to teachers on how to integrate ICT when teaching.

In other teacher training programs teach teachers to be about ICT and put very little emphasis on teaching with technology such that there is very little wonder why even computer literate teachers do not seem to know how to make proper use of ICT when teaching. Student teachers need to be grilled on teaching with technology instead of teaching about technology so that they can be well prepared and confident to use ICT in teaching to augment their standard classroom activities (Rosenthal, 1999). Teachers are more likely to integrate ICT in their courses, when professional training in the use of ICT provides them time to practice with the technology and to learn, share and collaborate with colleagues.

2.1.3 Gender of the Teacher

Literature has not revealed any relationship between gender and teacher effectiveness in teaching Geometry at secondary level, but at primary level, female teachers were found to do better than their male counterparts at primary level (Nyakowa, L. S. (2014). This result might be justified by the fact that females are generally more patient than males. However, Nyakowa, L. S. (2014). researched on age and gender differences with regards to their contribution in the overlooked context of how individuals adopt and make use of ICT in their respective workplaces. This study proved that gender-wise, men tended to show a positive attitude towards learning and using new

technology than women while age-wise, the younger workers showed more enthusiasm and inclination to learn and apply new technology as compared to the older workers.

Gender differences and its implication on ICT integration has been the focus of many researchers in varied fields of study but with regards to teaching, Luneta, K. (2015). have claimed that female teachers seem to exhibit lower levels of ICT use supposedly due to their lack of interest, poor computer skills and limited access to technology. Several other studies have shown an overall pattern with males and younger teachers showing more aptitude and tendency to integrate ICT in their teaching as compared to the elderly and female teachers.

2.1.4 Professional Support for Teachers

Professional support for teachers in form of seminars and/ or workshops is very useful in providing a repertoire for strategies and knowledge to respond to the demands of perceived difficulty topics such as Geometry (Saha, R. 2016). Researchers in Zimbabwe found that the professional support given so far to teachers is very inadequate due to shortage of funds, personnel and transport and also because some teachers are denied such opportunities. These researchers also reveal that teachers are in demand of such support systems (Verbruggen, S & Depaepe, F & Torbeyns, J. 2021).

The ICT Competency Framework for Teachers is a very powerful and comprehensive tool for analyzing and assessing educational policies which provides researchers and educators alike with a dependable platform for developing a national ICT policy that will encompass the local aspect with the international touch so as to meet the global village requirements of modern education systems. This framework emphasizes the importance of not just teacher ICT competence but also how to apply that competence in the teaching of students. Akgül, M. B. (2014), cites the need to train teachers to facilitate their students to become problem solvers through collaborative approaches and creative thinking which is brought about by use of ICT in their teaching. Thus, student academic achievement in perceived difficulty topics such as Geometry is automatically enhanced.

2.1.5 Teaching Materials and Infrastructure

According to Yanuarto, W & Maat, S & Husnin, H. (2021), the shortage of resources and adequate supporting structures such as textbooks and e-facilities has severe adverse effects on the performance of students in Geometry. Pupils need to be able to read them. Research done in Zimbabwe reveal a shortage of teaching materials and infrastructure. Nyakowa, L. S. (2014), found that most day secondary schools, especially in rural areas, have an adverse shortage of a variety of textbooks and the commonly textbook used is New general mathematics. Nyakowa, L. S. (2014), also discovered that other resources such as internet and library facilities are not common in these establishments. Comparing resources among schools, it was found that schools with better ICT resources perform better in Geometry and examinations in general, (Nyakowa, L. S. 2014).

ICTs while being expensive to procure, has the benefit of motivating both teachers and students while raising levels of learner engagement thereby producing learners who are self- starters and also turning the classroom environment into a more learner centered one as compared to textbooks, (Nyakowa, L. S. 2014). Access to ICTs outside of school also boosts learner confidence as most learners with such access are liable to enjoy studying ahead and discover more online sources to augment their classroom knowledge. This implies that parents also must make the effort to procure ICT tools for their children as this also helps to transcend geographical and time constraints especially for learners with special needs who will enjoy the benefit of anytime, anyplace access to education.

Maharjan, M & Dahal, N & Pant, B. (2022), posits the idea that it is not entirely necessary to build expensive infrastructures such as computer labs for pupils to have access to ICT, instead pupils can gain from cheaper ICTs such as smartphones which can allow students to browse the internet, access e- books, sample exams papers, worksheets, resource persons and their teachers.

Platforms such as Facebook and Google Scholar also enable pupils to meet and share with their peers on online forums. Maharjan, et al, (2022), further points out that such flexibility in learning provides what the writer terms just- in- time learning by utilizing the 24/7 aspect of the internet and mobile services, thus leading to the democratization of education. Especially in developing countries like Zimbabwe, effective use of ICT for the purpose of education has the potential to bridge the digital divide and to eliminate the crippling lack of infrastructure.

2.1.6 Methods of Teaching

Many researchers and educationalists are in favor of active teaching and learning approaches. Luneta, K. (2015), stated that active teaching and learning are important in determining the quality of curriculum implementation and opposed teacher demonstration which they say is characterized by rote and reception learning. These authors also wrote in favor of field trips, which, according to them, constitute an important instructional approach that helps to link theoretical work to reality. Other factors which are also vital include effective teacher training and proper linkage between ICT usage and sound pedagogy. ICT integration in itself would shift the teaching approach from transmission-type teacher centered to more learner centered pedagogical approaches.

2.2 The Effect of ICT in the Teaching of Geometry

According to Arbain, N. and Shukor, N. A. (2014), ICT assists teachers in accessing digital efficiently and effectively thereby keeping them updated and in touch with the rest of the Mathematical world. ICT supports self-directed learning which is good for both teachers and students alike, (Adegoke, A. I. 2016). Clark-wilson, A. and Mostert, I., (2016), also highlight sharing of material and ideas as one of the most powerful aspect of teaching Geometry using ICT. Teachers can share ready made material with which to help instruct their students. Sharing helps those teachers whose ICT grasp is limited to using and not creating content Çetin, H & Turkan, A. (2022).

Denbel, G. D. (2015), is of the opinion that teaching through Geometry ICT produces a creative learning environment which excites learners and motivates them as well as capture their attention thereby improving their retention thresholds. Use of ICT to teach Geometry promotes collaborative learning in a distance learning situation, (Drijvers, P. H. M., Monaghan, J., Thomas, M., & Trouche, L. 2015). Use of such online learning platforms such as WhatsApp, Facebook, Google Classroom and Zoom further assist the teacher to teach Geometry anytime and anyplace. ICT offers more opportunities to advance critical (higher-order) thinking skills in learners, better education, including collecting quality.

2.3 Chapter Summary

Clearly measuring the effect of ICT in the teaching particularly of Geometry is no easy feat and has no clear-cut procedures but taking stock of its extent of integration is a fair measure since the more the integration observed the higher the impact ICT has in the teaching of Geometry at ordinary level.

From the literature reviewed it becomes more apparent teacher factors have a very profound impact on how they will employ and apply ICT in their teaching and as such, to the overall impact of ICT in teaching Geometry. Other equally intrinsic factors to the impact of ICT in the teaching of Geometry would include infrastructure, the home environment and the attitude of the school administration towards use of ICT in the teaching to mention just a few. The teacher factors in turn would be informed by teacher training and the influence of ICT myths and beliefs. It is suggested that this study could also inform on the effectiveness of in-place strategies currently employed to integrate ICT's in teaching Geometry at ordinary level.

This chapter on literature review leaves no doubt that all the factors affecting the impact of ICT in the teaching of Geometry especially among ordinary level mathematics teachers should be perceived as a unit within a system for successful educational performance. What is quite apparent is that these factors are quite many and it is only by delineating them well can specific data be obtained and analysed. However, the determination of attitude, access, perception and ability on the part of the teacher cannot be taken as exhaustive.

CHAPTER 3: Research Design and Methodology

3.0 Introduction

This chapter outlines the methodological approach adopted in this study. It highlights the various steps taken to carry out the study. The research design and methodology is important in that it states the design, the population from which the sample will be extracted as well as the sample size. Ways of data validation such as triangulation will be discussed in this chapter.

3.1 Research Design

The study is a survey design but incorporates some aspects of a case study. Objective quantitative and qualitative data will be collected. The survey design is preferred because it enables obtaining information from a representative selection of the population. According to Yin, (2014), case studies are suitable when studying individuals, groups, processes, events, decisions, programs, or any other phenomena that are encased by temporal and spatial boundaries. Also the case study aspect enables in-depth study within a limited time scale. Both nominal and ordinal data are to be obtained for analysis and comparison.

3.2 The Population

Ackerman, B., Schmid, I., Rudolph, K. E., Seamans, M. J., Susukida, R., Mojtabai, R., & Stuart, E. A. (2019), define a population as the total collection of elements about which we wish to make some inferences. This represents the entire population under study as specified by the objectives. A population can be defined as any set of subjects having common observable characteristics. The population of the study will be taken from schools in Chiredzi District. From these schools, ordinary level Mathematics teachers form the population.

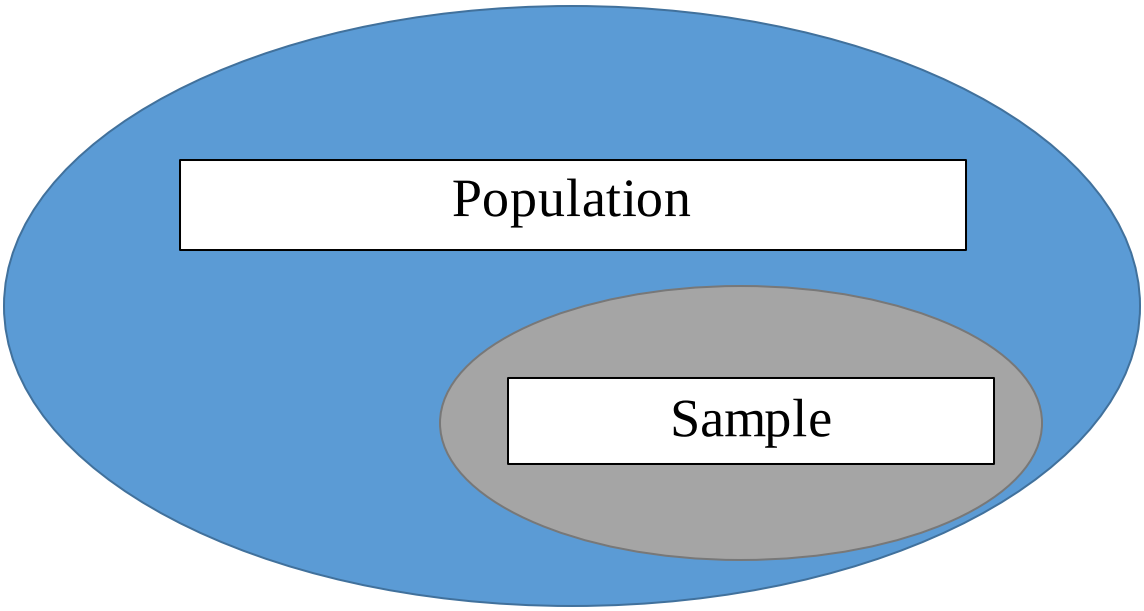
3.3 Sampling and Data Collection Procedures

Purposive sampling strategy was used to come up with the required sample. Purposive sampling or judgement sampling, is the intentional selection of a participant because of the characteristics and qualities the individual possesses (Etikan et al., 2016). The common denominator is that participants are selected because they possess specific qualities which are of interest to the investigator. This sampling method, is more popular within qualitative research designs (Pat-ton, 2015). Schools accessible by public transport were chosen. Purposeful sampling is preferred because the researcher wants to get information from a specific group within a limited time factor. Thirty Mathematics teachers were purposely selected to participate in this research.

Teachers were given questionnaires to complete and the heads of Mathematics departments from these schools were interviewed. Online distribution of the instruments was also employed to maximize the outreach and enable the respondents time to respond without pressure.

SAMPLE

A sample is an extract from the true population, selected to represent the population of interest (Gravetter & Wallnau, 2017). The data provided about the sample was analyzed and the results inferred (quantitative) or transferred (qualitative) to the population of interest (the mathematics teaching and learning world). Since the sample was purposely extracted, then it truly is representative of that population of interest, a requirement addressed by prescribing the correct sampling frame and by using an appropriate sampling method.



3.4 The Research Instruments

Two instruments will be used to collect information in this study. A questionnaire will be used to collect information from teachers and an interview schedule will be used to collect information from heads of Mathematics departments. The questionnaire is part Likert scale in order to research the degree of feeling over certain aspects and also it is easy to administer and does not require in depth study in order for the respondent to answer satisfactorily.

The interview is meant to gather much more comprehensive and exhaustive data and to also accord the respondents an open-ended platform where they can raise issues which the interviewer may have overlooked but which may be critical to the research. To assure reliability and validity in the instruments, question items have been checked against ambiguities. Colleagues have been asked to assist in checking for ambiguity and also whether the items are suitable and able to collect the required information. A pilot study will be carried out for that same purpose.

3.4.1 Administration of Instruments

The researcher personally delivered the questionnaires to schools and interviewed heads of departments during these visits. Alternatively, the researcher used email and WhatsApp to distribute and collect the required information.

3.4.2 Teachers' Questionnaire

The teachers' questionnaire had structured questions with choice options for ticking, and some open-ended questions seeking a further explanation.

It had an introduction and three sections: *The introduction*: This explained the purpose of the questionnaire and also highlighted that the information to be given was to be treated confidentially. Also on the introduction the teacher was advised not to write his/ her name or the name of the institution.

Section A: This constituted questions seeking information about the age, gender, academic and professional qualifications, and teaching experience of the respondent. ***Section B***: This constituted questions seeking information about the respondent's pre-service experience in ICT- whether the teacher used ICT during their school days or not, at what level(s), and the self-rating of the teacher on ICT literacy. ***Section C***: This constitutes questions seeking information about the respondent's in-service experience with ICT. The information needed was the number of teaching periods, whether the teacher is confident or not in teaching through ICT, their view on the general performance of ordinary level students learning using ICT and the problems encountered by the teacher when teaching and by the students when learning using ICT, suggested interventions to improve teaching and learning of Geometry using ICT.

3.4.3 Head of Departments' Interview Schedule

The teachers' interview schedule is formal with structure parts where the interviewer ticks the exact answer supplied or the category of the answer given and some open-ended questions which needs the interviewer to summarize the answer given. Like the first two instruments, the interview schedule has an introduction and two sections.

The introduction or rapport constitutes of self- introduction, explanation about the purpose of the research and its importance to the practicing teacher.

Section A constitutes questions on personal details like gender, age and questions seeking information about the pre-service experience of the interviewee in relation to the use of ICT: at what level he or she first used ICT, his or her feeling about ICT, and which concepts were difficult to understand and why. ***Section B*** constitutes questions seeking information about teaching experience, feeling about the use of ICT, whether he or she encounters a problem in teaching using ICT, concepts of ICT which are difficult for teachers to integrate, concepts which are difficult for students to assimilate, students' general performance in Geometry and the causes if the performance was bad, intervention strategies that could help improve teaching and learning of Geometry.

3.5 The Pilot Study

The pilot study was done to test the instruments used and also identify the possible main issues to be raised by teachers. Alpha-Mpapa high school was chosen for the pilot study due to several factors. Alpha-Mpapa high school had the largest number of Mathematics teachers and issues under investigation are likely to be represented at this school. All Mathematics teachers at this school were chosen to participate in this research.

3.6 Chapter Summary

This chapter described how the data will be collected and what type of data collection instruments as well as the methodology to be used in order to produce reliable results. The justifications were also stated as to the choice of population and sample size.

CHAPTER 4: Presentation, Analysis and Interpretation of Results

4.0 Introduction

In this chapter, the researcher presents the data in form of tables and bar graphs. Twenty-six teachers' questionnaires were returned. The information from these instruments was summarized and analyzed using descriptive statistical methods. The responses and analysis are outlined below.

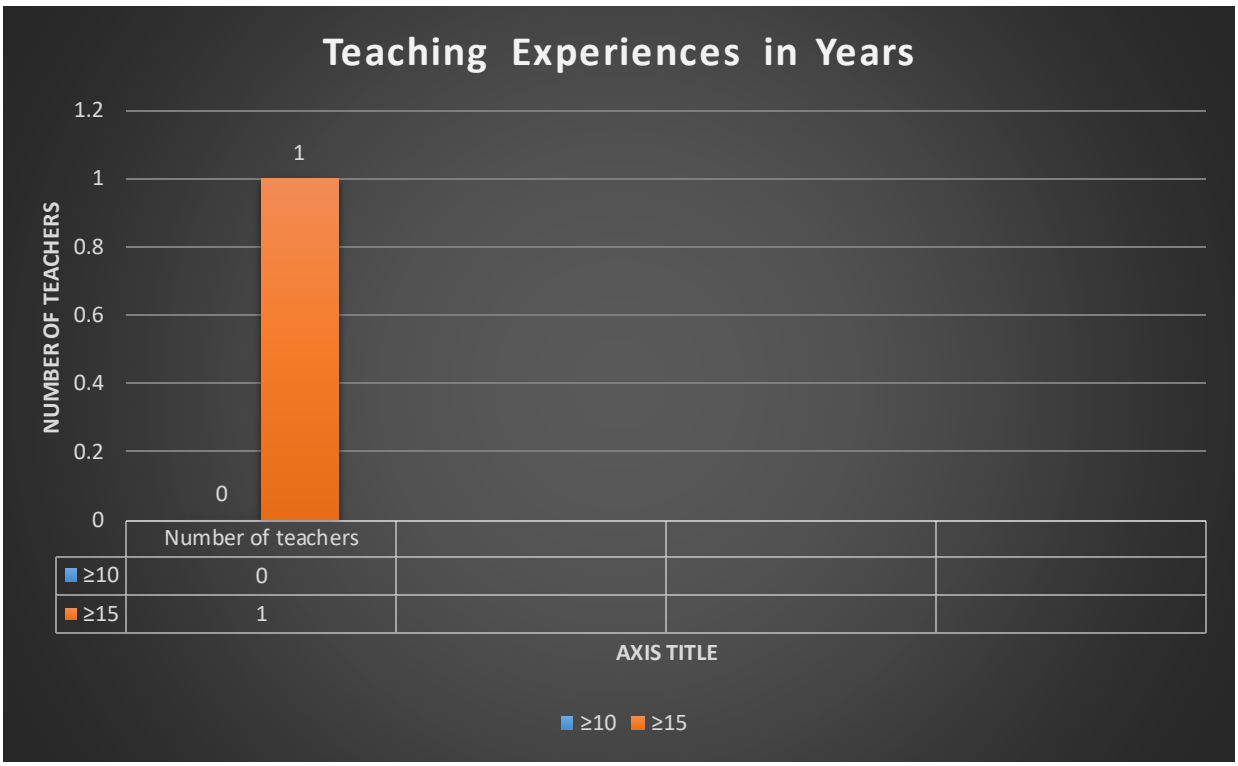
4.1 Experience in Teaching

The teaching experiences of the 22 teachers were as shown in table 3 below.

Table 1: Teaching Experiences in Years

Teaching Experience	Males	Females	Total	Percentage
Less than two years	2	3	5	19.24
2 to 5 years	6	7	13	50
6 to 10 years	2	2	4	15.38
More than 10 years	3	1	4	15.38

Figure 1: Teaching Experiences in Years



These figures show that a fair number of the teachers had a decent level of experience (5 years onwards). However, the experience alone, without continued rejuvenation through in-service training and further studies, may not be of value to the quality of teaching.

The teachers with more than 10 years of experience also were the ones who claimed less confidence in using ICT in the classroom thereby proving correct the findings by Drijvers, P. H. M., Monaghan, J., Thomas, M., & Trouche, L. (2015), who supposed that new teachers were more likely to adopt new curriculum thrust compared to the experienced ones.

4.2 Teachers' Pre-service Experience in Computer Literacy

The pre-service experience in computer literacy referred to whether the teacher learnt the use of computers during school days and also the level of education in which the teacher was when he or she began learning computer literacy. There are only two subsections for this part of the chapter, that is to say, level of first encounter with computer literacy and teachers' pre-professional performance in computer literacy. Teachers' responses to questions on their pre-service experiences in ICT and findings are as outlined below.

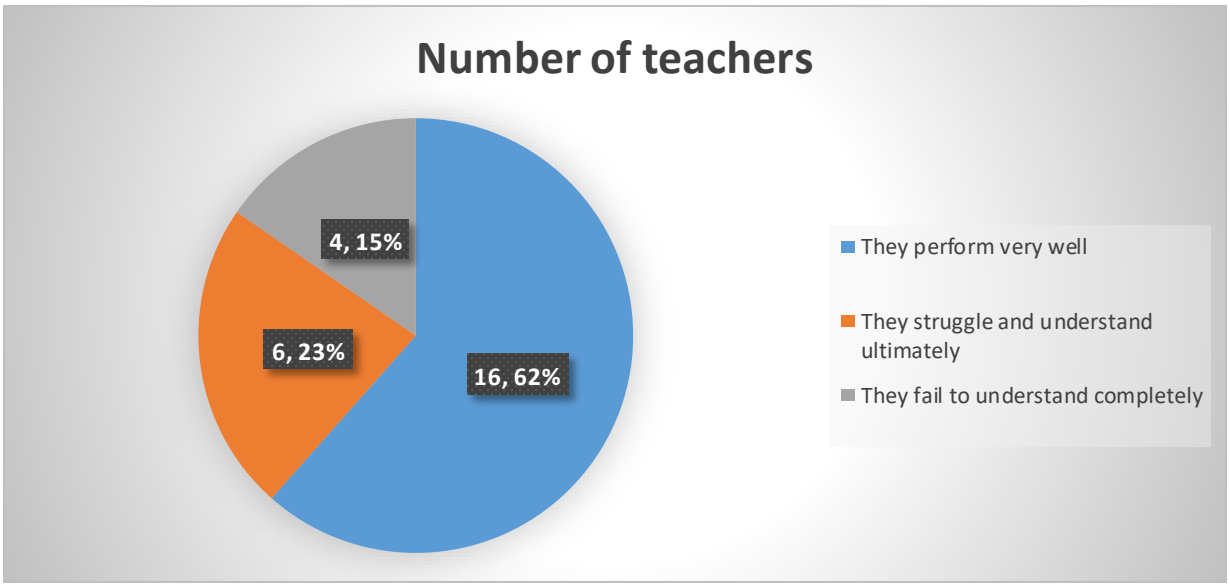
4.2.1 Level of Teachers' First Encounter with Computer Literacy

About 31 % of teachers were found to have learnt computers at ordinary level. About 65% of teachers first encountered the computers when training to become teachers and only 4% encountered the computers while already teaching. Most of the teachers who expressed confidence in ICT use in the classroom also happened to be the majority of those who had first been introduced to ICT at ordinary level and during training as anticipated by the Department of education, (South Africa). (2016).

Table 2: Level of First Encounter with ICT

Level of first encounter with computer literacy	Number of respondents.	Percentage
At ordinary level	8	30.77
During training	17	65.38
Already teaching	1	3.85

Figure 2: Level of First Encounter with ICT

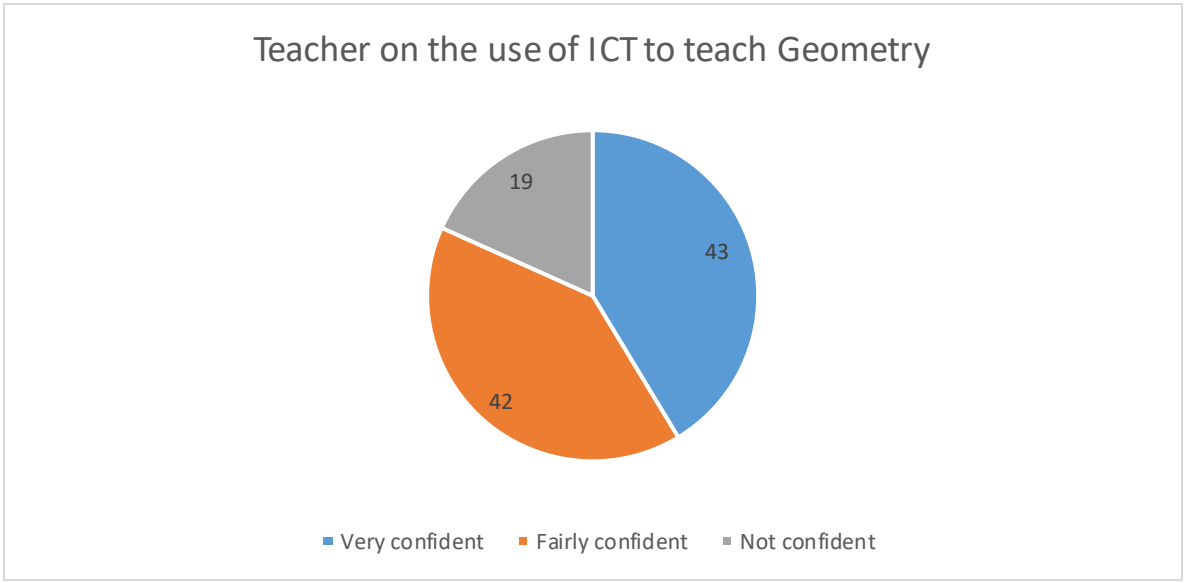


4.2.2: Teachers use of ICT in the teaching of Geometry

Table 3: Teachers use of ICT in the teaching of Geometry

Scale	Web surfing	Hardware familiarity	Use of mathematical software	Use of internet downloads	Total
Very confident	7	10	6	20	43
Fairly confident	16	10	11	5	42
Not confident	3	6	9	1	19

Figure 3: Teachers use of ICT in the teaching of Geometry



The majority of the teachers revealed that they were very confident when teaching using ICT. Only a minority felt less confident. None declared lack of confidence. However, the more confident were those of the current generation who did computers at school and at university. These also were the teachers who had personal computers and did not entirely rely on the school's. The results also confirm ICT integration does not necessarily rely on the school's infrastructure (Clark-wilson, A. and Mostert, I., 2016).

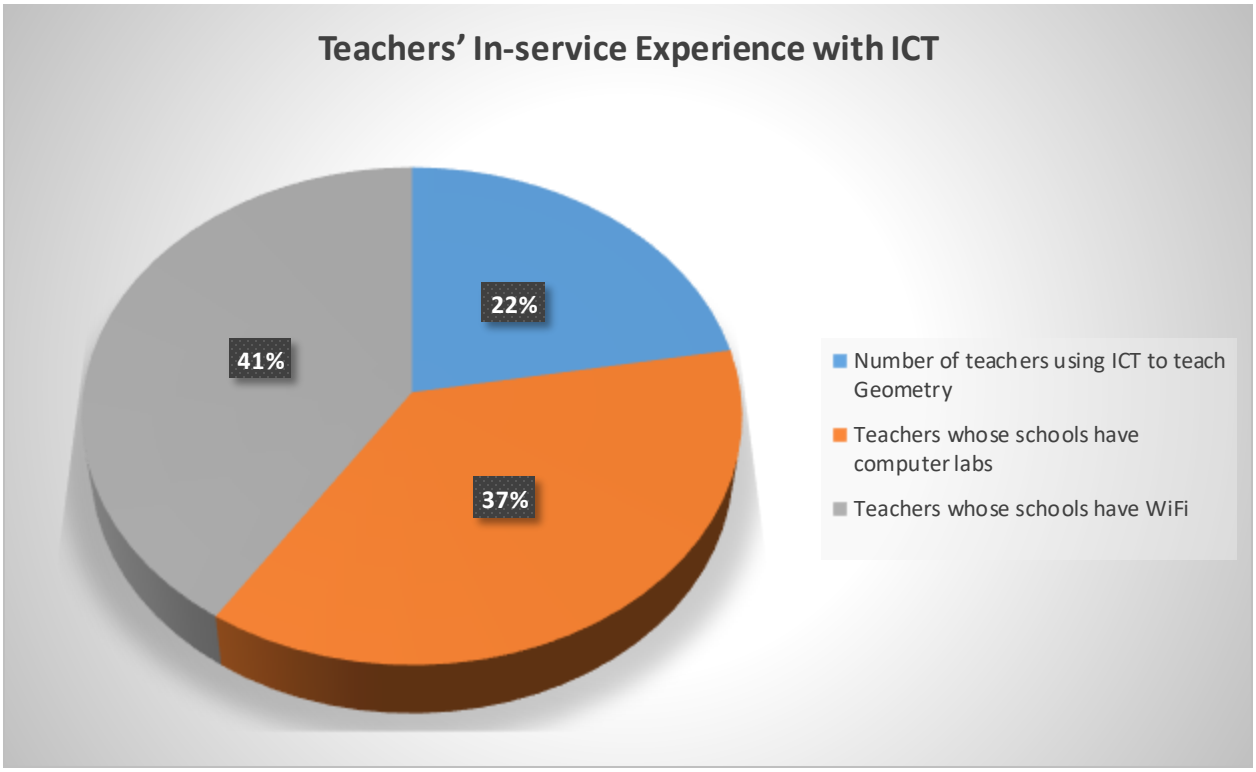
4.3 Teachers' In-service Experience with ICT

The in-service experience with computer literacy refers to the present conditions the teacher is working under, more specifically, in relation to teaching mathematics using ICT and on the other hand his or her perceptions about students' performance when taught through ICT. This subtopic is treated using the subheadings: teaching loads, teachers' feelings when teaching using ICT, teachers' perception on students' performance when taught using ICT, experienced difficulties by the teachers in teaching using ICT, and instructional strategies used by teachers when teaching through ICT.

Table 4: Teachers use of ICT in the teaching of Geometry

	Number of teachers using ICT to teach Geometry	Teachers whose schools have computer labs	Teachers whose schools have Wi-Fi
	6	10	11

Figure 4: Teachers use of ICT in the teaching of Geometry



The teachers who confirmed using ICT to teach Geometry are mostly those whose schools have internet connection even if the school does not have a computer lab. This result implies that teachers maybe using personal gadgets to access the internet and do not rely on the school's ICT gadgets.

4.3.2 Teachers' Perceptions on the Value of ICT in the teaching of Geometry

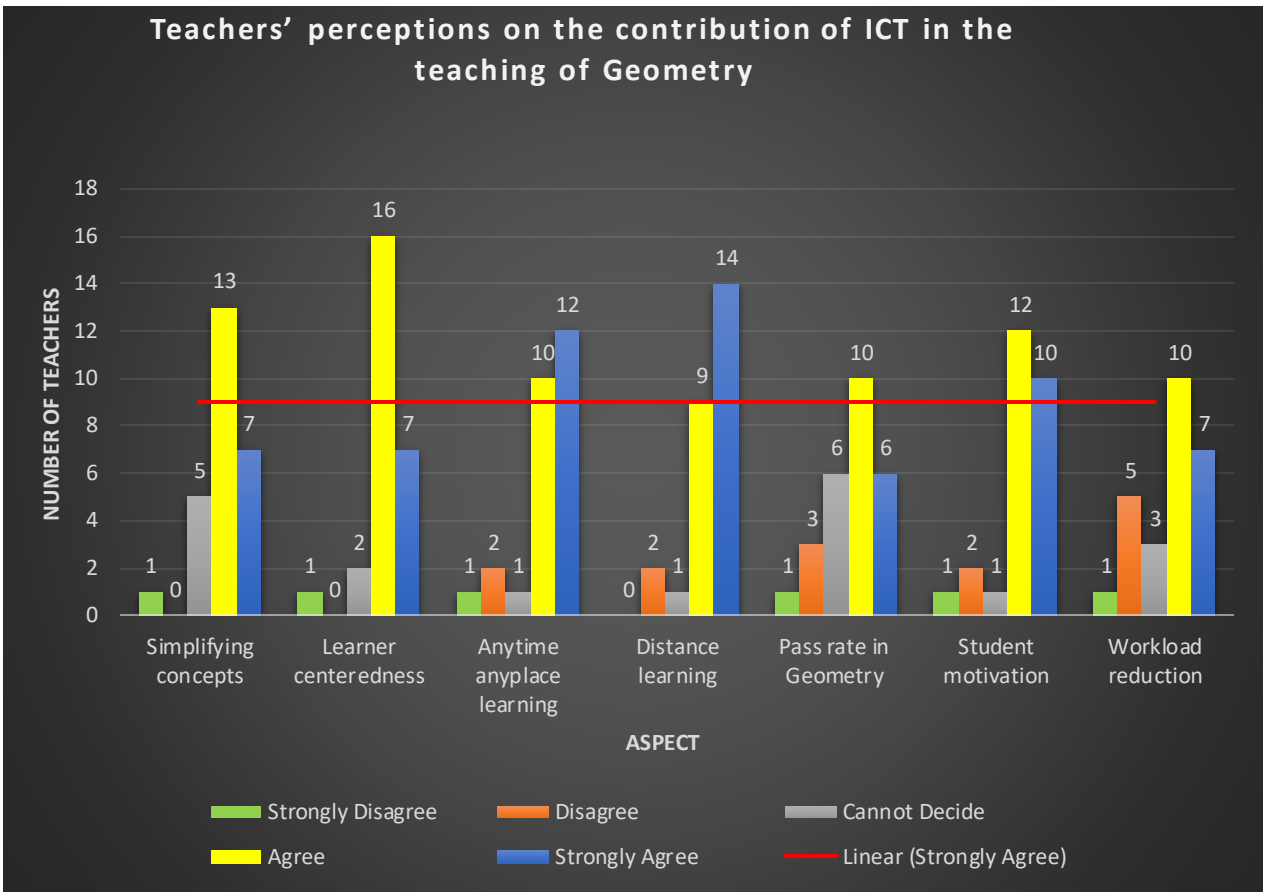
When asked about their perceptions on the contribution of ICT in the teaching of Geometry, the responses found were as shown in the table 6 below.

Table 5: Teachers' perceptions on the contribution of ICT in the teaching of Geometry

Aspect	**Number of teachers**				
	Strongly Disagree	***Disagree***	***Cannot Decide***	***Agree***	***Strongly Agree***
Simplifying concepts	1	0	5	13	7
Learner centeredness	1	0	2	16	7
Anytime anyplace learning	1	2	1	10	12
Distance learning	0	2	1	9	14
Pass rate in Geometry	1	3	6	10	6
Student motivation	1	2	1	12	10
Workload reduction	1	5	3	10	7
Total	**6**	**14**	**19**	**80**	**63**

These findings strongly suggest that most teachers do agree that ICT use greatly benefits the teaching and learning of Geometry as earlier suggested in the findings of (Drijvers, P. H. M., Monaghan, J., Thomas, M., & Trouche, L. 2015).

Figure 5: Teachers' perceptions on the contribution of ICT in the teaching of Geometry

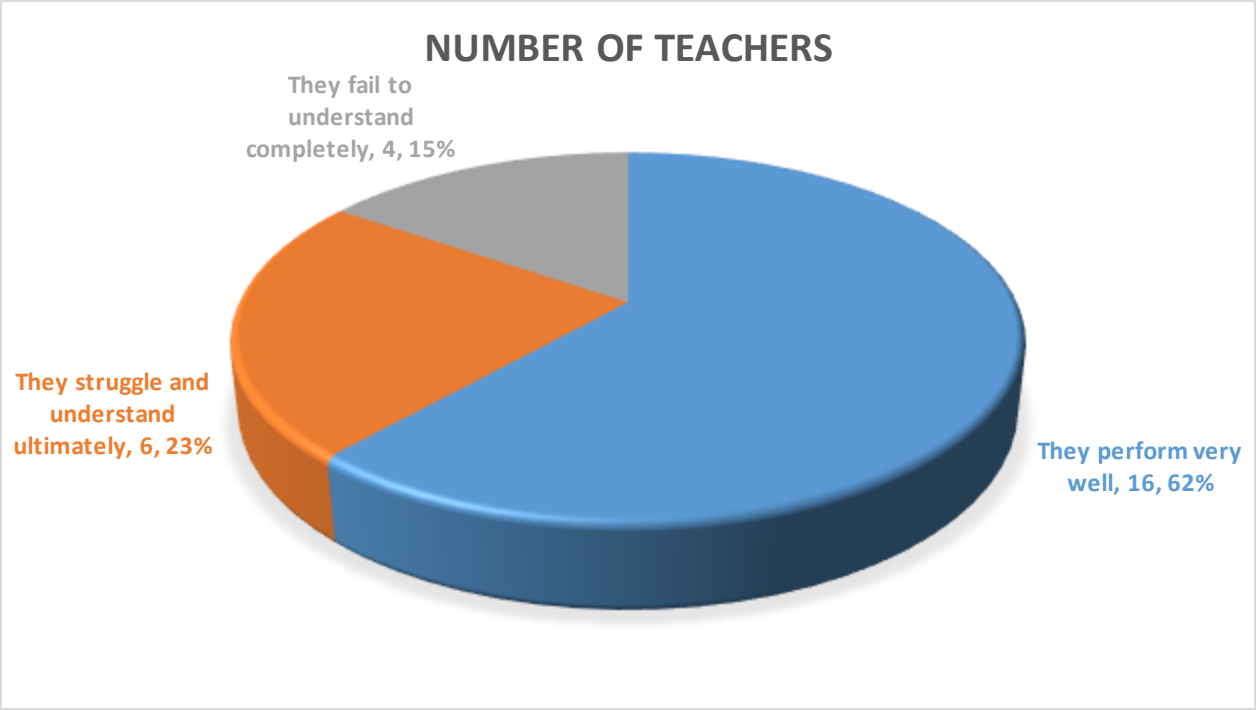


The teachers' indications about the general students' performance in mathematics when taught through ICT using transformation geometry as an example topic are summarized in the table below.

Table 6: Students' Performance in Transformation Geometry when Taught Through ICT as Perceived by Teachers

Performance	Number of teachers
They perform very well	16
They struggle and understand ultimately	6
They fail to understand completely	4

Figure 6: Students' Performance in Transformation Geometry when Taught Through ICT as Perceived by Teachers



The findings here reveal that most teachers perceive a marked improvement in student performance when taught using ICT especially for topics like Geometry. Only four teachers did not perceive improved performance and these were the old horses who are set in the old ways where the teacher is the main source of knowledge.

These findings confirm what was found by Rana, N. (2013). The few teachers who had difficulties cited complications in using projectors and mathematics software like Maple. This marked improvement in geometry scores was also noted by Arbain, N. and Shukor, N. A. (2014). on their research on the benefits of geometry software packages to the understanding of geometry. The same results were realized by Yanuarto, et al (2021).

4.3.4 Experienced Difficulties when Teaching Through ICT

It was found from teachers' indications that teachers' difficulties when teaching and student difficulties when learning had a cause-effect relationship. Teacher difficulties were actually in trying to eliminate student difficulties. As a result, the same points were repeated in both items but from different angles.

From this, it is noted that teachers have increased the domain of approaches they use and this is an improvement from what was found in researches by Yanuarto, W & Maat, S & Husnin, H. (2021); Koparan, T., and Yılmaz, G. (2015). However, there is still a need for teachers to use more of the active teaching approaches like inquiry learning, group discussion, problem solving, manipulation of variables and also field trips when they are feasible.

4.4 Chapter summary

This chapter was dedicated to presenting the findings from the data collected in form of tables and graphs to give a clearer picture of the trends and also the relationships between the trends observed by the researcher. The findings were also compared to those of other researchers in chapter 2. Most findings seemed to liken to those done in other countries on like though different projects, suggesting the possibility of other researchers benefiting from these findings.

CHAPTER 5

5.0 Introduction

In this chapter, the researcher drew conclusions and then cited recommendations based on the researcher's findings on the effect of ICT in the teaching of Geometry at ordinary level in Zimbabwe.

5.1 Recommendations

This section outlines recommendations for meeting the challenges in developing a positive ICT impact in the teaching of Geometry at ordinary level by maximising and ensuring proper ICT integration. The recommendations are motivated by a commitment to improving teaching and learning of Geometry at ordinary level. These recommendations are:

a) Schools must invest in transforming their learning environments into ICT enabled and conducive ones by installing services such as WIFI and building computer labs as much as they invest in libraries and textbooks. Digital textbooks and resources do not deteriorate and do not eat up tons of space while they are portable and need less maintenance. Most pupils in this age have access to smartphones which they can use to access and store tons of material without the cost of replacing books borrowed in a given time. To reduce the cost of infrastructure can be adopting measures such as locally assembled hardware/software to avoid reliance on imported one.

b) The above point obviously raises the need for a professional ICT resource person the equivalent of a librarian but more of an expert who will ensure the smooth running of the system, trouble shoot problems and offer advice and help to pupils and teachers alike. This ICT person will not be a teacher but an auxiliary staff member who is available for consultation as needed.

c) The ICT expert will also be responsible for running regular teacher ICT workshops and assessments on their use of ICT in teaching in the classroom.

d) The curriculum must include in the summative assessment of Geometry in Mathematics at ordinary level, a component of ICT in practical. This will check on the impact of ICT and on the extent of ICT integration in teaching of Mathematics and Geometry in particular at

this level. The head of departments must also assess teacher use of ICT in the classroom as part of regular assessment.

e) The curriculum must be adjusted from the computer literacy stance it has to a more ICT application one where pupils are required to demonstrate not knowledge of ICT but practical use of ICT in their respective subject areas on top of the knowledge aspect.

f) Since the veteran teachers are the ones more resistant to change from teacher centred to pupil centred pedagogical approaches as well as being more resistant to ICT integration, the ministry must work on injecting new blood into the ministry to compensate and balance this negative aspect with the hope of gradually polarising this obstacle in time as the old horses retire.

g) The ministry on hiring new teachers must make ICT competence a pre-requisite for all mathematics teachers with proof required.

h) The curriculum must focus also on demystifying ICT to the general populace and parents by demonstrating its benefits such as the ability to track your child's progress and grades as well as conduct at school at the press of a button.

i) Parents must be made to see that while ICT tools such as laptops are expensive to buy but their long-term benefits make them cheaper than textbooks which change as the child goes up the levels demanding repeated replacements. These eye openers also include anytime anyplace learning and the benefit of access to uncountable other sources of learning over the internet and group discussions on social and scholarly platforms such as Facebook, WhatsApp and google- scholar and easy retrieval of recorded lessons for later viewing enabling slow students to catch up at their own pace and in the comfort of their homes. With ICT, parents will also find it easier to meaningfully assist their children on homework. All the above and then some, can be conveyed to the parents by the school administration on meetings such as the annual general meetings and parents visiting days.

These recommendations are not intended as recipes or quick fixes, rather as principles to guide teachers, curriculum developers and teacher educators in developing their own approaches to supporting mathematical reasoning which is required in Geometry.

5.2 Conclusion

ICT has proved to be a cornerstone of modern society at all levels of life while Geometry remains a critical topic in Mathematics. Early introduction to Geometry taught through ICT has proven to produce better Mathematicians in pupils and also creates powerful problem solvers who will become productive members of society regardless of chosen field of study. Thus, students need to acquire skills for further application in abstract Geometry at higher levels. It is important that the learners first understand Geometry through visualisation so that they can appreciate and concretise the concepts in Geometry.

Towards the attainment of this goal, it has emerged through this research that teachers should always incorporate a component of ICT when teaching Geometry in order to make the learning more learner centred and interesting to the pupils as well as to help dispel the myths around Geometry as a horrible and difficult topic. While the resources and infrastructure may not suffice, the teacher must improvise as it has been made clear that the range of ICT tools is very wide, from a simple calculator to programmes such as Maple soft and smartphones.

5.3 Chapter summary

In the last chapter, the researcher put together the findings of the research to come up with conclusions on the effect of ICT use in the teaching of Geometry at ordinary level which were that the effect of ICT is very low, poor and in some instance's negative and could be maximized by carrying out a series of recommended suggestions to argument the current weak and outdated approach being employed.

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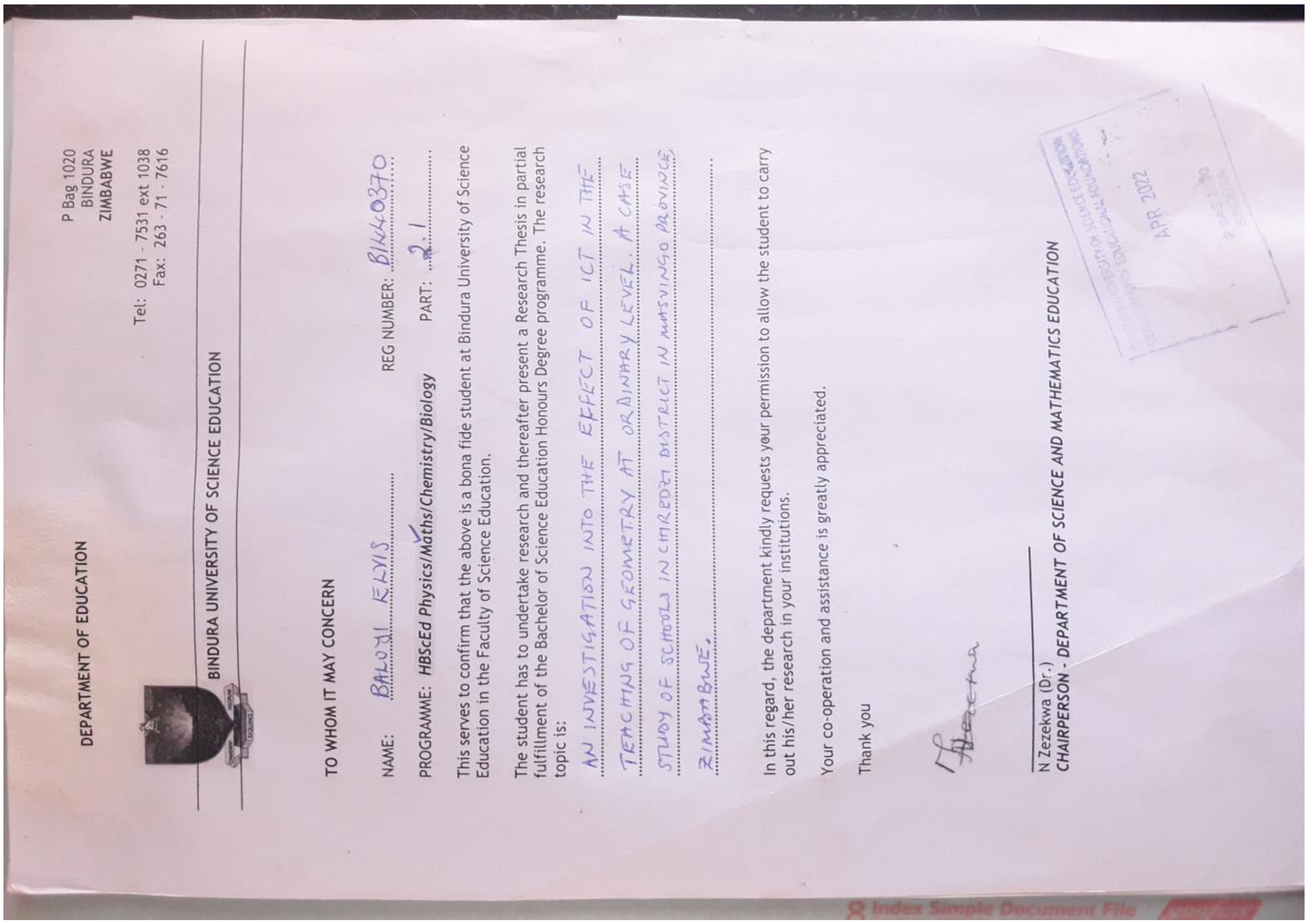
APPENDICES

Appendix 1: Data Collection Form



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BINDURA UNIVERSITY OF SCIENCE EDUCATION

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TO WHOM IT MAY CONCERN

NAME: BALOYI ELVIS REG NUMBER: B1140370

PROGRAMME: *HBScEd Physics/Maths/Chemistry/Biology* PART: 2.1

This serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Thesis in partial fulfillment of the Bachelor of Science Education Honours Degree programme. The research topic is:

AN INVESTIGATION INTO THE EFFECT OF ICT IN THE TEACHING OF GEOMETRY AT ORDINARY LEVEL. A CASE STUDY OF SCHOOLS IN CHIREDZI DISTRICT IN MASVINGO PROVINCE, ZIMBABWE.

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

N Zezekwa (Dr.)
CHAIRPERSON - *DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION*

APR 2022

Appendix 2: Letter of introduction

May 01, 2022

Dear Participant:

I would like to enlist your help. I am a graduate student in science education at Bindura State University. I am conducting a survey on the impact of Information and Communication Technology (ICT) in the teaching of Geometry at ordinary level for my HBScEd-Mt thesis. The purpose of the study is to examine how much ICT has been integrated in the teaching of Geometry at ordinary level and assess its impact as well as to examine the factors affecting the integration of ICT in the teaching of Geometry at ordinary level.

Would you please help me by completing this questionnaire? The exercise should only take about 15 -20 minutes of your time. Your answers are anonymous, DO NOT put your name on the questionnaire. All answers will be kept confidential. Only the research results will be presented or documented, not individual answers. Your help with this research is strictly voluntary. You do not have to answer any questions you do not want to. Return of an answered questionnaire will indicate your consent to participate in this study. The results of this research will be presented publicly at Bindura State University.

If you have questions or concerns, please contact me at 0785218457/ 0717534328, elvisbaloy@gmail.com.

Thank you for your time and consideration.

Yours sincerely,

Elvis Baloyi

Student Researcher

Appendix 3: Teachers' questionnaire

Introduction: This questionnaire serves to solicit information on the impact of using information and communication technology (ICT) in the teaching of Geometry at ordinary level.

Personal details *(Tick where appropriate)*

1. Sex Male [ ] Female [ ]
2. Age (years) 25 and below [ ] 26- 30 [ ] 31 and above [ ]
3. Teaching experience (years) ≤ 2 [ ] ≤ 5 [ ] ≤ 10 [ ] ≤ 15 [ ] ≥ 16 [ ]
4. Do you have a personal computer? Yes [ ] No [ ]
5. Have you ever had any computer literacy training? Yes [ ] No [ ]

At the work place *(Tick where appropriate)*

1. Have you ever used ICT to teach Geometry in the classroom? Yes [ ] No [ ]
2. Does your school have a computer lab? Yes [ ] No [ ]
3. Does your school have Wi-Fi connection? Yes [ ] No [ ]
4. How many periods do you teach per week? [ ]

Teacher perceptions on value of ICT *(Tick where appropriate)*

Using ICT during lessons in Geometry has a positive impact on the following aspects?

Aspect	**Strongly disagree**	**Disagree**	**Cannot decide**	**Agree**	**Strongly agree**
Simplifying concepts					
Learner centeredness					
Anytime anyplace learning					
Long distance learning					
Pass-rate in Mathematics at o' level					
Student motivation					
Workload reduction					

How would you rate yourself on teaching through ICT on the following aspects: *(Tick where appropriate)*

1. Web surfing

   Very confident [ ], Fairly confident [ ], Not confident [ ]

2. Hardware familiarity such as how to connect and use a projector

Very confident [ ], Fairly confident [ ], Not confident [ ]

3. Use of mathematical software such as Maple

Very confident [ ], Fairly confident [ ], Not confident [ ]

4. Making use of internet downloads such as video tutorials and worksheets

Very confident [ ], Fairly confident [ ], Not confident [ ]

Thank you for your participation.

Appendix 4: Interview Schedule

Opening

a. self-introduction

b. purpose of interview……to assess the effect of ICT in the teaching of Geometry at ordinary level.

c. time line……..about 30 minutes in all.

Body

(Topic) Education

1. Teaching experience (years)
2. Do you have a personal computer?
3. Have you ever had any computer literacy training?

(Topic) Experiences

1. Have you ever used ICT to teach Geometry in the classroom?
2. Does your school have a computer lab?
3. Does your school have Wi-Fi connection?
4. Topics like geometrical transformations are best taught through ICTs like overhead projectors. Do you agree?
5. Do you worry that computers will take over your job?
6. The use of ICTs could counter geographical and time constraints. Do you agree?
7. With the integration of ICT in the teaching of Geometry at ordinary level, we could bridge the digital divide and give our pupils world class education. What is your opinion on this?
8. How best can we integrate ICT in the teaching of Geometry at ordinary level?

Closing

A. (Summarize)