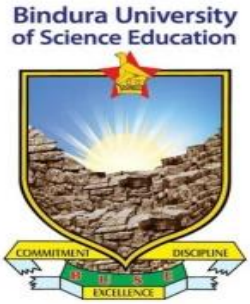

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DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

BACHELOR OF SCIENCE EDUCATION HONORS DEGREE IN MATHEMATICS

EXPLORING STUDENTS AND TEACHERS PERCEPTION IN THE TEACHING AND LEARNING OF VECTORS USING SIMULATION.

BY

NYENGERAYI LIBERTY

REG NO: B225518B

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

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   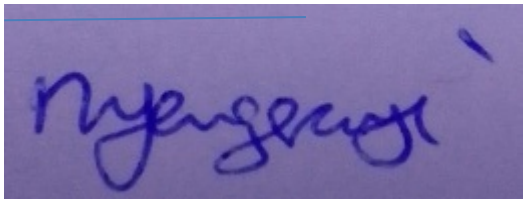

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   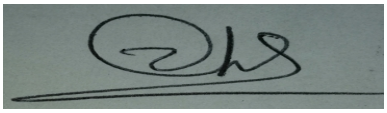

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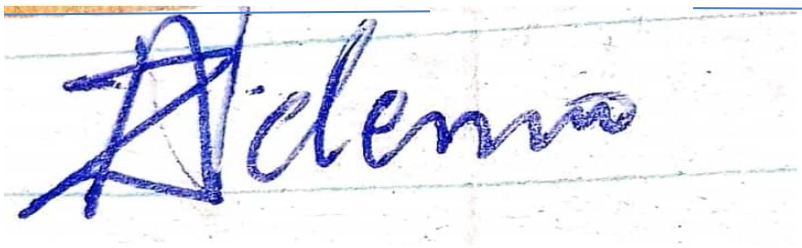

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DEDICATION

This study is dedicated to family, my dear friends and colleagues I am thankful for all the encouragements you have given me.

-

ABSTRACT

Students Mahusvu at wazvaremhaka cluster have demonstrated their struggle to visualize vectors in two dimensions that find it hard to comprehend vector notations include magnitude, direction and unit vectors. This study investigated the use of simulations to alleviate learning struggles of students. The study conducted the quantitative method. The study is aiming to explore the aims of students and teachers' perspectives in the teaching and learning of vectors in mathematics at ordinary level at one rural school in Mashonaland East. Participants of the project are 70 students at four secondary schools in wazvaremhaka cluster in Mashonaland east and 20 teachers who teaches mathematics in the cluster. The method used to choose students and teachers was unbiased. After the survey was conducted the findings were collected analyzed in percentage forms. The researcher found out that in schools there are mathematics teachers who are technologically illiterate. On teacher expectation simulation based learning can supplement traditional teaching methods. On students expectation simulation can improve problem solving skills. The study reveals that both teachers and students have high expectations for the use of simulation in the teaching and learning of vectors. The findings suggest that simulation based learning can enhance student engagement and motivation.

Key words: Perspectives, Simulation, Teaching and learning, Vectors , Participants

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY.

Vectors are a fundamental concept in mathematics and physics, crucial for understanding various phenomena in science, engineering, and technology. However, students often struggle to comprehend vector concepts, leading to difficulties in problem-solving and visualization. The traditional teaching methods, relying heavily on abstract mathematical representations, may contribute to this struggle. Recent advancements in technology have enabled the development of simulations, offering an innovative approach to teaching and learning vectors. Simulations can provide interactive, visual, and dynamic representations of vector concepts, potentially enhancing students' understanding and engagement. Despite the potential benefits, there is a need to investigate how students and teachers perceive the use of simulations in teaching and learning vectors. This study aims to explore the perceptions of students and teachers regarding the effectiveness of simulations in enhancing vector comprehension, identifying challenges and opportunities, and informing the development of simulation-based instructional materials. By examining the perspectives of both students and teachers, this research seeks to provide a comprehensive understanding of the role of simulations in vector education, ultimately informing strategies to improve teaching and learning practices.

1.2 STATEMENT OF THE PROBLEM

Despite the potential benefits of simulations in enhancing the teaching and learning of vectors, there is a lack of understanding regarding the perceptions of students and teachers on the effectiveness of simulations in improving vector comprehension, visualization, and problem-solving skills. This study aims to address these questions and explore the perceptions of students and teachers on the use of simulations in teaching and learning vectors, with the goal of informing the development of effective simulation-based instructional materials and strategies."

1.3 RESEARCH QUESTIONS.

i. What are the perceptions of students regarding the effectiveness of simulations in enhancing their understanding and visualization of vector concepts.
ii. How do teachers perceive the role of simulations in teaching vectors, and what factors influence their decision to adopt or reject simulation-based instruction in their teaching practices?
iii. What are the similarities and differences between students' and teachers' perceptions of the benefits and limitations of simulations in vector education.

1.4 RESEARCH OBJECTIVES.

i. Explore student's perceptions of the effectiveness of simulation-based learning in enhancing their understanding of vector concepts.
ii. Investigate teacher's perceptions of the role of simulations in teaching vectors and their experiences with simulation-based instruction.
iii. Identify the similarities and differences between students and teachers' perceptions of simulation-based learning of vectors.

1.5 SIGNIFICANCE OF THE STUDY

By exploring students and teachers' perceptions, the study can ultimately enhance the teaching and learning of vectors, leading to improved academic achievement, increased student engagement and more effective teacher practices. This study is aimed at helping to point out and understanding challenges that are being faced by students at this particular school in Mashonaland East. The finding will also help the researcher to become an effective teacher in mathematics since he is involved in the teaching profession.

1.6 ASSUMPTIONS

a) Students and teachers have had some experience with vectors and simulation- based learning.

b) Participants will provide honest and accurate responses to the survey.

c) The researcher assumes that when participants were answering questions were not under duress. Participants participated freely in the study, and they contributed their best in the formulation of data.

1.7 DELIMITATION

The study focused only focussed on ordinary level secondary schools learners in Chikomba wazvaremhaka cluster and the targeted group will be mathematics teachers and learners at the school. Study was done in a period of eight months from February 2024 to June 2024. The researcher dealt with 70 students at the very cluster the researcher teaches and 20 teachers who teaches mathematics in the same cluster**.**

1.8 DEFINITION OF TERMS.

A vector is a geometrical quantity or phenomenon that has two independent properties: magnitude and direction (Barniol, P. and Zavala, G., 2009).

Simulation is a powerful technique used in various fields to model and analyze complex systems. When it comes to vectors, simulations can be used in different ways to study their behavior and applications. Vectors are extensively used in engineering and design applications, such as structural analysis, fluid dynamics, and electrical circuit simulations. Simulations based on vector calculations can help engineers evaluate the performance and behavior of systems under different conditions, predict potential failures, and optimize designs. Physical Systems: Vectors are often used to represent physical quantities such as velocity, acceleration, force, and displacement. Simulations can be employed to model the motion of objects in a system and analyze vector-based

interactions. For instance, in a physics simulation, vectors can be used to represent and simulate the movement of projectiles under the influence of various forces like gravity and air resistance

1.9 CONCLUSIONS

This chapter has given the background, the statement of the problem, the aim of the study and its accompanying objectives together with the research questions. The chapter has also given the significance of the study as well as the chapter outline. The next chapter discusses a review of the related literature. The intention of the literature study is to gain more understanding of the problem. This study considered (Kiat, 2005)'s and Newman's Error Analyses (1977) contributions to construct, adopt and identify students' simulations whilst solving vectors.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.0 Introduction

At ordinary level, the study of vectors typically forms part of the mathematics curriculum. Vectors are mathematical entities used to represent quantities that have both magnitude and direction. They are commonly encountered in fields such as physics, engineering, and mathematics itself. Here is a background on vectors at the ordinary level with some citations to relevant sources. Understanding vectors is crucial in various fields of science, mathematics, engineering, and computer science. Vectors, which have both magnitude and direction, provide a powerful tool for representing physical quantities and solving complex problems.

2.1 LITERATURE REVIEW

A vector is a mathematical object that represents both magnitude and direction in a defined space. Vectors are widely used in various fields, including physics, engineering, and computer science. According to the Encyclopedia Britannica, a vector is defined as "a quantity that has both magnitude and direction and that is commonly represented by a directed line segment whose length represents the magnitude and whose orientation in space represents the direction." The textbook "Mathematical Methods for Physics and Engineering" by K. F. Riley, M. P. Hobson, and S. J. Bence defines a vector as "a quantity that has both magnitude and direction. It is represented geometrically by a directed line segment and algebraically by a set of three real numbers (components) that specify its Cartesian coordinates." In the context of computer graphics, "Computer Graphics: Principles and Practice" by J. D. Foley, A. van Dam, S. K. Feiner, and J. F. Hughes defines a vector as "an entity with both direction and magnitude." The authors further

explain that in computer graphics, vectors are often used to represent positions, directions, and transformations in three-dimensional space. A vector is commonly represented as an ordered set of elements, typically enclosed within angle brackets or written in columnar form, Stewart, J. (2015).

Vectors provide a powerful framework for representing quantities that have both magnitude and direction. Developing a solid conceptual understanding of vectors is crucial for effectively solving problems and reasoning about relationships in these disciplines. The key aspects of conceptual understanding of vectors. A vector is commonly defined as an entity characterized by its magnitude and direction. It can be represented geometrically by an arrow, with the length of the arrow indicating the magnitude of the vector, and the direction of the arrow indicating its direction in space. Vectors can also be represented algebraically as ordered sets of numbers or variables. Components and Coordinate Systems, vectors can be decomposed into components along different axes in a coordinate system. In two-dimensional space, a vector can be decomposed into horizontal and vertical components. The choice of coordinate system affects how vectors are represented and manipulated.

Vector Operations, vectors can undergo several operations, including addition, subtraction, scalar multiplication, and dot product. Vector addition involves the combination of two or more vectors to produce a resultant vector, while vector subtraction results in a vector pointing from one vector to another. Scalar multiplication involves multiplying a vector by a scalar, which changes the magnitude of the vector without affecting its direction. The dot product yields a scalar by multiplying the magnitudes of two vectors. Geometric Interpretation, vectors have a geometric interpretation in terms of displacement, velocity, force, and other physical quantities. For example, a displacement vector represents a change in position, while a velocity vector represents the rate

of change of position. The geometric interpretation allows us to understand vector quantities in relation to real-world phenomena.

Understanding vectors can be challenging for students due to several common difficulties. These are abstract nature, vectors are abstract mathematical entities represented by magnitude and direction. This abstract nature can be difficult for students to visualize and grasp. According to Selden and Selden (2015), "The geometric nature of vectors seems to be a serious stumbling block for many students" (p. 104). Notation and Symbols, vector notation and symbols, such as arrows, boldface letters, and component form, can be confusing for students. Misinterpretation of these symbols can lead to errors in calculations and understanding. Hsu (2004) observed that "students are notorious for getting lost in the notation" (p. 24). Vector Operations: Understanding vector operations, including addition, subtraction, and scalar multiplication, can be challenging for students. Difficulties can arise from misconceptions about how these operations affect both magnitude and direction. In their study, Chiappetta and Adams (2005) reported that "Many students have problems when it comes to adding and subtracting vectors" (p. 44). Frame of reference, students sometimes struggle with the concept of vectors in different frames of reference, such as Cartesian coordinate systems or three-dimensional space. This difficulty arises from the need to adjust and align vectors based on the chosen frame of reference.

Gire, Price, and Tiskus (2009) noted that "Students find it particularly challenging to switch between coordinate systems or align vectors in different frames of reference" (p. 256). Application to Real-World Problems, applying vectors to real-world problems, such as motion and forces, can be challenging due to the need to translate real-world situations into vector representations. Larkin and Simon (1987) found that students often struggle to understand "how vectors can be used to represent and analyze complex physical systems" (p. 79). It is worth noting that individual students

may face varying degrees of difficulty in understanding vectors, and these challenges can depend on factors such as prior mathematical knowledge, learning style, and instructional approach. Addressing these difficulties requires a combination of effective teaching strategies, visual aids, hands-on activities, and ample practice opportunities.

Also there are challenges of traditional teaching methods. Traditional teaching methods refer to the conventional approaches used in education for imparting knowledge and skills to students. While these methods have been utilized for centuries, they do come with certain limitations that have been widely discussed in educational research. Passive Learning, traditional teaching methods often rely on a lecture-based format where the teacher is the primary source of information, and students passively receive the content. This approach limits active student engagement and critical thinking. "In lectures, students are largely passive participants, receiving information and taking only limited responsibility for their own learning" (Bligh, 2000).

One-Size-Fits-All Approach, traditional methods tend to assume that all students have similar learning styles and abilities, which may not be the case. This approach can fail to cater to the individual needs and diverse learning styles of students. "One-size-fits-all teaching methods are a poor match for the broad range of learning styles and preferences found within the classroom" (Pashler et al., 2008). Lack of Personalization, traditional teaching methods often lack the flexibility to adapt to individual student interests, strengths, and weaknesses. This can hinder students' motivation and hinder their ability to acquire a deep understanding of concepts. "Traditional teaching often fails to reach all students because it does not take into account their individual needs, abilities, and interests" (Wang, 2012).

Limited Opportunities for Active Participation and Collaboration, conventional teaching methods often provide minimal opportunities for students to actively participate in the learning process or collaborate with their peers. This can impede the development of critical thinking, problem-solving, and interpersonal skills. "Students who do not have regular opportunities to solve problems collaboratively may be denied the opportunity to learn critical thinking and teamwork, which are important outcomes of cooperative learning" (Johnson et al., 2019). Focus on Memorization and Repetition, traditional teaching methods often prioritize rote memorization of facts and repetitive practice rather than fostering deeper understanding and application of knowledge. This may result in shallow learning and difficulty in transferring knowledge to real-world contexts. "Traditional teaching methods that emphasize rote memorization can limit students' ability to apply their knowledge in meaningful contexts" (Hake, 2005). It is worth noting that while traditional teaching methods have their limitations, they have also been successful in certain contexts. However, as educators should recognize these limitations.

Also there is need for innovative approaches to teaching and learning. Some innovative approaches to teaching vectors in mathematics are, Visualization and Manipulation Tools: Incorporate interactive visualization software or apps, such as GeoGebra or Desmos, to help students visualize vector operations and transformations. These tools allow students to interactively explore vector concepts and gain a deeper understanding of vector addition, subtraction, and scalar multiplication. (Hohenwarter, M., & Preiner, J. (2007). Dynamic mathematics with GeoGebra. Journal for Geometry and Graphics, 125-133.) Real-world Applications, introduce real-world applications of vectors to engage students and demonstrate the relevance of vector concepts. For example, show how vectors are used in navigation, physics, computer graphics, or even sports. By connecting vectors to practical scenarios, students can better grasp the importance and usefulness of vectors.

(Lappan, G., Fey, J. T., Fitzgerald, W. M., Friel, S. N., & Phillips, E. D. (2006). The role of contexts, how will it impact the development of key ideas in mathematics? Journal of Curriculum Studies, 503-517). Interactive Activities and Games, design interactive activities or games that involve vector manipulations for instance, online platforms like Kahoot can be used to create quizzes or challenges where students answer vector-related questions and compete with their peers. Gamification makes learning vectors enjoyable and can enhance student engagement and motivation. (Kay, R. H., & LeSage, A. (2019). Examining the use of an online, game-based learning platform in a high school mathematics classroom. Computers & Education, 142.) Multiple Representations, present vectors using various representations, such as diagrams, coordinate systems, and algebraic notation. This approach helps students develop a holistic understanding of vectors and how they can be represented differently depending on the context. Students can practice translating between different representations to reinforce their comprehension. (Dreyfus, T., Hillel, J., & Sierpinska, A. (2019). Bifocal views on negative numbers and operations. Educational Studies in Mathematics, 225-254). Peer Collaboration and Exploration: Encourage collaborative learning and exploration of vectors by assigning group projects or problem

Simulation refers to the process of imitating or replicating real-world situations, systems, or processes using computer models or physical representations. It involves creating a simplified version of a complex system in order to understand its behavior, make predictions, test hypotheses, or train individuals in a controlled environment. There are some characteristics of simulation that is Model Representation, simulation involves the construction of a model that captures the essential elements and behaviors of the real-world system being simulated. The model can be

represented using mathematical equations, computer algorithms, physical objects, or a combination of these. Abstraction and Simplification, simulation requires the abstraction and simplification of the real system. Not all details of the system are included in the simulation model, but only the relevant factors that affect the behavior or outcomes of interest. The use of simulations in the teaching of vectors has numerous benefits. Firstly, simulations provide students with a deeper understanding of abstract vector concepts by making them more concrete and accessible.

Using simulation in education offers several advantages. These are active learning, simulations promote active learning by engaging students in hands-on experiences. They allow learners to actively participate and make decisions, leading to a deeper understanding of the subject matter compared to passive learning methods. Experiential learning, simulations provide students with realistic and immersive experiences that simulate real-world scenarios. Students can apply knowledge and skills in a safe and controlled environment, allowing them to experiment and learn from their actions and consequences.

Simulation plays a crucial role in enhancing conceptual understanding across various fields and disciplines. It allows individuals to interact with virtual models or scenarios that mimic real-world situations, providing them with a dynamic and immersive learning experience. There are some key roles of simulation in enhancing conceptual understanding. Experiential Learning, simulations provide learners with hands-on experience and an active learning environment, promoting experiential learning. According to Kolb's experiential learning theory, individuals learn best when they actively engage with the material and reflect on their experiences. Simulation provides this experiential learning opportunity by allowing learners to manipulate variables and observe the outcomes firsthand (Kolb, 2015). Visualizing Abstract Concepts, simulation helps learners grasp

and visualize abstract concepts that may be challenging to comprehend through traditional teaching methods alone.

By providing visual representations and interactive elements, simulations make complex concepts more accessible and understandable (Beheshti et al., 2019). Fostering Critical Thinking: Simulations encourage learners to think critically and analytically. They often require learners to make decisions, solve problems, and evaluate the consequences of their actions in simulated scenarios. This helps develop higher-order thinking skills, such as problem-solving, decision-making, and logical reasoning (Alessi & Trollip, 2001). Enhancing Engagement and Motivation: Simulations often incorporate interactive elements, gamification techniques, and realistic scenarios, which can enhance learner engagement and motivation (Savery, 2006). The active and immersive nature of simulations can increase learners' excitement and willingness to explore and understand complex concepts.

When teaching vectors, simulation tools can be valuable in helping students visualize and understand vector concepts. These are GeoGebra, PhET, Desmos and Vector Field Plotter. GeoGebra is a dynamic mathematics software that offers various tools for exploring and visualizing vectors. It allows users to create vector representations, perform vector addition and subtraction, and explore the properties of vectors in two and three dimensions.

.2.2 Availability Of Resources.

The use of simulations in teaching vectors at the ordinary level can greatly enhance students' understanding and engagement with the topic. Simulations provide a dynamic and interactive way to explore vector concepts and their applications. Educational Websites, there are numerous educational websites that offer interactive simulations and tutorials on vectors. These websites

often provide visual representations of vector quantities, vector addition and subtraction, and vector components. They may also include quizzes and practice exercises to reinforce learning. Educational Software: Some software programs designed for mathematics education offer simulation modules for teaching vectors. These programs can be installed on computers or accessed online and provide a range of interactive activities and visualizations related to vectors. Mobile Apps: With the increasing use of smartphones and tablets, there are also mobile apps available that focus on vector simulations. These apps often feature interactive animations, games, and quizzes to engage students and enhance their understanding of vector concepts.

2.3 Learner and teacher attitude towards the vector's topic:

One way or the other the way pupils may not feel comfortable in answering the problems relating to vectors as a result of negative attitude. Negative attitude can become a cause for them to make errors. As a result of fear of the unknown or little confidence in their ability, learners are likely to make errors(National Research Council, 2001). (Perso, 1991)is of the view that leaners who are not good at directed numbers, linear equations and algebra are likely to face similar problems as they faces in the very topics so as in vectors. And those who failed to develop interests in the very topic may feel not comfortable in the topic of vectors since the topic on vectors requires application of these topics (Nesher, 1987). Positive attitude of the teacher can contribute to lower levels of making errors: the teacher will take appropriate measures and devotion to do all what is necessary to achieve the best results in the teaching and learning of vectors. As such the attitude of the teacher has a bearing in the development of the knowledge block in learners, negative attitude can be a pushing factor for teachers to use traditional teaching and learning approach which involves drilling (Owusu, 2015), but positive attitude can be ones' strength to use constructivist approach

which focuses on the re-organization of the learners' experience by reconstructing conceptual connections (Luneta, K and Makonye J, 2008). It is therefore lies in the discretion of the teacher in relation his/her attitude to use a teaching method aiming to develop a learner or just covering a topic as required by the syllabus. According to (Fumador, E , S and Agyei, D . D, 2018), constructivist teachers tend to explore how students perceive the problem and why their path towards a solution seems promising (Sergei et al., 2019). According to (White, 2005), children may learn mathematics not by internalizing the formula and rules enforced by an external authority. Still, they learn mathematics by constructing meaning from the inside on their natural thinking abilities.

(Abadi, A., Agustyaningrum, N. and Mahmudi, A., 2018).(Lochhead, J and Mestre, J . P, 1988) suggested that for a meaningful transformation of knowledge, leaners have to be able to interpret words properly and conversion of words to algebra can be a learning curve , as such the teacher as an instructor has to be vigilant to take note that leaners have negotiated smoothly the learning curve.

2.4 Literature gap

The review provided the researcher with a better understanding of the problems caused by inadequate knowledge of simulation in Mathematics which is a powerful and pivotal aspect in vectors, and in adequate availability of ordinary level vectors literature is a clear sign that this area has little ideas invested in researches. However, some problems are due to carelessness, overconfidence and also teachers' content gaps despite efforts rendered in this area to nip the problem of simulation.

Chapter 3: Research Methodology

3.0 INTRODUCTION

This Chapter identifies the methodology was used to carry out the research. The researcher clearly interprets the information collected in the chapter to follow. Quantitative analysis was used by the researcher to collect the information. The researcher used questionnaires and interviews to determine the problem with the learners in taking the topic. Data collection was made with the respondents 'knowledge of being observed. Observation was done in their natural state so as to record the accurate information. The researcher used a sample of ten students drawn from a population of seventy student at the station in Wazvaremhaka cluster in Chikomba.

1.5 Research Approach

The researcher used a quantitative method when carrying out the research. The objectives is explore students perceptions of simulation based learning of vectors and also to investigate teachers perceptions of the role of simulations in teaching vectors. The researcher used a questionnaire for both teachers and students. The researcher collects a sample of 70 ordinary level students and 20 teachers who have taught vectors using simulations.

According (Mcmillan, J. H and Schumacher, S , 2010), methodology structures the specific procedures about which will reflect the true information on the ground. According to (Falle, 2007) defines research methodology as instruments or tools used to collect data in research. Chiromo

(2006: 26) defines a population as, “all individuals, units, objects or events that will be considered in a research project.”

3.1.1 THE RESEARCH DESIGN OF THIS STUDY

The researcher giving both teachers and learners some questionnaires. In order to ensure reliability of the questionnaires, the researcher ensured that the group was different in this case he considered all the form three classes. The researcher also made sure that the learners were given enough time to complete their questions. The researcher also made sure that the questionnaire was good enough for well the assessment. These methods of assessment were also chosen so as to ensure the validity of the assessment procedures.

3.2 RELIABILITY

Opie (2004) views reliability as being synonymous with worthy of trust and unambiguousness of the representation of the total population under study. Reliability deals with the ability to come up with the same review of a given phenomenon if and when the review is conducted under same conditions (Gertz, 1973). Therefore, reliability is just an indication of the extent to which results can provide quality assurance in quantitative research because of bias being rooted in all individuals. Data can be interpreted differently by different individuals. Therefore, the researcher needed to try the best to have dependable data for the consistency of the study.

3.3 VALIDITY

Validity is not an article that can be purchased with a skill; instead, validity is like nobility, character and quality to be assessed relative to purpose and circumstances (Brinberg and McGrath,

1985). McMillan and Schumacher (2010) defined validity as the extent to which inferences based on instrument are reasonable. It is a measure of the degree to which explanations of an event match reality. Validity can be viewed as not depending on the data but the interpretation of the data. A test can be viewed as valid if it serves its intended purpose well (Mbewe, 2013). In this study, the test questions were constructed in line with ordinary level exam papers as well as relying on common errors encountered by the researcher in the teaching/learning situation.

As the researcher frequently discuss with the supervisor concerning the findings did not take for granted the existence of bias, as such, the researcher monitored beliefs, insights and preconceptions about learners' misconceptions solely based on practice.

3.4 TARGET POPULATION

In this study, the target population was all ordinary level learners from one rural Secondary School in Wazvaremhaka Cluster, Chikomba District in Mashonaland East Province.

3.5 SAMPLE AND SAMPLING TECHNIQUES

In the study, the population was all ordinary level learners from one rural Secondary School in Wazvaremhaka Cluster which consists of 150 pupils in Chikomba District in Mashonaland East Province. The researcher identified the population on which data collection methods were to be applied to gather information. McMillan and Schumacher (2010) define a sample as a group of individuals from whom data is collected. Therefore, a sample is part of the entire population which usually represents the whole group under study. Sampling is necessary because it is not always possible or practical to study the whole population.

The participants in this study were randomly selected from a population of 70 learners from four secondary school. The researcher used a purposive sampling that is selecting participants who have experience with simulation-based learning of vectors for ensuring relevant data. The researcher's justification in the selection of students from only one cluster schools was to take advantages of convenience to the researcher and the researcher could relate well with the sample resulting in quality and credibility of research data.

3.6 RESEARCH INSTRUMENTS

3.6.1 QUESTIONAIRES

The researcher began by seeking permission from the District Education Offices in Chikomba to conduct the questionnaire. The researcher got responses from both learners, and participants who had adequate time to respond to questions without the interferences of other parties. The researcher resort to use interviews in order to allow learners to communicate their opinions and to express their actions which certify the insights in their thinking process. It was during such questionnaire when contradictions, insufficiencies or misconceptions were manifesting from the students. The researcher clearly explained the data in the next chapter.

Recording of solutions was done. The researcher made sure that no harm was done to any of them as the researcher was observing the frequent information, more frequent data would be assumed to be an indicator of the true value of the research topic as supported by statistical calculations as well. The researcher did not use names of the participants but the researcher recorded simply the lesson activities.

3.7 CONCLUSION

A questionnaire was used as the instrument of this study to identify the causes of pupils in failing to use simulation from the perspective of the students themselves. The sample was made up of 70 Form three students from four secondary schools in Wazvaremhaka cluster. Data was analyzed using descriptive statistic. The next chapter will look at data analysis, presentation and discussion presented using tables and graphs which are easy to interpret. In addition, explanations were used to justify the conclusions of results

Chapter 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 INTRODUCTION

The main aim of this research study was to identify the use of simulations in vectors. Learners committed to use simulation in solving vectors problems. This chapter present a discussion of the findings of the study and relates the findings to the theoretical background and literature review connected to the study. The discussion of the findings which are presented in tables, bar graphs and pie charts. The researcher is also going to analyze two written exercises and a test together with interview data of ten learners and ten mathematics teachers.

4.1.0 PARTICIPATION IN LEARNER QUESTIONNAIRES

Fig 4.1 below shows the number of learners who participated in the investigation.

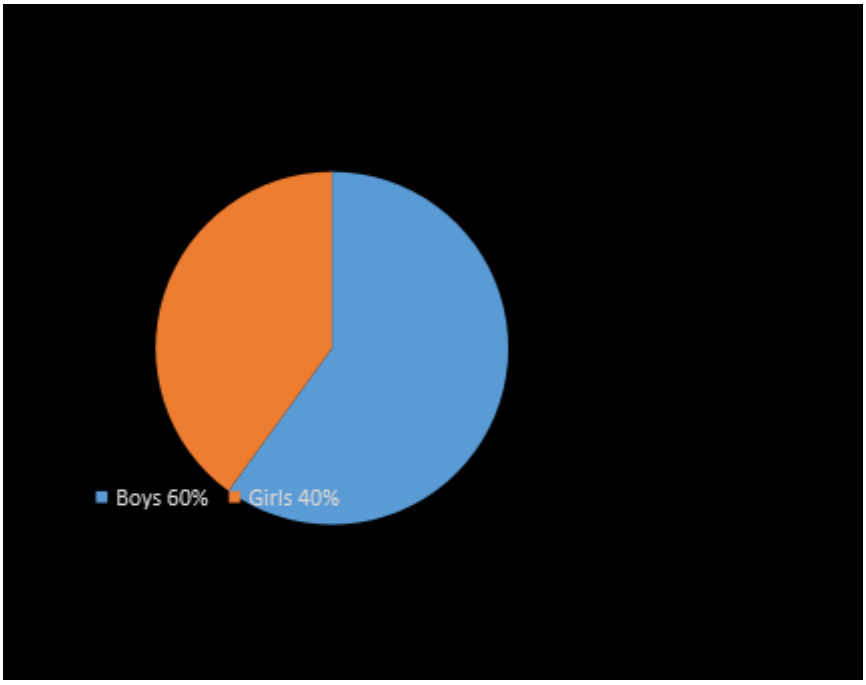


Fig 4.1 Participation spread of learners in the study

4.3 LEARNERS' QUESTIONNAIRES AND THEIR RESPONSES.

1) Did you enjoy studying vectors using simulation? The table below summarizes their responses, the graph depicts what is on the Table 4.1.

Table 4.1: Enjoyment status on usage of simulations on teaching vectors

Learners enjoyed with vectors.	70%
Learners not enjoyed with vectors.	30%

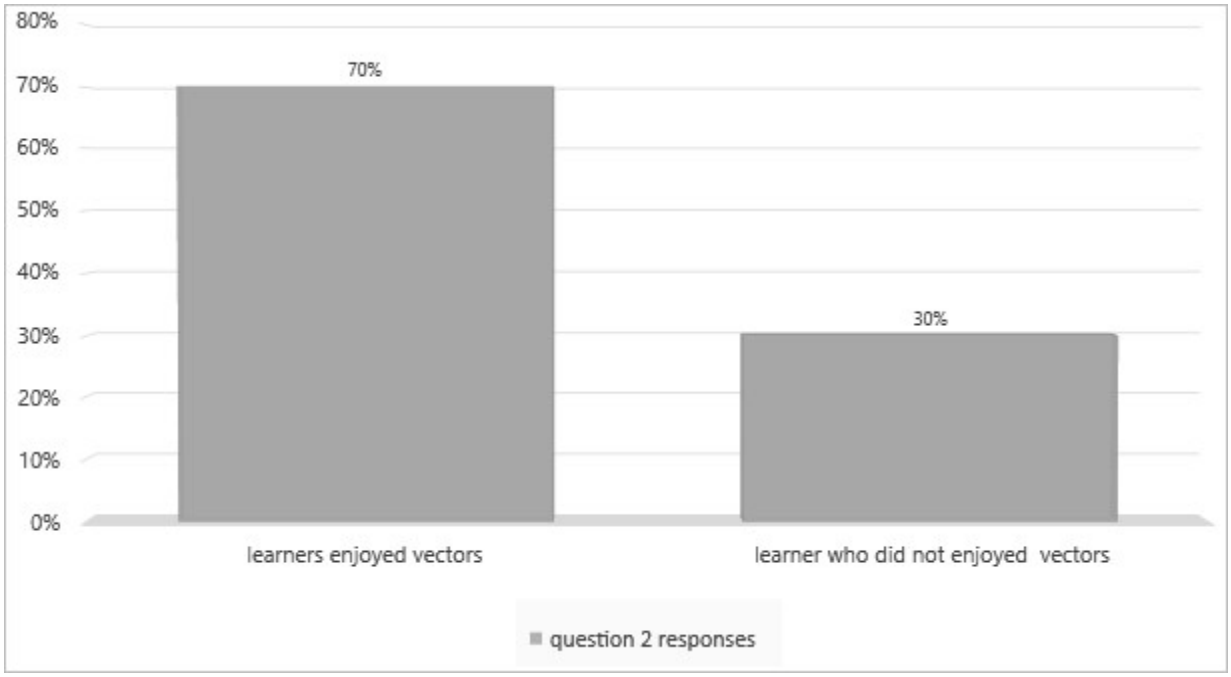


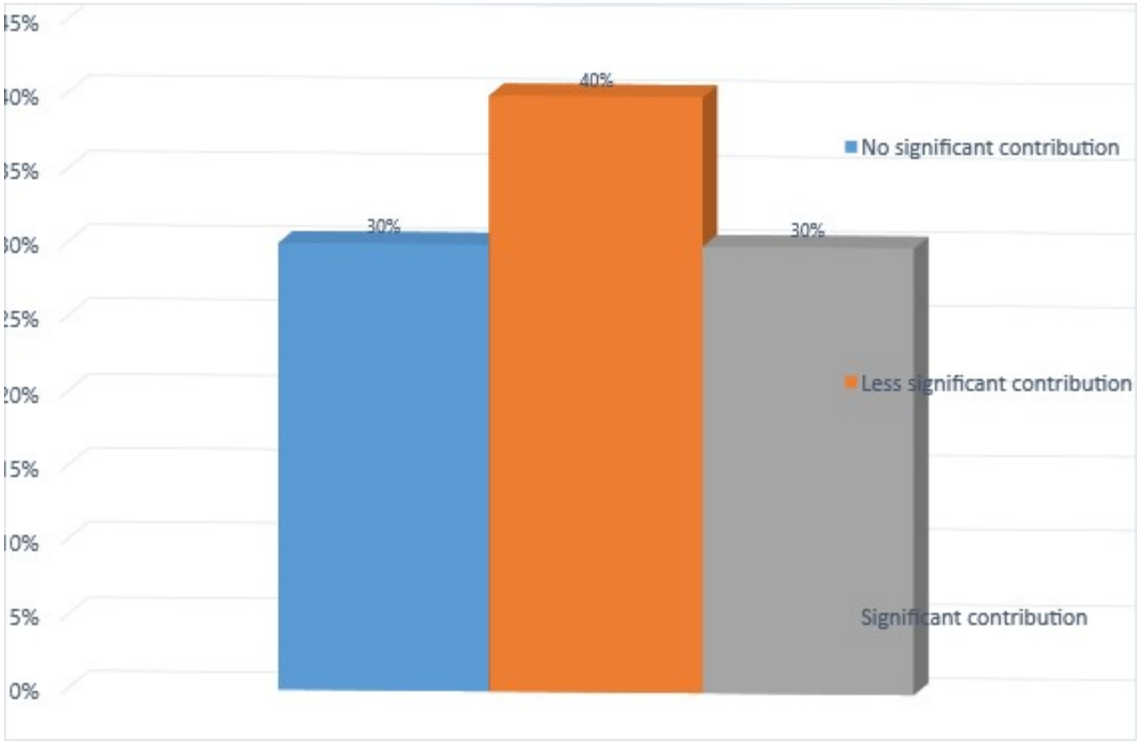
Fig 4.2 : Level of enjoyment on usage of simulations to teach vectors

Fig 4.2 graph indicates 70% of the sample of learners who were under study. They testify that they enjoyed the topic of vectors. They suggested that the topic needs a lot of concentration failure to do that one could hardly understand it. 30% said that they did no enjoy the vector topic and they argued that the topic is long one and complicated to grasp.

2 Do you think the topic on vectors will contribute much in the passing of mathematics?

Below is the Fig 4.3 the graph is indicating responses learners gave to the researcher.

Fig 4.3:



Contribution of Vectors topic in the examination

Fig 4.3 indicates that 30% suggested that the topic has no significant contribution, while 40% are of the opinion that less contribution and 30% suggested that the topic contributes significantly to the pass rate.

2) Have you experienced any challenges while using simulations to learn vectors? (YES/NO)

Table 4.2: Challenges in using Simulations to learn Vectors

YES	80%
NO	20%

Table 4.2 above 80% of the learners said they have experienced challenges while using simulation but only 20% said they have no challenge while using simulations to learn vectors.

3) Have you used simulation to learn vectors before? YES/NO.

Table 4.3: Usage of Simulations to learn vectors

YES	30%
NO	70%

Table 4.3 above showed that 30% of the students said they used simulation to study vectors before whilst 70% of the students they did not used simulation to study vectors before.

4.2 TEACHERS QUESTIONNAIRES.

Indicate in these columns, your satisfaction with the following issues or factors that affect students' performance in Mathematics at your school**.** The table 4.4 indicates the responses teachers gave to the researcher and the graph below shows the summarized responses.

Table 4.4 Teacher satisfaction statistics on the current student performance in Mathematics

40%	Satisfactory.
60%	Not Satisfactory.

Generally Table 4.4 shows that 60% teachers are not satisfied with the performance of students in mathematics.

1) Do you have a problem in teaching vectors using simulation? YES/NO. The table below is a summary of what teachers indicted in their experiences in teaching vectors, and the graph also express the same information.

Table 4.5

80%	Had no problem with teaching vectors using simulation at ordinary Level.
20%	Had a problem in teaching vectors using simulation at ordinary level.

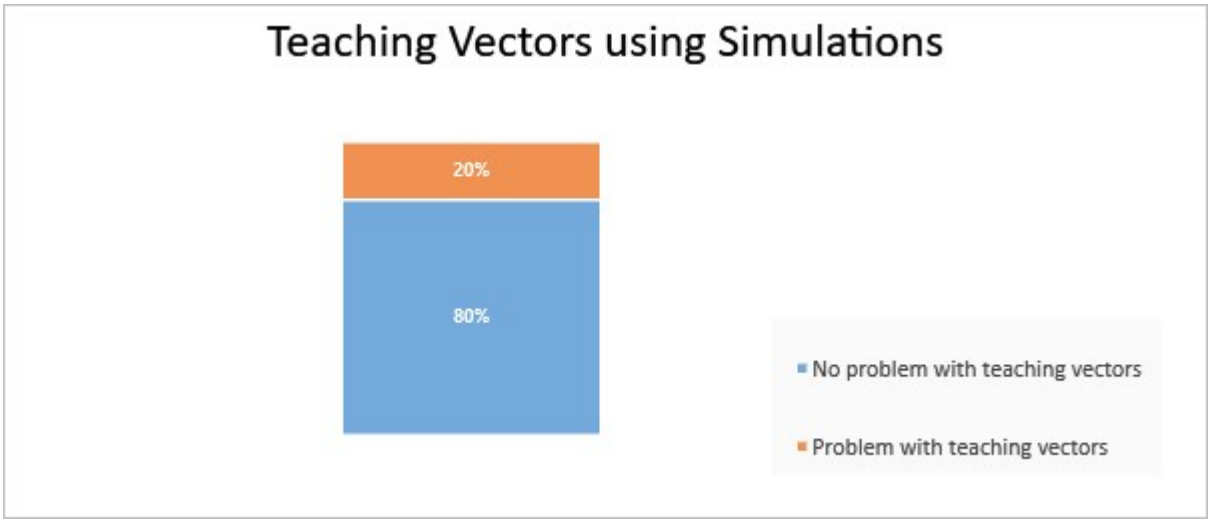


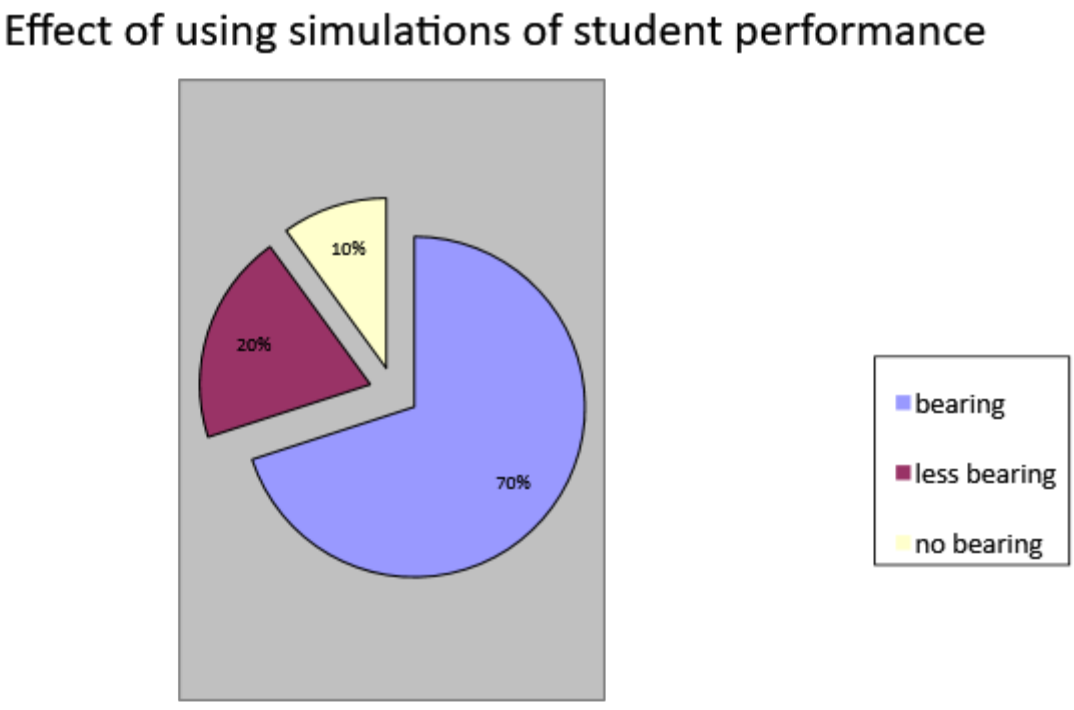
Fig 4.4

Of the sample: 20% responses indicated they are not comfortable with the topic of vectors, their defense was that they were not trained to teach mathematics, and their mathematics history was not that strong. 80% of the teachers said they like and some said they enjoy teaching mathematics and nowhere they could not like the topic of vectors.

2) Do you think the use of simulation in this topic of vectors has bearing on the pass rate in mathematics? The table shows teachers responses. The pie chart in Fig 4.5 also depicts teachers' responses to this question.

Table 4.6 Effect of using simulations on student performance

Bearing	70%
Less bearing	20%
No bearing	10%



About 70% teachers who participated in this research shown that the vector topic has strong base and contributions to the pass rate. Their concern was that it is one of the topic caries some marks and optional in paper two. In addition to that it gives learners another chance to

revise the following areas: simultaneous linear equations, linear algebraic expressions, fractions and ratios as well. Therefore, is the reason why the topics has bearing in one's pass rate.

There are other teachers who also suggested that the topic has little bearing in the pass rate, and is minor area to major with. Their concern was that a learner who already mastered all other topics have little or no chance to fail. Then it means he/she can perform very well in simultaneous linear equations, linear algebraic expressions, fractions and ratios as well.

Also the other contribution made during the research indicated that there is no bearing the topic of vectors can be attached to the pass rate. Their suggestion was that the topic is an optional topic which one chooses to teach or answer during exams. When the topic is not taught learners still have large ground to work on.

3) Do you think you have enough time to teach vector topic using simulation? The table below shows the responses to question three and further presented in a form of a pie chart.

Table 4.7 Availability of time to use simulation to teach vectors

Yes	30%
No	70%

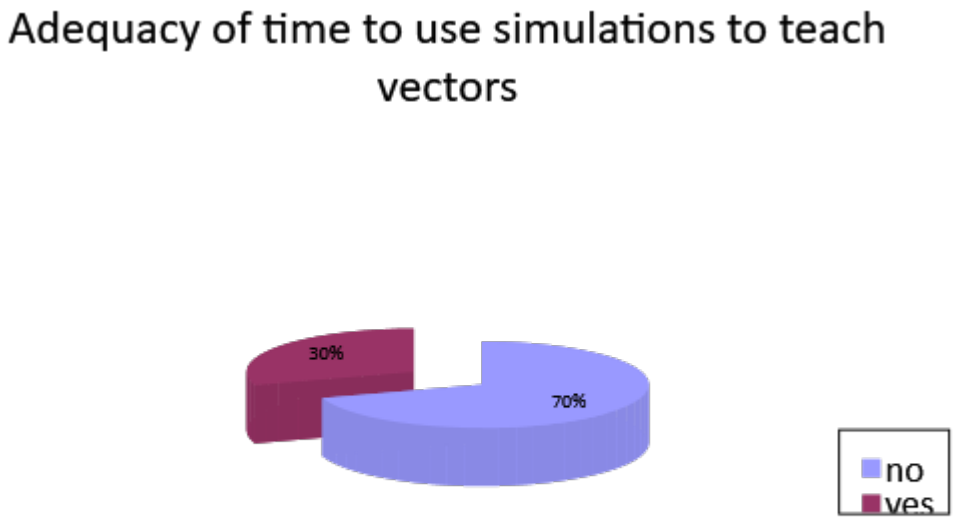


Fig 4.6

Teachers indicated that time to exhaust the topic and time for revision is very short. Teachers were also complaining about time allocated as a subject and is not being given value and impression it has to carry, as such the time allocation maybe equal to time allocated to arts subjects as if mathematics is grouped in the same category with arts and commercial subjects.

4.5: CONCLUSION

The researcher left no stone unturned in an effort to clear the air on why ordinary level learners make errors when computing vectors. In this study the objectives of this study was to determine the type of errors made by the students when solving the vector problems and to identify the factors that lead students to make these errors in the test and exercises. The type of error is partly based on Newman Error Analysis and other scholars.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter is going to summarize the data presented in chapter four and provide recommendations in line with what the researcher found out. It is going also to give us limitations which other researchers may need to take care of as they conduct their studies.

5.1 GENERAL ANALYSES ON THE USE OF SIMULATION IN THE TEACHING OF VECTORS AT ORDINARY LEVEL.

The use of simulation in teaching vectors at the ordinary level is that, It Improved understanding: Simulation helps students develop a deeper understanding of vector concepts, such as magnitude, direction, and resolution. Also it enhanced visualization: Simulation provides interactive and dynamic visual representations, making it easier for students to visualize and comprehend complex vector concepts. Increased engagement is also another factor, Simulation-based learning is more engaging and interactive, motivating students to learn and explore vectors in a more enjoyable way. Better retention: Simulation helps students retain vector concepts better, as they are more likely to remember interactive experiences than traditional lectures. Personalized learning: Simulation can be tailored to individual students' needs, allowing for personalized learning experiences. Development of problem-solving skills: Simulation provides opportunities for students to apply vector concepts to real-world scenarios, developing problem-solving skills. Improved spatial awareness: Simulation helps students develop spatial awareness and intuition, essential for understanding vector concepts. Reduced misconceptions: Simulation can help identify and address common misconceptions and misunderstandings in vector education. By

incorporating simulation into vector education, teachers can create a more engaging, interactive, and effective learning experience for their students.

5.2 RECOMMENDATIONS.

1. Interactive Graphical Vectors: Utilize simulations that allow students to manipulate vectors graphically, exploring addition, subtraction, and scalar multiplication.

2. Real-World Applications: Use simulations to demonstrate vectors in real-world contexts, such as projectile motion, force, and velocity.

3. Vector Addition: Employ simulations to illustrate the concept of vector addition, enabling students to visualize the resultant vector.

4. Vector Resolution: Utilize simulations to teach vector resolution, allowing students to practice resolving vectors into components.

5. Interactive Problems: Incorporate simulations that present interactive vector problems, encouraging students to apply concepts to solve them.

5.3 LIMITATIONS

Mathematics books are written in English which make it a challenge to learners to translate it to meaningful instructions. Limited understanding of vector concepts that is students may struggle to grasp abstract vector ideas, making it hard to apply them in simulations. Teachers' mood is always changeable: the teacher's morale is very important to motivate students. Economic hardships have dragged the parental support into doubt especially to middle and lower income earners in rural and

urban dwellers, subsequently students fail to buy individual laptops used for simulation which is very important in the learning of mathematics and schools are also being stricken by the same wave resulting in failing to provide sustainable pupil laptops ratio. Another challenge is from the government policy on learner teacher ratio: if the enrolment of a school does not suit the stipulated guidelines on staffing of the very school, learners can be disadvantaged by this policy ending up being deprived from accessing quality services. More often may be taught by untrained teachers in mathematics or left unattended at the end they fail mathematics. Also there is limited engagement that is students might find simulations too abstract or disconnected from real life scenarios, leading to disengagement. The researcher cannot exhaust the list is endless but looked at a few.

5.4 CONCLUSION

This study found occurrence of reading, transformation, comprehension, process skill errors and other error outside these. It is therefore important to suggest that the learner and the teacher must understand the importance of the use of simulation in attention to vectors. Failure to tackle errors at the early stages, it will give pronounced impact to the students' mathematics experiences in the future. Also, this study can give information to other researchers, teachers and academic institutions on the use of simulations by tracking the findings covered in this study. The explanations of the origins of the use of simulation have been related to the existing literature in a way linking them to the broader theoretical views. In short, the role of teachers is important in enhancing the potential of students. Educators must be creative and determine appropriate approaches of delivery a topic concepts focusing on producing best quality results

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ANNEXURE 1

QUESTIONNAIRE FOR THE SCHOOL HEAD

My name is Nyengerayi Liberty. I am a student at Bindura University of Science Education (BUSE), studying for a Bancellor of Sciences Degree and Honors in mathematics Education. I am currently working on are search project entitled: Exploring the use of simulation in the teaching and learning of vectors at Ordinary level: A case of Mahusvu Secondary School in Chikomba 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.

1.0 RESPONSIBLE AUTHORITY

Is your institution private or Public? *Indicate by ticking against your preferred choice*

Government	
Private	

2.0 Gender

Which one best applies to you? *Indicate by ticking against your preferred choice*

Male	
Female	

3.0 Age

In which range is your age? *Indicate by ticking against your preferred choice*

25-30 years	
26-30 years	
31- 35 years	
Over 36 years	

4.0 HIGHEST ACADEMIC QUALIFICATIONS

What is your Qualifiation? *Indicate by ticking against the choice that best applies to you*

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

Other (State which).....

5.0 Were you officially educated and trained for your post at college or university? Yes/No

If your answer is "No: briefly explain how you acquired your leading knowledge and skills.....
.....

6.0 Working Experience as a secondary school headmaster or principal

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

7.0 Indicate in these columns, your satisfaction with the following issues or factors that affect students' performance in Mathematics at your school.

KEY:

Not satisfactory NS

Satisfactory S

Item No	Item	**1** **NS**	**2** **S**
i	Teachers' competences in mathematics		
ii	Availability of ICT tools in the school		
iii	Availability of a computer Laboratory		
iv	Trends in mathematics pass rate.		

Elaborate or comment on some of your responses on the spaces provided below:

.....

.

ANNEXURE 2

QUESTIONNAIRE FOR MATHS TEACHERS

My name is Nyengerayi Liberty. I am a student Bindura University of Science Education (BUSE), studying fo ra Bachellor of Sciences Degree and Honors in mathematics Education. I am currently working on are search project entitled: Impact of simulation in the teaching and learning of transformation at Ordinary level: A case of Mahusvu Secondary School in Chikomba 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

1.0 Gender

Which one best applies to your gender? *Indicate by ticking against your preferred choice*

Male	
Female	

2.0 Age

Which one best applies to your Age? *Indicate by ticking against your preferred choice*

26-30 years	
31- 35 years	
Over 36 years	

3.0 Highest Academic Qualifications

Which one best applies to your qualifiation? *Indicate by ticking against your preferred choice*

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

Other (State which) .....

1. Do you have a problem in teaching vectors using simulation? YES/NO

2. How effective do you think simulations are in helping students understand vectors?

Tick where applicable

Bearing	Less bearing	No bearing

3. How often do you use simulations to teach vectors? *Tick where applicable*

1	2	3	4	5
Not use it	Slightly use it	Averagely	Frequently	Very frequently

4. Do you think you have enough time to teach vector topic using simulation?
(YES/NO)……

5. what percentage of the time per term do you use simulations to teach vector lessons? ……..%

ANNEXURE 3

QUESTIONNAIRE FOR ORDINARY LEVEL STUDENTS.

My name is Nyengerayi Liberty. I am a student at Bindura University of Science Education (BUSE), studying for a Bancellor of Sciences Degree and Honors in mathematics Education. I am currently working on a research project entitled: Exploring students and teachers perceptions in the teaching and learning of vectors using simulation: A case of Mahusvu Secondary School in Chikomba 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 (√) and by filling in the gaps provided.

Thank you in advance for your cooperation

1.1 Gender

Tick where applicable

Male
Female

2.0 Age

Tick where applicable

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

1. Do you think the topic on vectors will contribute much in the passing of mathematics?
   Tick where applicable

1	2	3
NO SIGNIFICANT	LESS SIGNIFICANT	SIGNIFICANT

2. Are the resources sufficient for you to do simulations?

   YES/NO……

3. Did you enjoy studying vectors using simulation?

   YES/NO……

5. Have you experienced any challenges while using simulations to learn vectors? (Yes/No)
   Tick where applicable

YES	NO

6. Have you used simulations to learn vectors before? (Yes/No)

YES	NO

Tick where applicable

ANNEXURE 4: PERMISSION TO CARRY OUT THE RESEARCH INSTRUMENT FROM CHIKOMBA DISTRICT OFFICE.