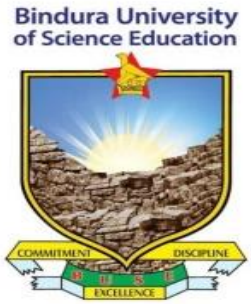

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

BACHELOR OF SCIENCE EDUCATION HONORS DEGREE IN CHEMISTRY

THE IMPACT OF SIMULATION IN THE TEACHING AND LEARNING OF TRANSFORMTAION AT ORDINARY LEVEL: A CASE OF MLICHI SECONDARY SCHOOL IN HURUNGWE DISTRICT.

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN MATHEMATICS EDUCATION

YEAR 2024

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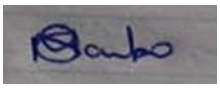

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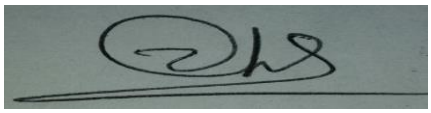

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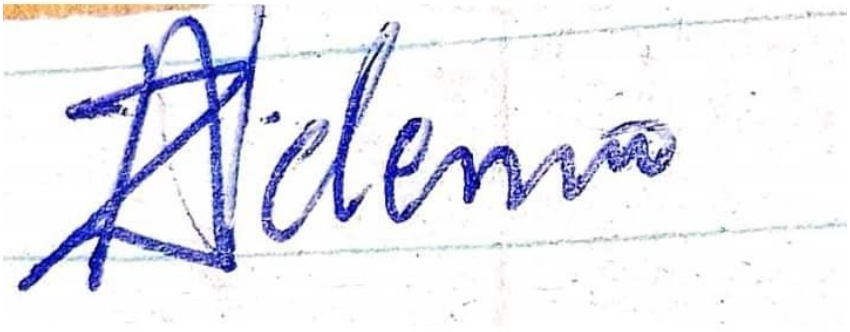

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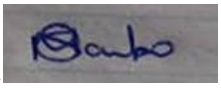
Signed…  …… Date…30/06/24

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DEDICATION

This study is dedicated to my lovely wife Blessed Mlambo who encouraged me to soldier on through all circumstances to accomplish this project. This dissertation is as much a testament to your sacrifices as it is to my own work. To my daughter, Exalt Favour Mlambo, you are the reason I have so much courage to move on when the road gets tough.

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ABSTRACT

The nature of the topic of transformation in mathematics makes teaching and learning difficult as students fail to understand the abstract concepts as they fail to visualize the movements, rotation, translation, enlargement, the shear, amongst others of objects amongst others. In an endeavor to make students have the conceptual understanding of transformation the study investigated the use of simulation in teaching the topic of transformation at Ordinary level at Mlichi secondary school. The students were exposed to digital simulation and an evaluation was made thereafter. To assess the change of perspectives on the topic, a mixed-methods approach, combining quantitative assessment with qualitative analysis of students' and teachers' perceptions and experiences was employed. Also, the study made use of the purposive sampling technique in selecting the respondents and a sample size of thirty-three participants was developed, that is, thirty students, two mathematics teachers and one administrator. Both qualitative and quantitative data were collected simultaneously and analyzed separately. Data was collected using in class pre-and post-tests, interviews and questionnaires and these were administered to the subjects prior and after the exposure to digital simulation and the results were compared. Analysis of the results revealed significant improvements in learners' performance in the topic of transformation after they were exposed to digital simulation. This was evidenced by increased learners' participation and engagement. Study findings revealed that shortage of resources and teachers' incompetence are a hindrance towards usage of simulation. Based on the findings, the research also identified and evaluated potential interventions to address the identified challenges. Strategies which were considered included teacher training programs, as well as engagement of various stakeholders to ensure resource mobilization.

KEY WORDS: Transformation, Learners, Challenges, Population, Technology, Simulation**.**

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CHAPTER 1:GENERAL INTRODUCTION

1.1 INTRODUCTION

Mathematics has always been a core subject in the senior secondary school curriculum in Zimbabwe. The central role played by Mathematics in all areas of Science and Technology, necessitates the importance of providing secondary school students with a sound and wide mathematical background (FRN, 2013). Students seeking entry into tertiary institutions for STEM in Zimbabwe are expected to be competent in mathematics.

With the increasing emergence of new technology and innovative teaching techniques, new challenges are generated for teachers (Too, 2007). In this 21st century, there are tremendous changes in teaching and learning of mathematics in the epistemology, assessment and technology advancement. The major transformation is that teaching and learning is no longer a one-way process but is a shared responsibility between the instructor and the students (Krishnan, 2016). Learning require an active process which includes student participation, engagement and involvement in the learning process. Presently, the teaching and learning environment has changed from teacher-centred to learner- centred using technology to enhance effective learning. One of such technological tools is simulation-based instruction.

The current study intends to assess simulation's ability to ensure effective teaching and learning process of transformation in Mathematics at ordinary level. The study shall assess possible measures that can be put in place to improve usage of simulation in the teaching and learning process of transformation in Mathematics at ordinary level. This chapter is an introduction to the study. It provides the background to the study. The chapter also provides the statement of the problem. Main research question, sub-research question, research objectives which guide the study are outlined. Delimitations and limitations of the study are discussed. Key terms are defined and a summary is provided at the end of the chapter.

1.2 BACKGROUND TO THE STUDY

Global trends indicate that teaching of commercial disciplines in secondary and tertiary institutions is increasingly being driven by technological support. Gulavani& Joshi (2014) claim that in developed countries, digital libraries, networked computers, multimedia communication and audio-visual media are some of the tools widely in use in schools.

Mulholland et al (2008) carried out a study on measures of assisting children with disabilities in the USA. Their sample size involved children ages between 14-16 years. They found computer-based instruction to be very motivating for students and engaged them for longer periods of time than instruction by traditional behavioral interventions.

In a study conducted by Tata (2015) in Poland, it was discovered that the use of simulation has replaced the chalk and board in the classroom. Students in Polish institutions are actively engaged in the learning process. He mentioned that Mathematics becomes a difficult subject only if learners are passively involved in the classroom. Tutors employ simulation in teaching and learning to explain certain concepts to the learners so that they understand better. The study findings by Tata (2015) are similar to those of Rosa and Omar (2021) who carried out a study on tertiary institutions and technology adoption in Malaysia. They argued that the diffusion of new technologies can significantly impact the country's sectors, including economic growth and development. Educational institutions need to involve technology in their business operations as this gives them a competitive advantage over their competitors.

Oke, Ezanwafo & U moru (2012) also claim that tools such as lecture presentation using PPT, bulletin boards, and use of applications software are a common feature in classrooms in developed countries. However, as pointed out by Oke, Ezanwafo & and Umoru (2012), usage of technologically advanced tools as well as simulation at schools in Africa is still at its early life. While Talebiana; Mohammadia & and Rezvanfara (2014) claim that the degree of usage of technology support services in schools that are in developed countries is high with majority of tutors having reached very advanced stages in utilizing technology in teaching and learning, in Africa the scenario seems different. For instance, Okeke, Emenalo, Umoru (2012) found out that

technology utilization by students during learning was very low in Nigerian Technical Colleges. According to Chiwerei; Azih & and Okoli (2013), most learners in Africa are subjected to traditional chalk and lecturer talk methods with very minimal exposure to technology although computers and accompanying e -resources are now widely viewed as driving forces in the delivery of instruction in today's education and training the world over. These observations may indicate gaps that still exist in Africa.

The role of simulation in the teaching and learning process of Mathematics at secondary schools seems to be at an infantry stage. In Zimbabwe, many studies carried out by Mutema (2018), Gwadzoka (2017) and Sozwana (2020) were all focusing on computers in general without including simulation-based instruction. It is against this background that the current study focuses on the impact of simulation in the teaching and learning of transformation in Mathematics at Ordinary level. The study becomes a panacea to the challenges faced by learners in Mathematics.

1.3 STATEMENT OF THE PROBLEM

The motive to carry out this study stems from the realization that performance of students in Mathematics at Mlichi Secondary school has not been satisfactory over the years. The poor performance in Mathematics has seen learners' pass rate not exceeding 15% between 2010 to date thus affecting their careers negatively. The researcher has noted with concern that Mathematics is becoming a boring subject if learners are not actively involved in the teaching and learning thus affecting negatively the nation's programme of STEM subjects. The researcher having taught the subject for three years noticed that when teaching transformation, most learners are less engaged thus affecting overall pass rate in Mathematics. The researcher intends to carry out a study on the impact of video-based instructional method so as to curb the above-mentioned problem.

1.4 RESEARCH OBJECTIVES

The objectives of this study are

1) To examine positive effects of simulations in the teaching of transformation at Ordinary level Mathematics.

2) To evaluate challenges brought by usage of simulation in the teaching of transformation at Ordinary level Mathematics.

3) To determine possible measures so as to improve usage of simulation in the teaching of transformation at Ordinary level Mathematics.

1.4.1 RESEARCH QUESTIONS

1. What are the positive effects of simulation in the teaching of transformation at Ordinary level Mathematics?
2. What are the challenges brought by usage of simulation in the teaching of transformation at Ordinary level Mathematics?
3. What are the possible measures that can be put in place so as to improve usage of simulation in the teaching of transformation at Ordinary level Mathematics?

1.5 JUSTIFICATION OF THE STUDY

The study is worth carrying out as it provides a framework through which Mathematics pass rate can be improved. An institution that is able to cultivate learner active participation is capable of yielding positive results. The researcher is aware that this study may not be a ground-breaking study but it adds to the existing stock of knowledge some strategies through which learners with facing difficulties in Mathematics maybe attended to so as to ensure a positive development.

1.6 SIGNIFICANCE OF THE STUDY

The study findings shall be useful to teachers, learners and policy makers. This is discussed below:

LEARNERS

The findings of this study shall enable children to improve their skills. Such skills include recognizing taught information, imitation and producing learnt information at appropriate contexts. Through this study, learners will be able to employ acquired skills when responding to various questions in the given subject and topic.

TEACHERS

The study acts as a framework so that teachers can implement intervention phase as a way of assisting learners with difficulties. Teachers shall be guided accordingly when choosing instructional media.

POLICY MAKERS

The study shall enable policy makers to evaluate available policies and implement an alternative so as to enable positive development of learners in Mathematics. In this regard, it may guide in coming up with policies, monitoring and evaluation of methods of teaching employed by education personnel when it comes to imparting knowledge to learners in all subjects and Mathematics in particular. The Education department shall also use study findings to source resources necessary for teaching learners in the era of technology.

1.7 ASSUMPTIONS OF STUDY

The study is based on the following assumptions:

It is assumed that students possess fundamental skills of geometric transformation prior to engaging with simulation. The baseline knowledge is crucial as it allows learners to interact with simulations meaningfully, building upon existing concepts rather than starting from scratch. The effectiveness of simulation relies heavily on this prior understanding, enabling students to grasp more complex ideas and applications of transformations.

Another critical assumption is that the use of simulation will lead to improved learning outcomes. It is expected that students participating in simulation -based learning will demonstrate better retention of concepts, enhanced problem-solving skills and an overall improvement in their understanding of transformation.

Furthermore, the proficiency of educators in utilizing simulation tools is an essential assumption in this study. It is presumed that teachers at Mlichi Secondary School have received necessary skills to implement simulation -based teaching effectively. The success of the intervention largely depends on educators' ability to guide students through the learning process and leverage the simulations to enhance learning.

By understanding these assumptions, the study aims to explore how simulation can enhance the teaching of transformation at Ordinary level.

1.8 DELIMITATIONS OF THE STUDY

This study is strictly focused on the impact of simulation in the teaching and learning of transformation at ordinary level Mathematics at Mlichi Secondary school in Hurungwe District.

1.9 LIMITATIONS OF THE STUDY

The study will be conducted at one secondary school, focusing on 'O' level students. However, the small size may limit the study's generalizability to other schools, and potentially weaker the statistical significance of the findings, making it difficult to apply the results to broader contexts.

The research may suffer from withholding of information by research participants. To address this problem, the researcher shall emphasize on the concept of confidentiality as well as explain that the information shall be strictly utilized for the purpose of this study.

1.10 DEFINITIONS OF TERMS

To ensure conformity and clarity throughout the study, the following definitions are given:

Simulation can be defined as a technique used to model the operation of a system, often using a computer software to analyze the behavior of the system under various conditions, Law and Kelton (2000).

Transformation is defined as a function that takes a figure and maps it to another figure, resulting in a new position, orientation or size, Greenberg (2008)

1.11 SUMMARY

This chapter has introduced the study that is mainly focused on the use of simulation in teaching transformation at Ordinary level Mathematics. Basic foundations of the study which include background of the study, statement of the problem, significance of the study, research objectives, research questions, assumptions, delimitations and limitations of the study were also presented in

this chapter. The next chapter shall present a review of literature for the study. The literature review shall be theoretical and empirical with an agenda of specifying research gap in line with the current study.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter introduced the study through presenting basic foundations of the study. The chapter provided among others relevance of the study as well as research background. This chapter presents literature review of the study. The chapter shall present theoretical review, conceptual framework, empirical review as well as research gap. The argument of this chapter is that the study is not a groundbreaking study as it builds from other studies conducted before. As such, the chapter shall justify the position of the study in Hurungwe District.

2.2THEORETICAL FRAMEWORK

The topic of transformation in mathematics refers to the geometric operations that alter the position, shape or orientation of geometric figures. Simulation can be a valuable tool for teaching and exploring transformation in mathematics education. It can help students visualise the effects of transformation and develop a deeper understanding of geometric concepts.

This study is based on John Sweller's Cognitive Load Theory (2005). This theory states that the ability to learn or the mental capacity of a learner is limited to the learners' age and mental ability and that learners may receive overwhelming information in terms of too much content or complex concepts and when the instructional materials are not properly utilized, this will result in over-load where students are provided with more content than they can learn or handle. This impairs the schema or outline of the planned lesson objectives for acquisition resulting in lower performance or less learning on the part of the student (Sweller, 1988). This theory suggests that learning happens best under conditions that are aligned with human cognitive architecture or mental structures, pictures or images that learners build from what they learn through visual and auditory perception with the aid of instructional media.

Learning is limited in the number of elements it can contain simultaneously unless enhanced by use of instructional media. The Cognitive Load theory helps in understanding the combination of elements, as the cognitive structures that make up an individual's knowledge base (Sweller, 1988).

When teachers use instructional material, they intentionally choose a means of presenting information (Flaming and Levie, 1993). Instructional strategies may vary depending on content but may range from organizational strategies, sequencing, cues, feedback, orienting or question techniques, and this should involve different types of media and this will result in enhanced learning. This theory is important in simulation usage as an instructional media. For example, when a question is presented, simulation reduces the complexity of its meaning and this enhances learning.

The absence of media as an integral part of the whole teaching and learning process provides great difficulty on the part of the learner to effectively learn. The interrelationship between instructional media and enhanced learning becomes therefore a matter of central concern of researchers (Blamires, 1991). This theory is suitable for the study because it embraces both students' aspect and teacher's aspect of use of Instructional Media in teaching and learning. Through this theory, the researcher argues that learners' cognition will not be overloaded with content which they do not understand, but rather simulation shall make the concept of transformation less complex.

The Cognitive Load theory is criticized for its inability to standardize measurement methods. According to (Blamires, 1991), the theory fails to provide a method of measurement for what is considered as cognitive load. Be that as it may, it is of utmost importance to point out that the CLT can be relied on when it comes to unpacking roles of simulation. The current researcher argues that whilst there is no standard measurement, there can be a generalized measurement by the researcher which can be employed for the purpose of research as lack of it signifies that one can come up with own measurements.

2.3 CONCEPTUAL FRAMEWORK

Teaching leads to a certain level of learning. Enhanced learning is a product of the interplay of several factors that involve the teacher, teaching strategies, the lesson objectives, content and mode of delivery with the aid of appropriate instructional media or teaching material for learners to achieve in an enhanced experience, the expected learning. Enhanced learning by students therefore, is a product of how the teacher makes use of instructional media to aid the students to conceptualize, concretize and retain what they have learned.

The inputs in this process are the learners, the teachers and the learning process which involves the modern learning materials which are videos, audios, and simulation. The expected outcome, in this case is enhanced learning. This study seeks to establish and describe the kind of experience that takes place in students in regard to the teachers' use of simulation in enhancing learning. Enhanced learning is influenced by the extent to which teachers utilize simulation.

Generally, teaching, learning, instructional media and enhanced learning are interrelated and inter-dependent. Teaching effectively may lead to learning; however, teaching that leads to enhanced learning calls for use of intermediary factors found in Instructional Media.

In this study, the independent variable is use of simulation. This variable is what is selected or manipulated by the researcher to determine its effect, influence on learning of the transformation which in this case, is the dependent variable. The intervening variables are the Selection of instructional media, provision of simulation and use of simulation which eventually influence students' learning of transformation which is the dependent variable.

Students' learning of transformation as the dependent variable is the outcome factor which is observed or measured to determine the effect of the independent variable and the intervening variables, as the factors that would appear, be enhanced or varied.

Teaching and learning of the transformation requires among other things careful choice, selection and use of instructional media. The use of such aids is what leads to enhanced learning and the interrelationship can be addressed from various perspectives. The relationship among these factors is shown in the figure 1.

C**onceptual Framework: Own generated**

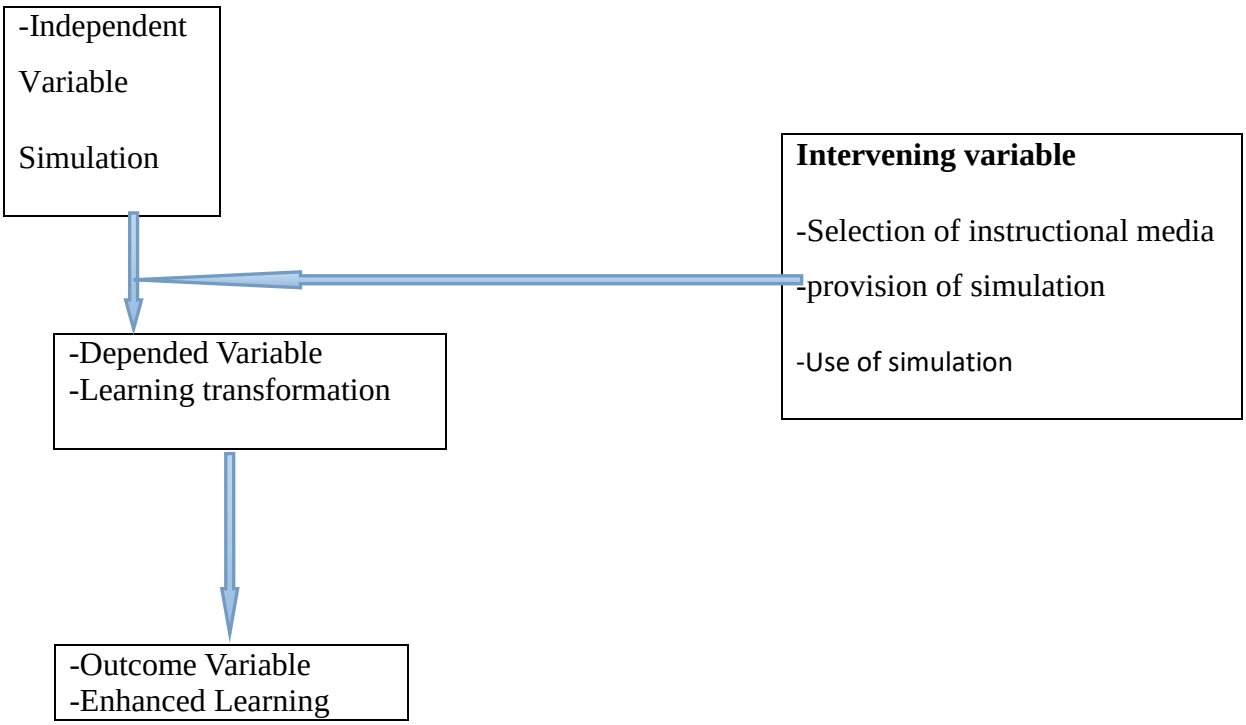

Fig 2.1: Conceptual Framework Model

2.4 EMPIRICAL REVIEW

2.4.1 *TRANSFORMATION AT FIRST GLANCE*

Transformations involve altering or manipulating mathematical objects, such as shapes, functions, or equations, to produce new objects that retain certain properties. These transformations are fundamental in various mathematical concepts and applications. Ordinary level learners make misconceptions when it comes to transformation. It is a result of such misconceptions that transformation becomes a difficult topic in Mathematics. Bansilas and Naidoo (2012) discovered that misconceptions involving the concept of transformational geometry included the incompetent use of algebraic manipulations. The challenge of lack algebraic manipulations assumed knowledge will also make it difficult for learners to calculate translation vector. These findings concur with the suggestion that students have “deficiencies of

mastery prerequisite skills, facts and concepts and errors due to the application of irrelevant rules or strategies" (Egodawatte 2011: 36).

Other misconceptions and difficulties noted were that some students sometimes confuse a reflection and a rotation. This was reported in the June 2010 ZIMSEC examiners' report. However, the examiners reported that many candidates do not really understand the concepts reflection and rotation. In her study, Zorin (2011) noted that some participants sometimes identified a reflection as a translation when symmetric shapes were used. The author also discovered that sometimes they misunderstood reflections and confused them with rotating figures. Developing the concept of invariant relationships between the figure and its image is needed to help dismiss the misconceptions. Also, Edwards and Zazkis (1993) noted that the most difficult type of reflection for students is reflecting a figure over a line of reflections that intersects the pre- image, this type of transformation reflects the image to overlap itself.

Misconceptions found on rotations are that rotations are sometimes confused with reflections or translations. In the June 2010 ZIMSEC examiners' report it was noted that some candidates confused rotation with reflection. Also, in the June 2011 ZIMSEC examiners' report, indicates that some candidates failed to derive the rotation matrix for a given rotation. Ada and Kurtulus (2010) observed, in their study, that mistakes made by students showed that the students seemed to know the algebraic meaning of rotation but they did not seem to understand the geometrical meaning of it. Also, Ozerem (2012) in his findings for a study carried out found that there were wrong images of rotation, meaning the students had difficulties in rotating shapes. Masters and DiMatteo (2009) noted that students struggle with distant points of rotation. Soon (1989) and Soon and Flake (1989) both in Zorin (2011) found in their studies that students experienced the most difficulty in rotation of a figure with the centre of rotation given as a point external to the figure. According to the findings of Soon and Flake (1989) students frequently disregarded the direction of the turn indicated in the transformation. Findings from the related literature revealed that students had difficulties in identifying and naming transformation of rotation, finding the centre, angle of rotation and locating the exact image of a rotated figure after rotation.

Guidelines to the teaching of Mathematics (1995) identified that one of the problems which the students face in non-isometric transformations was to distinguish between enlargement, stretch and shear. The examination report of June 2011 explained that some candidates cited the

required transformation as a stretch instead of enlargement. Also, Zorin (2011) discovered, in her research study, that a number of students had difficulties in identifying invariant lines when a figure and its image were given. She went on to say the biggest problem was found when a shear was involved. Learners often face challenges in describing fully the transformation given the original shape and the image under stretch and shear. Stating the matrix of transformation of stretch and shear is a common error among learners

Learning is enhanced when media is used. The nature of the topic transformation requires visual teaching and learning aids for example when introducing reflections, a mirror need to be used to enhance understanding of the concept. The integration of technology and e-learning in mathematics education positively contribute to arousing teaching and learning of transformational geometry. According to the NCTM (2000), technology has become one of the key principles to enhance quality learning in mathematics. Ironically, most challenges faced by learners are caused by lack of suitable media to enhance learning. Idris (2006) identified the causes of difficulties in geometry learning as visualization abilities and ineffective instruction. According to Vasquez (2015) visual learning is a powerful tool as it involves skills such as observation, recognition, interpretation, perception and self-expression. These skills provide the learner with the opportunity to see, examine something and then to visually recall and interpret information leading to comprehension and understanding of mathematical concepts. Hollebrands (2004) also noted that some of the results of some misconceptions are due to what the learners visualize. Based on the above findings, it can be noted that instructional media plays a pivotal role towards the teaching and learning of transformation.

2.4 .2 STUDIES ON SIMULATION AND THE TEACHING OF TRANSFROMATION

Studies on simulation and the teaching of transformationhave been conducted by a numerous researcher such as Mobolaji (2017), Egolum and Chukwuma (2014), Marti (2015), Dike and Avwiri (2020). However, the above-mentioned studies were mainly focused on West African communities with those in Zimbabwe such as those by Mandina (2012) were mainly focused on use of visuals in other subjects excluding Mathematics.

Traditionally, classroom teachers have relied heavily on the talk-chalk method during their teaching. But recently, instructional materials help to provide variations in the ways in which messages are sent across. In using instructional materials, teachers and students do not only extend the range of sense organs we use but also extend the range of materials used for convening the same message through the same organ.

Wells (2012) conducted a study at Georgia University about technology and learning. The study found that the use of dynamic geometry software facilitated students' understanding of transformational concepts by enabling them to manipulate geometric figures and observe the effects of transformations in real time.

In a study conducted by Tata (2015) in Poland, it was discovered that the use of simulation has replaced the chalk and board in the classroom. Students in Polish institutions are actively engaged in the learning process. He mentioned that Mathematics becomes a difficult subject only if learners are passively involved in the classroom. Tutors tend to play videos and also explain certain concepts to the learners so that they understand better. The study findings by Tata (2015) are similar to those of Rosa and Omar (2021) who carried out a study on tertiary institutions and technology adoption in Malaysia. They argued that the diffusion of new technologies can significantly impact the country's sectors, including economic growth and development. Educational institutions need to involve technology in their business operations as this gives them a competitive advantage over their competitors.

Twoli, (2007) carried out a similar study in Turkey. His findings revealed that technology may bring about changes that are frequently resisted by teachers in the educational field due to fear of being replaced as teachers by the upcoming instructional media advancement and the automation of education with consequential loss of personal relationship between teachers and students. Once selected and put in use, instructional media do not replace instructors. Study findings by Twoli also revealed that instructional media in themselves may not affect teachers. They are not designed to be a substitute for the effective teachers' role but supplement their capabilities and make unique contributions. They in fact improve the teacher's performance and this study seeks to establish if in-deed, it is the case.

Instructional media enhances and facilitates learning (Patel and Mukwa, 1993) and this leads to faster and enjoyable learning. This kind of learning is preferred by students as compared to the traditional methods (Unwin, 1978) in which all knowledge is a preserve of the teacher and learners are passive recipients of this knowledge. When instructional media is integrated into the learning process, greater learning is accomplished in less time (Smith and Nagel, 1972).

Smith further observes that instructional media is very effective in the teaching and learning process by providing concrete experiences, increasing retention, developing continuity of thought and providing variety in learning.

Communication between the teacher and the learner is improved with learners' motivation when instructional media are used in class. Motivation is the degree of desire to learn new things, to put in more time to study and to find out more about what is being taught. It implies one's cooperation with the teacher in order to gain knowledge from the experience and what the teacher does to arouse and maintain interest in students (Ayot and Patel, 1987) People learn purely as motivated to learn. Learners learn better when motivated. It is not motivation for learning as such which is important to teaching but motivation for learning a particular aspect (Cook, 1991). Cook further states that the choice of teaching materials should correspond to the motivations of the students. The use of these materials in the motivation of students is what this study seeks to establish in the at Mlichi Secondary School in Hurungwe district.

Instructional materials are interesting and flexible as they bring real life information to class about remote things or activities (Wittich, et. al, 1962). Similarly, Mobolanji (2017) conducted a study on audio or visuals in Nigerian institutions. The findings from his study were that teaching mathematics requires a lot of instructional media with simulation included. The students' enrolment in high school institutions is increasing on yearly basis and it is an open secret that the teachers if they rely on the traditional methods of teaching, they may not yield any results.

Umaru (2011) conducted a study in Nigeria. The study was on the relevance of instructional materials when it comes to improvement of academic performance. Findings of his study were that utilization of instructional resources enhance a concrete basis for conceptual thinking and makes learning more interesting. His study also revealed that instructional materials develop a continuity of thought and this is especially true of motion pictures, as they provide experiences

not, easily obtained through other materials and contribute to the efficiency and variety of learning.

Cascading to East Africa, Omesa et al (2013) noted that different levels of success for entities in Kenya could be a result of techniques which are used by the entities. They also discovered that amongst these techniques is technology-based media. Their study also established simulation as a tool for entrepreneurship which if utilised wisely can see Kenya rise and become a successful community. Their argument was that whilst simulation can be used as a tool to enhance learning, it can motivate learners to make similar entities and become successful entrepreneurs.

Mandina conducted a study on role of instructional media in teaching Chemistry. His main focus was on how media can contribute to poor performance in Chemistry in Gweru district. He discovered that lack of qualifications and resources are the main causes of poor performance at Advanced level chemistry in this district. From Mandina's view, entrepreneurship through Chemistry can only be attained if teachers have adequate skills and resources. He further mentioned that a chalk, a textbook and a chalkboard are outdated media in the classroom.

2.4.3. *POSSIBLE CHALLENGES BROUGHT BY THE USAGE OF SIMULATION WHEN TEACHING TRANSFORATION*

Developing effective teaching application of available Instructional Media needs time and effort and this makes the teacher's work quite challenging. Due to this, teachers are reluctant in trying new and unfamiliar methods in teaching (Brown and Thornton, 1971) and this may actually affect the rate their students' learning. This study too, explored reasons why some Mathematics teachers in secondary schools may be reluctant to use instructional media in enhancing the learning of transformation while teaching and most gave reason of materials not being available and others no being operational as the main reasons.

2.5 RESEARCH GAP

No conclusive results can be drawn from the above studies in line with role played by simulation in teaching mathematics. Much focus has been on Mathematics learning in general. More studies were carried out in other African countries as well as outside Zimbabwe. In Zimbabwe, focus

was on instructional media and performance of learners in Chemistry. As such, it is crystal clear that research on simulation and the teaching of transformation in Mathematics is still at an infantry stage. It is the intention of this study to conduct a research on the relationship between simulation and the teaching of transformation in Mathematics at Ordinary level in Hurungwe district.

2.6. CHAPTER SUMMARY

This chapter has presented theoretical framework, conceptual and empirical review. The chapter indicated that Cognitive Load Theory shall inform the study. Relevant literature to the study has been reviewed. The chapters indicated that research on simulation and transformation in Mathematics is still at an infantry stage. The next chapter shall present research methodology for the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter has presented literature review in line with the objectives of the study. This chapter presents the research methodology, research design, area of study, population, sampling method, research sample, data collection procedures, data collection instruments, study, interviews, observations, and ethical considerations. This chapter intends to respond to the what, why, who, where, when and how questions in line with the objectives of the study.

3.2 RESEARCH METHOD

A mixed-methods approach will be used by the researcher. Gathering, evaluating, and integrating qualitative and quantitative data using methods such as interviews and surveys is part of this study strategy (Saunders and Bezzina 2015). Bernard (2013) defines it as a type of research in which a researcher or group of researchers employs elements of qualitative and quantitative research methods, such as qualitative and quantitative viewpoints, data collection, evaluation, and inference methods, for the purposes of depth and breadth of understanding, as well as corroboration. The choice of the above research approach is informed by the view that the researcher is in search of numerical and non-numerical data so as to respond to the research questions and also meet the research objectives. The quantitative part of the approach is time economical whilst the qualitative part is meant to gather sufficient data for the study. The data for this study shall be collected from April to May 2024.

3.3 RESEARCH APPROACH

Research approach explains the reason as well as manner of conducting research. Different research approaches include deductive, inductive and abductive approach. This study adopts a deductive research approach. According to Mhonyiwa (2014), this approach is used to test validity of assumptions or theories. The choice of this approach stems from the realisation that data collected is the one used to evaluate hypotheses in relation to the theory. In this case, the researcher does not want to make assumptions hence the need to make relevant and tested arguments using the above chosen approach.

3.4 RESEARCH SAMPLING AND POPULATION

3.4.**1** RESEARCH POPULATION

It is important to note that a study must always have a research population which refers to a group or objects that represent the entire population. A population is the entire group of objects or events which have got an equal opportunity of being included in a research due to their similar characteristics which are of interest to the researcher. In support of this, Bryman (2014) also defines population as the set of people entities to which findings are generalized. Deducing from these definitions, it is crystal clear to notice that the expression "set of people "opts that any population is characterized by its items or elements bearing same characteristics or properties that make it a complete set.

Population for this study comprises of Head of Department, Mathematics teachers, ordinary level Mathematics learners as well as the Headmaster.The above choice of the population is influenced by the objectives of the study. The size of my population comprised of **30** students , 2 teachers, one school head resulting in this study having 33 participants.

3.4.2 SAMPLE AND SAMPLING METHOD.

Murphy (2016) defines a sample as "a given number of subjects from a defined population which is representative of it". What one can gather from the above definitions is that a small portion of the research population is selected and should be enough to respond to the research questions and objectives of the study.

The researcher is aware that not everyone in the above mentioned list of population shall be involved in this study. It is against this background that purposive sampling technique shall be used in this study. Etikan *et al* (2016) define purposive sampling as a sample that implies that elements are selected on the basis of knowledge of the population and the aim of the study. They argue that purposive sampling subjects are selected for a good reason tied to the purposes of research. Through purposive sampling method, the researcher shall gather data from relevant sources only.

3.4.3 SAMPLING APPROACH

Research population shall be selected based on knowledge and experience in line with the aim of the study. This technique is relevant to the study in that schools have teachers who studied

collections and also gifted at teaching all subjects but not all of them are meeting the objectives and aim of the study. Also, to note is that not everyone working within the school environment will be able to respond to the matter understudy thus justifying the choice of the population. Apart from that, the study is focusing on Mathematics thus justifying the exclusion of other subjects and teachers in this research. The researcher shall select respondents who are knowledgeable about the subject matter.

3.5 NATURE OF DATA

The data that shall be collected for this study is a quantitative and qualitative data. This data shall be in the form of interview texts or numeric. The choice of this type of data is a result of the fact that the researcher uses mixed methods data collection approaches.

3.6 DATA COLLECTION PROCEDURE

3.6.1 RESEARCH INSTRUMENTS

Data for this study shall be gathered using desk research, semi- structured in-depth interview, tests, and structured questionnaires.

3.6.2 INTERVIEWS

According to Bisset and Mutter (2017), an interview is a conversation between two or more people whereby questions are asked by the interviewer to obtain facts or statements from the interviewee. It is important to note that interviews can be open and unstructured.

This study shall utilise semi-structured interviews. A semi-structured interview is a qualitative method of inquiry that combines pre-determined set of questions (questions that prompt discussion) with the aim of the interviewer to explore particular themes or responses (Shana 2021). It is important to note that the above-mentioned choice of interviews shall yield sufficient data for the study as research participants shall be given a room to explain more on the area under study.

Advantages of semi-structured interviews

Semi-structured interviews offer several advantages as a data collection method in research and qualitative studies. Semi-structured interviews provide a balance between structure and

flexibility. While they have a predetermined set of questions or topics, they also allow for additional probing and follow-up questions based on the participant's responses. This flexibility allows researchers to explore new avenues, delve deeper into specific areas of interest, and capture rich and nuanced data.

Semi-structured interviews enable researchers to gain in-depth insights into participants' perspectives, experiences, and beliefs. They allow for open-ended responses, providing participants with the opportunity to express their thoughts and feelings in their own words. This qualitative data can yield a deeper understanding of complex phenomena and provide rich descriptions and narratives.

In line with the above, semi-structured interviews promote participant engagement and involvement in the research process. Participants feel empowered as active contributors to the study, which can enhance the quality and authenticity of the data. The open dialogue and rapport established during the interview can encourage participants to share personal experiences and provide detailed responses.

By conducting semi-structured interviews, researchers can gain a contextual understanding of participants' perspectives within their own unique contexts. The interactive nature of the interview allows researchers to explore the social, cultural, and environmental factors that influence participants' views and experiences. This contextual understanding adds depth and richness to the data collected.

Semi-structured interviews allow researchers to access participants' personal experiences, emotions, and perspectives. This enables a deeper exploration of subjective experiences and the factors that shape them. The open-ended nature of the interviews facilitates the uncovering of unique insights and perspectives that may not be possible through more structured data collection methods.

3.6.3 QUESTIONAIRES

These are documents containing questions in line with research questions and objectives. Creswell (2014) defines questionnaires as documents that ask questions to all individuals in a sample. They go on to point out that, if the sample has sub-groups, the questions asked of each sub-group may vary. Also, to note is that questionnaires encompass a variety of instruments in which the subject responds to written questions to elicit reactions, beliefs and attitudes. From the above information, it can be noted that questionnaires should be structured in such a manner that will yield rich data for the study.

Structured questionnaires shall be utilised in this study. Relevance of this type of questionnaires is supported by the view that the researcher will be able to gather rich data that will be capable of responding to the research questions of the study. This is also supported by Mugano (2021) who states that in structured questionnaires, the respondent is asked to provide his/her own views. This allows the respondent to give relevant information without making generalizations.

3.6.5 TESTS

The term test can be defined as a means of assessment, which encompasses various methods of evaluating, assessing, or comparing something (Matron 2021). This can involve practical activities, questions, or other means to determine what someone knows, or what someone or something can do or is like. In this study, a test is a method of assessing simulation usage when teaching transformation in Mathematics. The researcher shall prepare pre- and post- tests so as to assess the significance of simulation in improving an understanding of transformation in Mathematics.

Tests are important as they provide a standardized and consistent way of measuring variables. They have predefined instructions, scoring criteria, and response formats, ensuring that all participants are assessed under the same conditions (Matron 2021, Dube 2021). This standardization allows for accurate comparisons between individuals and groups, enhancing the reliability and validity of the research findings.

Tests often involve objective measures, such as multiple-choice questions or performance-based assessments. According to Babbie (2014), these measures minimize subjective biases that may

arise when researchers rely solely on observations or self-report measures. The objectivity of tests enhances the reliability of the data collected and increases the confidence in the research outcomes.

3.7 DATA ANALYSIS

The researcher shall use the deductive approach to analyse data. This approach involves analysing qualitative data based on a structure that is pre-determined by the researcher

The researcher shall organize data through tabulating research objectives and matching them with collected data. The researcher shall then code qualitative data. This is whereby the researcher shall assign properties to the collected data. After coding, the researcher shall validate data to make sure that they are no flaws on the data collected before presenting it for professional or academic use. It is after completing the above steps for data analysis that the researcher shall finally present, interpret and discuss data collected for the study.

3.8 TRIANGULATION

Also known as Data triangulation, is a method used to increase the credibility and validity of research findings. According to Noble (2019), data triangulation involves using various methods to collect data so as to overcome flaws of each and every method of data collection. From the above information, it can be noted that data triangulation is significant when it comes to producing an authentic research project. The researcher shall use different data collection methods so as to validate data. Data shall not be analysed haphazardly so as to ensure reliability and validity of the study. What this entails is that the main reason why the researcher shall follow the above discussed steps of data analysis is because of the need to produce an authentic project.

3.9 VALIDITY AND RELIABILLTY OF DATA.

Validity and reliability of data depends on the instruments used in the research. Validity is the extent at which an instrument measures what is intended. In this case, findings must accurately describe the phenomena being researched and must ensure that element of the main issue to be covered in the research is a fair representation of wider issue under investigation. In order to ensure validity of the data collected and reliability of research instruments, a qualitative study shall be conducted in the District of Hurungwe.

Reliability of data shall be observed through triangulation method of data collection (one on one interviews, observation). In order to facilitate understanding between the research and participant, the research instruments need to be prepared in language that will be easily understood to respondents (Mhonyiwa 2014).

3.10 ETHICAL CONSIDERATIONS

Research ethics are rules and guidelines that researchers should follow when carrying out their researches. Gwatidzo (2020) also defines research ethics as the moral principles guiding research from its inception, through data collection, analysis and publication results and even beyond the above. From Gwatidzo's view, research ethics should be considered from coming up with a research topic up to the presentation and publication of results. These rules are important to researchers in as far as authenticity of their information is concerned. Commenting on the significance of ethics, Akaranga and Makarau (2016:2) are of the view that researchers should abide by these rules so that they protect the dignity of their subjects and publish authentic information they had researched. Using Akaranga and Makarau's argument, they are rules that guide the researcher in coming up with a research proposal, data collection as well as those that protect the research informants. This study shall consider the following research ethics:

3.10.1 INFORMED CONSENT

Generally, is understood as the willingness of the respondent to participate in a research after being informed about the nature of the research. According to Bryman (2014), this is whereby a participant is informed about the risks and benefits of the research, understands such risks and benefits and is able to give consent to participation, without coercion and inappropriate incentives. The current research shall be guided by this research principle and ensure that informed consent is obtained from research participants before research begins. The researcher also agrees to obtain both verbal and written consent so as to cater for both literate and illiterate participants. By considering this ethic, the researcher shall not force participants to participate in the research. The researcher shall also seek permission to conduct research from responsible authorities such as head of departments.

3.10.2 ANONYMITY, CONFIDENTIALITY AND PRIVACY

Protecting research participants is the most significant research ethic this study considered. In this case, the researcher shall try by all means to keep respondents' secret through non-identification of ethnic or cultural background. Mentioning of research participants' names shall only be done with the consent of participants. Information that is sensitive shall only be published if the participants are comfortable. This, as given by Akaranga and Makarau (2016:6), enhances honesty towards the research subjects by protecting them from physical and psychological harm. It is important to point out that this is only possible through avoidance of embarrassing questions which can shock the respondents.

3.10.3 PLAGIARISM

This is whereby the researcher does not acknowledge information taken from someone's publication. At times the researcher may take information from their previous works and chose not to cite that information which is again described as plagiarism (Hove 2018). The current study shall ensure that information taken from other sources is acknowledged. This gives birth to an original and authentic work.

3.10.4 FABRICATION AND FALSIFICATION

Fabrication refers to the creation, invention or faking of data or results which are then recorded or reported. The current study shall ensure that results and data for this study are authentic. What this means is that the researcher shall remain truthful in terms of data presentation and discussion of results. On the other hand, falsification is the manipulation of materials, equipment, processes, results or omitting some data or findings so that the research does not seem to have been well represented or recorded (Akaranga and Makarau 2016). The researcher aspires to be a trusted academician hence the need to consider fabrication and falsification as academically incorrect. What this therefore means is that results of this study shall be presented as they are so as to produce an authentic paper.

3.11 CHAPTER SUMMARY

The chapter has highlighted research design, population, sample and sampling techniques as well as various research instruments. The chapter has also stated the relevance of each instrument to the current study. The chapter also argued that no research instrument is perfect hence the

employment of various instruments to complement each other. The next chapter shall present, interpret, analyze and discuss data collected for the study.

CHAPTER 4:DATA PRESENTATION, INTERPRETAION AND ANALYSIS

4.1 INTRODUCTION

The researcher gathered information about the roles of simulation towards the teaching and learning of Ordinary level Mathematics. This information was gathered using a questionnaire, interviews, and written tests given to chosen O level learners to answer. The chapter presents and analyses data gathered through the above-mentioned methods. The data is then discussed responding to the research questions.

4.2 POSITIVE EFFECTS OF SIMULATION IN THE TEACHING OF TRANSFROMATION AT ORDINARY LEVEL.

4.2.1 INFLUENCE LEARNERS'S PATICIPATION AND ENGAGEMENT

Data from questionnaires revealed that simulation plays a pivotal role towards learner engagement and participation. Fig4. 1 below presents responses given through questionnaires by teachers and learners.

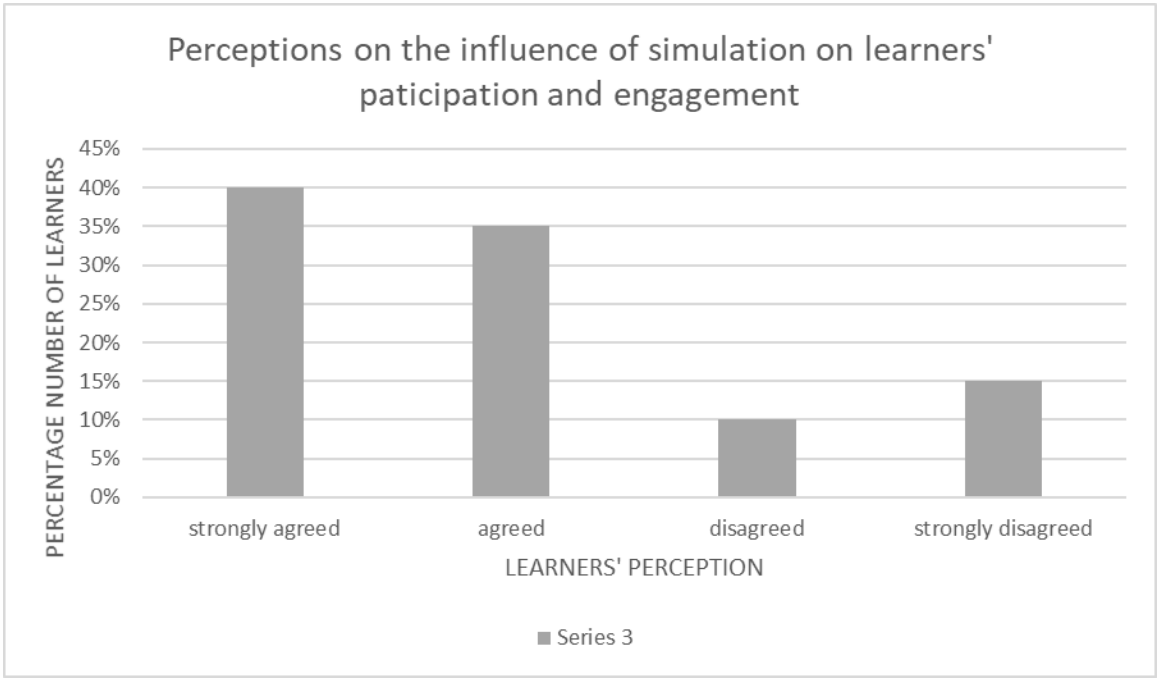

Fig 4.1: Simulation versus learners' engagement and participation

Study findings revealed that majority of the participants agreed that simulation is significant as it is capable of cultivating learners' participation and engagement. From fig 1 above, it is crystal

clear that 40% and 37% of the respondents all agree that simulation influences learners' engagement and participation. As such, this justifies the relevance of simulation in the teaching and learning process of transformation.

Interview data revealed that the use of simulations and visual representations can be incredibly helpful when teaching transformations such as translations, reflections, rotations, and dilations. Teacher B mentioned that

> *simulation is important as it ought to cultivate learners' participation within the classroom. They all want to be actively involved in the teaching and learning process,*

Learners also agree with the above view by teacher B. they mentioned that:

> *Isu totoida yakadaro cause inoita kuti saba rinake "We love it because it makes the subject interesting". [Interviewee G].*
>
> *Inotoita kuti isu tisarare "It prevents us from sleeping. [Interviewee M]*
>
> *Because of simulation, learning becomes interesting thereby making us all have the zeal to participate [Interviewee R]*

The above findings revealed that eeffective learning is possible in a class full of active rather than passive students. Engagement and participation through simulation, as given by Umaru (2011) is influenced by the visual type of instructional media which in this case is simulation which is able to capture learners' minds effectively. Simulations allow students to dynamically observe the effects of applying these transformations to geometric shapes, functions, and coordinate systems.

The study findings are in line with Sweller (1988)'s views that through instructional media, learners observe and follow procedures of a concept as compared to when no simulation is used. The findings resonate well with views raised by Unwin, (1978) in literature that if simulation is not used, learners become passive participants in the classroom hence the role of simulation cannot be underestimated. The same was echoed by Kołodziejczyk & Polak (2011) who mentioned that lessons with the use of multimedia are more involving for pupils and, as a consequence, they result in their greater commitment and participation towards the subject.

4.2.2 INSTANT FEEDBACK AND EVALUATION

Interview data revealed that simulation serves as a form of assessment or evaluation. The respondents from the study revealed that simulation allows both the learner and the teacher to instantly evaluate themselves. Teachers mentioned that through simulation, they will be able to assess if their learners are following the tutorial. At the same time, they mentioned that "*simulation enables learners to assess themselves and get the feedback they want on the way they answer questions in transformation*."

Study findings revealed that providing students with instant feedback as they work through transformation problems is crucial for reinforcing concepts and correcting misconceptions. This can be facilitated through the use of interactive software, digital worksheets, or even physical manipulatives with immediate visual cues. When students receive rapid feedback, they can recognize where they are making mistakes in applying transformation rules, experiment with different approaches and see the consequences as well as build confidence in their ability to correctly perform transformations.

The pre and post-simulation tests given to learners revealed that with instant feedback, students can also engage in self-evaluation, reflecting on their own thought processes and identifying areas that need more practice. This meta-cognitive awareness was essential for developing mastery of transformations. Before employment of simulation, results of the given work were as follows:

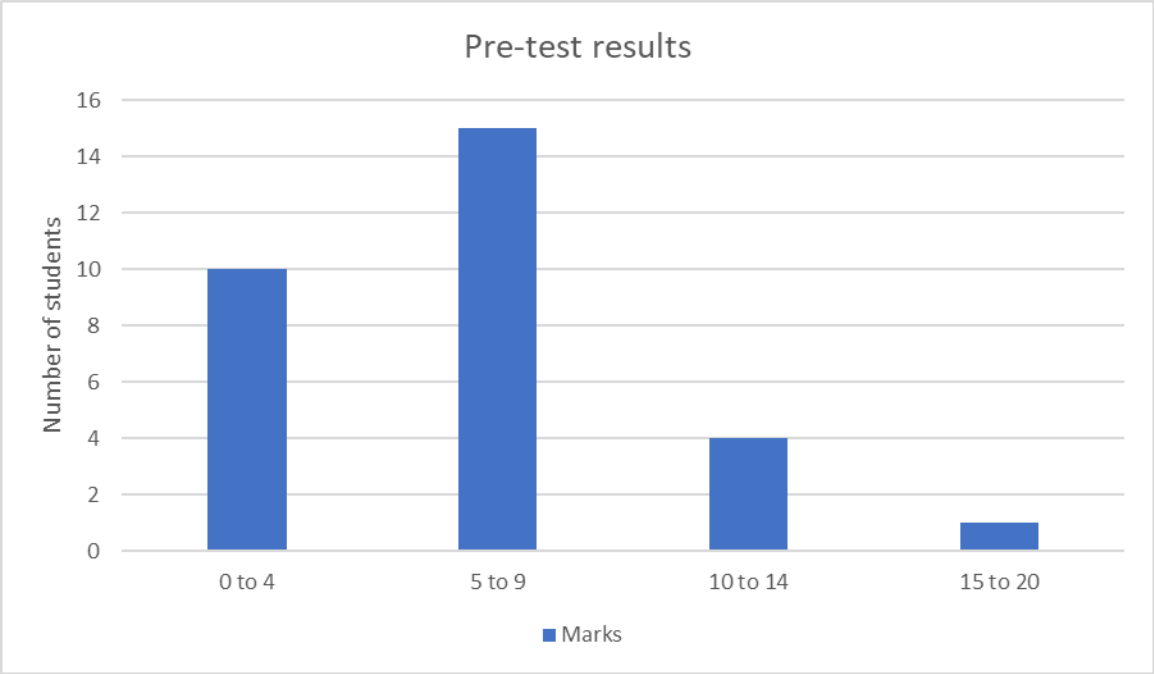

Fig 4.2: Pre -test results

Fig 2. shows the marks obtained by all the 30 students under investigation who wrote the pre-test. From the results on the written test it is evident that 25 learners got marks that were less than 50% and only 5 students got marks that were above 50%. On this test the percentage pass rate is 16⅔ %

The students' weak pre-test results reveal a lack of profound comprehension of transformation concepts. The absence of multimedia support may further marginalize students with diverse learning styles or abilities. Moreover, the abstract nature of the topic poses a significant challenge for students to grasp intricate ideas without the aid of engaging multimedia resources, which could have facilitated a more comprehensive understanding. According to Bornwell and Eison (1991), active learning such as simulation, engage students more effectively than traditional lecture methods. Since the students were taught using traditional instruction which often emphasizes rote memorization of definitions, theorems and formulas without providing students with opportunities to connect these concepts to their own experiences and develop deep understanding, it may be the cause of high failure rate. When students are simply memorizing

definitions, theorems and formulas, they may not have clear understanding of what these concepts mean or how they are related to each other, by so doing learners tend to forget these concepts overtime. This can lead to frustration and a sense of incompetence in the topic of transformation.

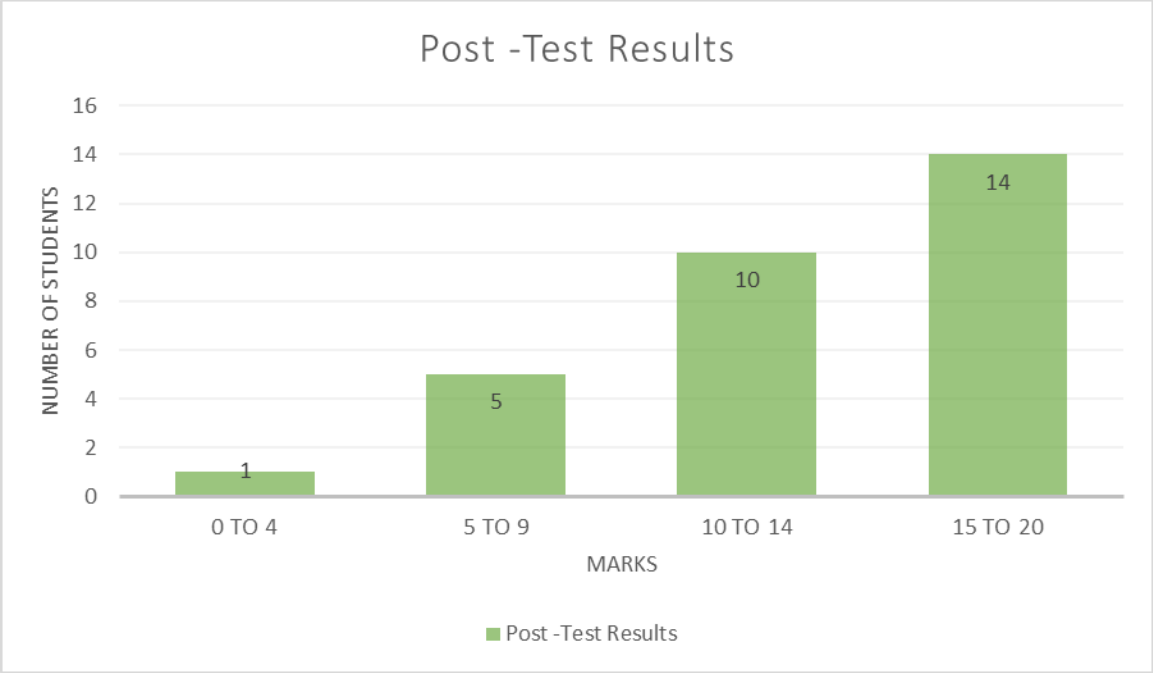

Fig 4.3 Post-test results

Fig 4.3 above shows the post-test marks obtained by 30 students. From the graph above it is crystal clear that 1 student got a mark between 0 to 4, 5 students got marks between 5 to 9, 10 students got marks between 10 to 14 and 14 students got 15 to 20.

The post-test results reveal a significant improvement, with 24 students achieving marks above 50% and only 6 students scoring below 50%. This notable success can be attributed to the effective use of simulation in teaching, which enabled learners to visualize and interact with transformation concepts. By making these abstract ideas more concrete and relatable to their everyday experiences, simulation likely played a key role in enhancing the students' understanding and performance. According to Bransford et al (2000), simulation helps to build a stronger connection between abstract ideas and real-life applications and this facilitates deeper understanding and retention of transformation concepts. Jonassen (2000), echoed that simulation

enables learners to learn at their own pace, repeating simulations as needed to reinforce their understanding.

4.2.3 CULTIVATES LEARNERS' INTEREST

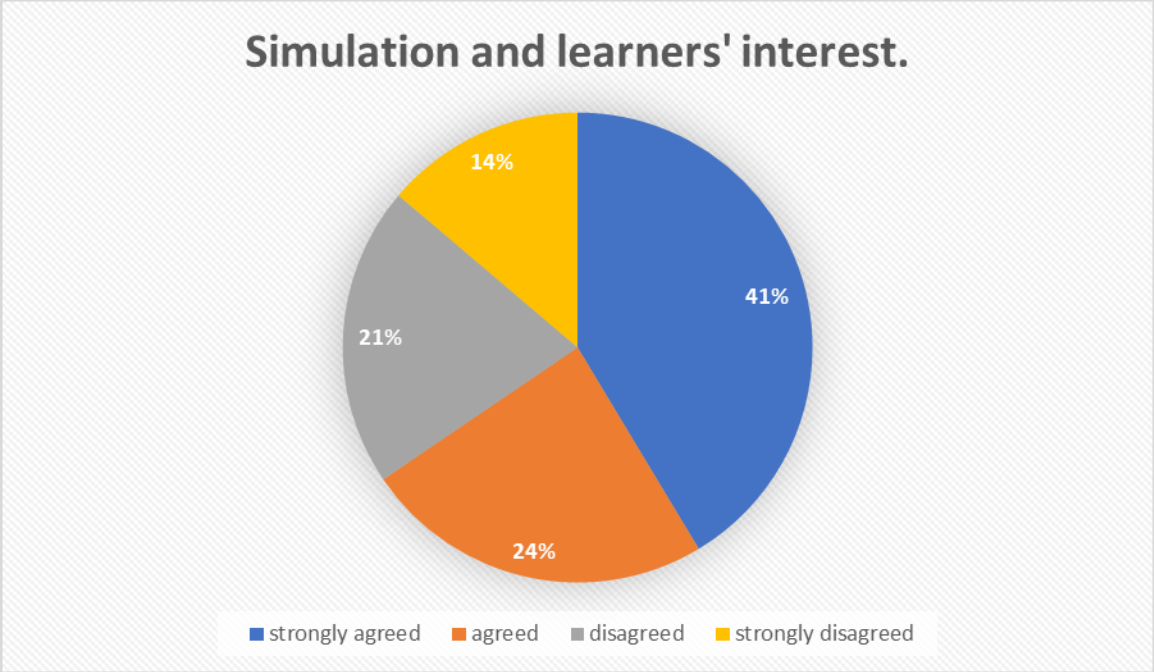

Fig4. 4: Simulation and learners' interest.

From Fig 5 above, it evident that 65% of the learners agreed that the use of simulation in the teaching and learning of transformation arouses their interest to learn the topic while only 35% had a negative attitude towards the use of simulation. Learners are motivated by the usage of multimedia in the teaching and learning. Questionnaires from learners revealed that transformation is a boring topic which many have lost interest into. However, through simulation, the same interest towards the subject matter has been cultivated.
Interview data had the following:

> *Iyo transformation inorwadza uye inobhowa. Haaa but chinhu ichi chopedza zvacho masports, choita tinakirwe netopic (Transformation is a boring subject but simulation makes us enjoy the topic) [interviewee S]*

My zeal towards the subject matter has actually improved as a result of simulation [interviewed G]

Both interview and questionnaires data revealed that visuals of rotation, translation, reflection and dilations enable learners to maximize their performance towards the subject matter. Interest towards the subject matter, as given by Kołodziejczyk & Polak (2011) is cultivated through the ability of simulation to eradicate passivity towards the subject matter. When simulation is used, no one wants to become a passive participant. The study findings resonate well with the findings of Ahmad (2016) who mentioned that the use of simulation as an instructional media can increase the students' interest in learning. Furthermore, it also increases the students' enthusiasm to learn, entertain, give twists to the method of learning, encourage students to be more effective in the classroom, help students to save learning time, increase students' understanding of subject contents, enhance the ability to remember and also expand their mind

4.2.4THEY ARE AN EFFECTIVE TEACHING TOOL

Table 4.1 Pre-test results.

X	**0-4**	**5-9**	**10-14**	**15-20**
S	10	15	4	1

KEY

X-Marks
s-students

Table 4.2 Post-test results

X	**0-4**	**5-9**	**10-14**	**15-20**
S	1	5	10	14

KEY

X- marks
S-Students

Study findings revealed that simulation is an effective teaching tool. Before the coming in of

technology, teaching and learning process involved use of lecture method which became monotonous. Teachers would talk about the subject matter till the talking becomes boring with each passing day. At times, teachers would use charts as teaching media to enable students understand the subject matter. It is a result of technology that new teaching aids such as video clips, films, pictures, audios have been adopted as teaching media so as to make the subject matter interesting and understandable. According to Swain (2003), simulation is effective. Learners remember more what they saw not what they heard.

The teacher when he utilized tests wanted to assess if learners were able to score the same marks before and after simulation. The researcher also observed learners' ability to translate or rotate correctly after the employment of simulation. Correct translation and rotation were observed by the teacher. In lesson 1, the researcher observed that most learners were unable to transform Their scores ranged between 0-10 respectively. The teacher observed that the intellectually gifted students scored between 11-20 marks respectively.

The researcher observed that through simulation, confidence, as well as creative, critical thinking and writing skills of learners were attained. The researcher observed that learners understood better when an audio-visual type of media was used.

The researcher also observed that after being taught about various forms of transformation using simulation, only one student scored between 0 to 4 while the marks of the rest of the students were now ranging between 5-20. The researcher observed that the less intellectually gifted scores were at ranging between 0 to 9. This was a result of the fact that the teacher employed an effective teaching method. The tests that learners wrote produced impressive results. Apart from the above, the researcher also observed that rotation is understood through a consistency practice using learner centered methods.

4.3 CHALLENGES BROUGHT BY THE USAGE OF SIMULATION IN THE TEACHING TRANSFFORMTION ATORDINARY ORDINARY LEVEL MATHEMATICS

4.3.1 SHORTAGE OF RESOURCES

Interview and questionnaires data revealed that usage of simulation is heavily affected by lack of resources. The school understudy is in remote areas, it is heavily affected by lack of resources to implement the usage of simulation.

The school Principal highlighted that lack of instructional resources is a challenge the school has experienced for years. He pointed out that:

> *There are no books and ICT equipment for teaching Mathematics in the school. One laptop is used to cater for science ,bursar ,and other subjects. Resources to cater for new technologies are a challenge we have been experiencing for years resulting in poor performance in Mathematic*s (Interview, 22 May 2024).

The above findings resonate well with Uwameiye & Oviawe, 2018) who mentioned that simulation usage is affected by shortage of resources. Study findings from teachers and learners also concur with the findings from the principal. This has seen learners failing to score marks as expected at both school and national level. Teachers are failing to deliver knowledge as expected due to insufficient resources and employment of traditional instructional media. As such, many learners end up dropping the subject as it is boring and also difficult to understand.

4.3.2 TEACHERS' INCOMPETENCES.

Study findings revealed that simulation usage is affected by teachers' incompetence. Teachers testified that they lack the skills to carry out lessons using simulation. They employ traditional methods of teaching. The school does not have enough money to hire those who have the skills.

It can be noted that teachers' incompetence is another hindrance towards teaching transformation using simulation. Some teachers are competent in delivering lessons using teacher-based methods as well as other methods which are not technologically based. Incompetent teachers fail to create a conducive learning environment for learning. This, as given by Eze, (2000) and Ketevan (2015) is the reason why some learners drop out of the subject. Learning in the 21st century require technologically based media. However, even if such media is available, as given by interview data, it is the incompetence of teachers that are hindering its usage.

4.4 POSSIBLE MEASURES TO IMPROVE THE USAGE OF SIMULATION IN THE TEACHING OF TRANSFROMATION AT ORDINARY LEVEL MATHEMATICS.

The key informants interviewed provided many strategies of ameliorating the challenges affecting usage of simulation. Mr. G and Mrs. A (Mathematics teachers) mentioned that:

"We should lobby the government and the private sector players to improve our facilities as this subject area is critical for the economic development of our country"

Similarly, T mentioned that "*the school has to set aside money so that they improve learning environment."*

Mary also stipulated that "*Learning material has to be bought. The school can engage various stakeholders for donations so as to improve usage of simulation and other technologically based media.*

P and S had this to say

"*Vabereki vedu dai zvaigona vatibatsirawo sechikoro nemari yekutenga zvinodiwa" (If possible, our parents must assist us with resources).*

Whilst learning materials are scarce, B highlighted that, *"resources have to be sought. Teachers have to be equipped with ample knowledge and skills on usage of simulation. Simulation usage has to be implemented so as to motivate us. This should be the school norm so that every teacher prepares himself or herself to deliver knowledge using simulation. Seeing the teacher every time and then on the chalkboard becomes boring and makes us loose interest towards the subject matter."*

Interview data revealed that there are various methods that can be put in place so as to improve usage of simulation in Mathematics. A learning environment motivates learners. Having managed to pay school fees, enrolled for the subject, learners are also motivated by their surroundings. Respondents testified that the school has to engage various stakeholders for resource mobilization and support. The research findings of this study are similar to those of Otilie (2012), Njuguma (2014) and Waweru (2012) who argue that the community must be engaged so as to ensure that new technologies become part and parcel of the school in terms of knowledge delivery. The study findings were that there is need to equip teachers with ample knowledge so that they can be able to employ simulation in learning.

4.5 **OVERALL OVERVIEW**

The study findings were that simulation is an effective tool in the teaching and learning of transformation in Mathematics. Study findings revealed that simulation cultivates learners' interest and serves as a motivational tool for learners to study Mathematics particularly the topic understudy. The researcher discovered that through simulation, learners actively participate in the teaching and learning. The study findings also revealed that there are certain factors hindering employment of simulation. These factors include lack of resources and teachers' incompetence are hindering teachers to effectively utilize simulation. Study findings revealed that the problem of underutilization of simulation can be addressed. Also, to note is that benefits of simulation have been proved through teacher made test with results of post-intervention impressive. As such, engagement of various stakeholders, equipping teachers with knowledge as well as funding from the school are some strategies that can be employed to improve usage of simulation.

4.6 **CHAPTER SUMMARY**

This chapter presented, interpreted and analyzed data for the study. Data presented revealed that simulation is an effective tool in the teaching and learning of transformation. Amongst the identified benefits include cultivating learners' interest, effective teaching tool, influencing engagement of learners and participation as well as providing instant feedback. Challenges and solutions were also provided. The next chapter gives, conclusions and recommendations.

CHAPTER 5:SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Through data analysis and discussion, the study revealed that there are a number of benefits brought by the usage of simulation in the teaching and learning of transformation in Mathematics. Challenges brought by the usage of simulation in the teaching of transformation in Mathematics were also identified. Therefore, this chapter ought to give a summary of the findings from the study, conclusions and recommendations. Summary and conclusions of the findings were drawn in respect of the research objectives. The chapter also seeks to establish the relationship between the area of study and the performance of learners as well as area for future research.

5.2 SUMMARY

Chapter 1 gave an outline on the fundamental subject of the research by providing the introduction of the study. The chapter also provided background information and statement of the problem. The chapter also presented research objectives, research questions, significance of the study as well as limitations and delimitations of the study.

Chapter 2 reviewed relevant literature to the study. The chapter also presented the theoretical and conceptual framework of the study. The theoretical framework that guided the entire study is the Cognitive Load theory. Through this theory, the chapter stated that the researcher will be able to to provide a framework to express benefits of utilizing simulation in the teaching and learning of transformation in Mathematics.

Chapter 3 presented the research methodology. It is in this chapter that data collection methods and analysis, research design, target population as well as sampling were presented. The chapter's emphasis was that the study is a mixed methods research which shall utilise qualitative and quantitative research instruments for data collection and analysis. The chapter presented interviews, questionnaires and tests as methods of data collection.

Chapter 4 was on data presentation, analysis and interpretation. The chapter used the theory of the study and data analysis instruments to interpret and analyse data. It is in this chapter that effects of simulation in the teaching of transformation, challenges brought by utilizing

simulation, as well as possible solutions to improve usage of simulation in the teaching of transformation in Mathematics were presented and analyzed. The findings presented in this chapter were that simulation influence learners' engagement and participation, provides instant feedback and evaluation, cultivate learners' interest as well as being an effective teaching tool. Challenges brought by usage of simulation are teachers' incompetences, as well as shortage of resources. The study findings revealed possible measures to address challenges brought by usage of simulation. These measures include staff development and resource mobilization above findings' implication is that simulation usage is only possible if the challenges are addressed. The chapter concluded that challenges brought by usage of simulation can be rectified.

In chapter 5, the researcher shall conclude the entire study. In this case, the researcher shall present a summary of findings, observations of the entire study as well as recommendations and areas for further study.

The general observation has been that simulation usage is effective when it comes to the teaching of transformation in Mathematics. It has also been observed that academic performance is possible in Mathematics if simulation is employed. The researcher also observed that there is need to source resources so as to ensure implementation of simulation.

5.3 CONCLUSION

Given the background of the above findings, the researcher made the following conclusions: -

i. Simulation influence learners' engagement and participation. Learners become active participants in the teaching and learning of transformation in Mathematics.

ii. Simulation provides instant feedback and evaluation to both teachers and learners.

iii. Simulation is an effective teaching tool which focuses on cultivating learners’ interest.

iv. Simulation brings challenges which can be rectified. Measures such as resource mobilization and staff development are important when it comes to implementation of simulation usage.

v. If mitigating measures are implemented, Simulation usage is possible.

5.4 Recommendations

In view of the above, the researcher recommends that the Ministry of Primary and Secondary Education, the school understudy, and the community have to implement the measures found by the researcher. Apart from that, the school understudy should find ways to fund the subject so that permanent solutions would be implemented. The researcher recommends the following areas for further study:

i. Simulation usage and the teaching of circle geometry in Mathematics.
ii. Simulation usage and the teaching of other STEM subjects.

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APPENDIX 1: QUESTIONNAIRE FOR MATHEMATICS TEACHERS

My name is Mlambo Solomon. I am a student at Bindura University of Science Education (BUSE), studying for a Bachelor of Sciences Honors Degree in mathematics Education. I am currently working on a research project entitled: Impact of simulation in the teaching and learning of transformation at Ordinary level: A case of Mlichi Secondary School in Hurungwe District.

I am kindly asking you to complete this questionnaire. Be assured that there is no wrong or correct answer. Your responses shall be strictly accorded the due recognition and confidentiality they so deserve. Please **do not** write **your name** anywhere on the questionnaire.

Please indicate your answer by a tick (√) and by filling in the gaps provided.

Thank you in advance for your cooperation

Section A..Demographic information

1. **Gender:** *Tick the option that best applies to your gender*

Male	
Female	

2. **Age:** *Tick the option that best applies to your age*

26-30 years	
31- 35 years	
Over 36 years	

3. **Highest Academic Qualifications** : *Tick the option that best applies to your highest qualification*

Standard six	
Junior Certificate	
CSC or 'O' Level HSC or 'A' Level	
BA/BSc	

Other (State which).....

4. Working Experience as a secondary Mathematics teacher: *Tick the option that best applies to your working experience*

Less than 1 Year	
1-5 years	
6-10 years	
11 years and above	

SectionB.Indicate your answers by a tick

1.Is simulation an effective tool in teaching transformation

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

2.Does the use of simulation enhance a deeper understanding of the topic of transformation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

3.Does the use of simulation promote learner engagement or participation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

4.Does simulation- based learning arouses learners' interests to learn

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree

5. Does the use of simulation improves the pass rate of students?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree

6. Did you encounter any challenge when using simulation in the teaching of transformation? If yes Explain?.....

7. Is the lecture method an effective approach in the teaching of transformation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

APPENDIX 2: QUESTIONNAIRE FOR ORDINARY LEVEL STUDENTS.

My name is Mlambo Solomon. I am a student at Bindura University of Science Education (BUSE), studying for a Bachelor of Sciences Honors Degree in mathematics Education. I am currently working on a research project entitled: The impact of simulation in the teaching and learning of transformation at Ordinary level: A case of Mlichi Secondary School in Hurungwe District.

I am kindly asking you to complete this questionnaire. Be assured that there is no wrong or correct answer. Your responses shall be strictly accorded the due recognition and confidentiality they so deserve. Please **do not** write **your name or that of your school** anywhere on the questionnaire.

Please indicate your answer by a tick by in the gaps provided.

Thank you in advance for your cooperation

Section A. Demographic information

1. **Gender:** *Tick the option that best applies to your gender*

Male	
Female	

2. **Age** : *Tick the option that best applies to your age*

14-15 years	
15-16 years	
16-17 years	

3. Type of school: *Tick the option that best applies to you*

Day [ ] Boarding [ ] Day and Boarding [ ]

4. Where is the school located?

Urban [ ] Peri-Urban [ ] Rural [ ]

Section B: Indicate the correct answer by ticking in the box provided.

1. Do you perceive the traditional method as the most relevant approach in the teaching and learning of transformation

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

2.Does the use of simulation promote a deeper understanding of the topic of transformation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

3. Does the use of simulation in teaching of transformation enhance learner participation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

4. Does the use of simulation cultivates learners' interest to learn?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

5.Do you think simulation usage in the teaching of transformation enhances the retention of learnt concepts?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

6. What challenges are you facing or you are likely to face when it comes to the use simulation in the learning of transformation? Tick all the answers that are appropriate.

unavailability of ICT tools e.g. computers [ ]

limited ICT tools [ ]

limited time [ ]

No challenge. [ ]

None of the above [ ]

7. In your opinion choose from the list below what you think are the potential benefits of using simulation in the teaching and learning of transformation?

enhanced visualization of transformation concepts [ ]

Improved understanding of taught concepts [ ]

Improved pupils' engagement during the lesson. [ ]

Time consuming [ ]

Teachers

8.Is availability of ICT resources influences the use of simulation in schools.

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

APPENDIX 3: QUESTIONNAIRE FOR THE SCHOOL HEAD

My name is Mlambo Solomon. I am a student at Bindura University of Science Education (BUSE), studying for a Bachelor of Sciences Honors Degree in mathematics Education. I am currently working on a research project entitled: Impact of simulation in the teaching and learning of transformation at Ordinary level: A case of Mlichi Secondary School in Hurungwe District.

I am kindly asking you to complete this questionnaire. Be assured that there is no wrong or correct answer. Your responses shall be strictly accorded the due recognition and confidentiality they so deserve. Please **do not** write **your name** anywhere on the questionnaire.

Please indicate your answer by a tick (√) and by filling in the gaps provided.

Thank you in advance for your cooperation

Section A. Demographic information

5. **Gender:** *Tick the option that best applies to your gender*

Male	
Female	

6. **Age** : *Tick the option that best applies to your age*

26-30 years	
31- 35 years	
Over 36 years	

7. **Highest Academic Qualifications** : *Tick the option that best applies to your highest qualification*

Standard six	
Junior Certificate	
CSC or 'O' Level HSC or 'A' Level	
BA/BSc	

Other (State which).....

8. Type of school

Day [ ] Boarding [ ] Day and Boarding [ ]

9. Where your school is located?

Urban [ ] Peri-Urban [ ] Rural[ ]

10. **Working Experience as a secondary school head.**

Less than 1 year	
1-5 years	
6-10 years	
11 years and above	

Section B: Indicate the correct answer by ticking in the box provided

1.Do you think that simulation activities help students develop a deeper conceptual understanding of transformation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

2.Does the use of simulation increase learners 'motivation to learn?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

3.Do you think that simulation activities provide students with a more engaging and more interactive learning experience?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

4.In your opinion does simulation increase students' interest in learning transformation?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

5.Does the integration of ICT in the teaching aligns with the educational curriculum of Zimbabwe?

Agree [ ] strongly agree [ ] disagree [ ] strongly disagree [ ]

6.Are you willing to allocate resources and support the further implementation of simulation techniques in the teaching of transformation. If Yes, Explain……
……
……

7.What are the factors that might limit the use of simulation in the teaching and learning atb your school. Explain

……
……

……
……

……
……

APPENDIX 4 INTERVIEW GUIDE FOR THE LEARNERS

Write your responses in the spaces provided.

1.How do you feel about using simulation techniques to learn about transformation compared to traditional teaching methods?

_____
_____
_____
_____

_____
_____
_____
_____

2.Do you think that simulation helps you to better understand and apply transformation?

concepts? Why or why not……
……
……
……

4.Have you witnessed any positive impacts or outcomes related to the use of simulation in the teaching of transformation……
……
……
……
……

5.What are the challenges if any, that you have observed in implementing simulation in teaching transformation?

……
……
……
……

6.What support can be given to teachers and learners for the successful implementation of the simulation

……
……

……
……

APPENDIX 5 INTERVIEW GUIDE FOR THE TEACHERS

Write your responses in the spaces provided

1.How often do you use simulation techniques in the teaching of transformation concepts in your mathematics lessons?

_____

_____

2.What are the advantages of using simulation in teaching transformation compared to the traditional

methods?_____

_____

_____

_____

3.In your experience what are the challenges that might be encountered in implementing simulation in the teaching of transformation at your school?_____

_____

_____

_____.

4.In your opinion what are the strategies you can recommend towards the successful implementation of simulation?_____

_____

_____

_____

APPENDIX 6: INTERVIEW GUIDE FOR THE SCHOOL HEAD

Write your responses in the spaces provided

1.In your opinion what are the key benefits of using simulation in the teaching of transformation as compared to the traditional methods?_____
_____
_____

2.In your opinion what challenges can hinder the successful implementation of simulation-based instruction in mathematics at your school?_____
_____
_____
_____

3.Can you describe any specific strategies or approaches your school can use to integrate simulation technology in the teaching and learning of transformation_____
_____
_____
_____-

4.What advice or recommendations would you give to other schools or educators interested in adopting simulation technology for teaching transformation?_____
_____
_____
_____

APPENDIX 7: PRE-TEST FOR THE LEARNERS

1). Name three transformations you have studied that are congruent to their images. (3)

……

……

……

……

2.Answer the whole of this question on a graph paper .Use a scale of 2cm to represent 2 units on the x-axis and 2cm to represent 1 unit on the y-axis for $-4 \leq x \leq 14$ **and $-5 \leq y \leq 5$.**

a. (i) Triangle ABC has vertices A(4;1) ,B(6;1) and C(6;2)

Draw and label triangle ABC [2]

(ii)Transformation T represents a translation vector

Draw and label triangle A_1, B_1C_1, the image of triangle ABC under **T. [2]**

iii).Transformation **R** represents a clockwise rotation of 90^0 about (4,4).

Draw and label $A_2B_2C_2$, the image of triangle ABC under **R [2]**

3.Triangle W has vertices at (-1;1) ,(7;-1) and (4;4) . Using a scale of 2 cm to represent2 units on both axes , draw the x and y axis for $-10 \leq x \leq 10$ and $-10 \leq y \leq 10$.

a).Draw and label triangle W [2]

b,)Triangle X is the image of triangle W under a reflection in the line $y=x+2$.

Draw and label clearly

(i)the line $y=x+2$

(ii)triangle X [3]

4.Triangle POQ has vertices at P (1;2) , O(3;2) and C(2;1) .Using a scale of 2cm to represent 1 unit on each axis , draw the x and y -axes for $-5 \leq x \leq 4$ and $-4 \leq y \leq 5$

a). Draw and label triangle ABC [2]

b).Triangle is mapped onto triangle $A_1B_1C_1$ by an enlargement of scale factor 2 with (2;-1) as centre .Draw and label triangle $A_1B_1C_1$ [2]

APPENDIX 8 POST TEST FOR THE LEARNERS.

1. Name three isometric types of transformations and three types of non-isometric transformations.

Answer the whole of this question on a sheet of graph paper.

2. Using a scale of 1cm to represent 1 unit on both axes, draw the x and y -axes for, $-10 \leq x \leq 10$ and $-12 \leq y \leq 8$

a). Quadrilateral H with vertices (0;6), (0;4), (-4; 5) and (-2;7) is the image of quadrilateral K with vertices (4;2), (2;2), (3;6) and (5;4)

(i)Draw quadrilateral K {3}

Y

(ii) Draw quadrilateral H [3]

(iii) Describe completely, the single transformation which maps K onto H. [4]

3.The vertices of a triangle PQR are P (3;1), Q (4;1) and R (4;3).

a). Taking 2cm to represent 1 unit on both axes, draw the x and y -axis for $-3 \leq x \leq 5$and $-6 \leq y \leq 5$.Draw and label triangle PQR. [2]

b). Triangle PQR is enlarged with centre (0;1) and a scale factor -½ and triangle $P_1Q_1R_1$

Draw and label triangle $P_1Q_1R_1$ [4]

c).Draw another triangle with vertices $P_2(3.5 ;0)$,$Q_2(4,5;0)$ and R(5.5;3).Describe completely a single transformation which maps triangle PQR onto $P_2Q_2R_2$ [3}

SAMED

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BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 05/05/24

TO WHOM IT MAY CONCERN

NAME: MLAMBO SOLOMON REGISTRATION NUMBER: B225520B

PROGRAMME: HBSc Edmt PART: 2.2

This memo 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 Project in partial fulfillment of the requirements of bachelor programme. The research topic is: IMPACT OF SIMULATION IN THE TEACHING OF TRANSFORMATION OF SCIENCE AT ORDINARY LEVEL: A CASE OF MUCHI SECONDARY SCHOOL

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

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2024
P. BAG 1020
BINDURA

Z. Ndemo (Dr.)
CHAIRPERSON - SAMED

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