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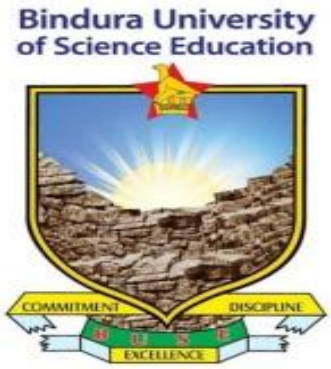

A COMPARISON OF PHYSICAL VISUAL AIDS AND INTERACTIVE TOOLS IN GEOMETRICAL TRANSFORMATION TEACHING AT ORDINARY LEVEL.A CASE STUDY OF MASHONALAND WEST PROVINCE.

BY

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REG NO. B225532B

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

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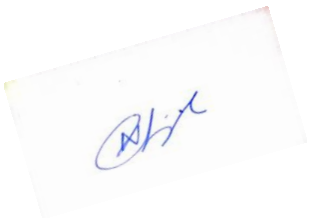

Signed: Date: 4 July 2024

(Student)

This research work was undertaken under the supervision of Dr. L. Mukavhi

Signed: Date:

DEDICATION

This research is dedicated to my son and daughter, who have been the light that kept me going and my family who gave me unconditional love and support throughout this course of study. I also dedicate this work to my lovely husband who has been my pillar of strength and my parents for their tireless efforts to make my studies complete.

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ABSTRACT

This study investigated the comparative effectiveness of physical visual aids and interactive tools in teaching geometrical transformations to Ordinary Level students. The study used a quasi-mixed method approach. A total of 46 students were randomly assigned to two groups: a physical visual aid group and an interactive tools group. The physical visual aids group used physical manipulatives such as shape sorters, mirrors, and geoboards, while the Interactive tools group engaged with interactive digital tools. The results revealed that students in the physical visual aids group outperformed their counterparts in the Interactive tools group in terms of understanding and applying geometrical transformations. Qualitative analysis of student interviews and written reflections indicated that the physical visual aids group developed a deeper understanding of spatial reasoning and problem-solving skills, as well as a greater confidence in their ability to apply transformation rules. The findings suggest that physical visual aids are more effective than interactive tools when teaching geometrical transformations at ordinary level. The tactile nature of physical manipulatives allows students to develop a deeper understanding of spatial relationships and geometric concepts, which is critical for success in mathematics education. The results have implications for mathematics education, highlighting the importance of incorporating physical visual aids in the teaching of geometrical transformations.

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CHAPTER 1

1.0 Introduction

Students' spatial reasoning and problem-solving skills are greatly enhanced by geometrical transformations, which entail altering the position, size, or shape of geometric forms. In addition to assisting students in manipulating and visualising shapes, understanding geometrical transformations lays the groundwork for more complex mathematical ideas in geometry and other subjects. Mukamba and Makamure (2020) defined geometrical transformations as mappings of geometric objects that preserve straight lines and incidence and thus formalise the notion of preservations of shape. To teach geometrical transformation, this study compared interactive tools and tangible visual aids. Visual aids are instructional items that portray information graphically and improve students' understanding of complicated concepts. Examples of these materials include charts, graphs, diagrams, movies, and props. According to Brown, Johnson, & Williams, E. (2019), visual aids heighten students' sensory perception, increasing the level of attention and interest in the learning process. Contrarily, teaching strategies encourage active student involvement in the learning process through group projects, debates, and practical work. Manandhar, Pant, and Dawadi (2022) stated, "Interactive tools promote deeper understanding and knowledge retention by encouraging students to actively engage with course materials and apply concepts in real-world contexts. The development of students' spatial reasoning and problem-solving abilities depends on their geometry instruction. Students must comprehend and be able to apply geometrical transformations, which include rotations, reflections, translations, and dilations, as fundamental ideas in geometry. This study was aimed to determine the optimal strategy for teaching geometrical transformations by evaluating the effects of these approaches on students' comprehension and memory of these ideas.

According to the ZIMSEC report of 2022, the component on geometrical transformation showed poor performance by the majority of the candidates. Question-by-question analysis showed that teachers and learners need attention to geometrical transformation in preparing for future examinations. The Cambridge of June 2022 also showed that the question of geometrical transformation was challenging for many

candidates. This study aimed to compare the effectiveness of two different teaching methods for geometrical transformation (using physical visual aids and using interactive tools).

1.1 Background of the study

An important part of teaching mathematics is assessing students' performance in geometrical transformations at the ordinary level, which was the subject of this study. Gol and Sinclair (2023) affirm that most students taking mathematics worldwide at the basic secondary level have difficulties need help understanding geometrical concepts. According to a study by Avcu and Cetinkaya (2021), learners have difficulties learning aspects linked to geometrical transformation. Mukumba (2020) claims that teachers have challenges in teaching geometrical transformation in a way that stimulates curiosity and motivation among learners. Although geometrical transformations are important in mathematics education, much research has yet to be done on students' performance in this domain. Using a comparison assessment to gauge students' comprehension and competency with geometric transformations, this study aimed to close this knowledge gap and offer insightful information on the potential and difficulties involved in teaching and learning geometrical transformations at the ordinary level. Thus, the study focused on the comparative assessment of Geometrical Transformation instructional strategies at the Ordinary level.

1.2 Statement of the problem statement of the Problem:

The student's performance on the topic could have improved even with the adoption of several instructional strategies. Despite efforts to apply various teaching methodologies, pupils needed help to reach the necessary levels of comprehension and skill in the particular subject area. González, Arnedo, and Sánchez (2022) found that incorporating interactive teaching methods, such as group discussions and hands-on activities, significantly improved students' engagement and understanding of the subject matter. Similarly, a study by Brown, Johnson and Williams(2019) highlighted the positive impact of visual aids, such as diagrams and charts, in enhancing students' retention and comprehension of complex concepts.

This research aimed to examine how well interactive teaching strategies and the incorporation of visual aids can improve student performance and learning outcomes when teaching geometric transformation. The

study aimed to find ways to enhance students' understanding, retention, and application of the material by analyzing the effects of several instructional strategies. Ultimately, the objective was to tackle education's difficulties and work toward improving academic results for every student.

1.3 Research Objective

1. To list the interactive resources and tangible visual aids used in Ordinary Level teaching of geometrical transformations, such as translations, rotations, reflections, and shear.

2. To assess how well geometrical transformations are taught at the Ordinary Level utilizing interactive technologies and tangible visual aids.

3. To identify the elements that makes a certain geometrical transformation teaching strategy effective.

1.4 Research questions

1. What instructional resources are utilized to teach geometrical transformations at the Ordinary level, such as translations, rotations, reflections, and shear?

2. How do interactive technologies and tangible visual aids compare when teaching and understanding geometric transformations?

3. Which one is considered adequate of the two geometrical transformation teaching approaches?

1.5 Significance of the study

This study was significant because it provided important new information about geometric transformations at the ordinary level in mathematics education. For several reasons, it is essential to comprehend how students perform when completing geometric transformations. The study's beneficiaries were teachers, students, policymakers, and the Ministry of Primary and Secondary Education (MOPSE).

1. Teachers:

The research findings gave teachers insight into the most efficient ways to teach geometrical transformations at the Ordinary level. By identifying and comparing various teaching styles, instructors could improve their lessons and increase student engagement. This enhanced the teaching experience for teachers by improving student results, raising student engagement, and improving comprehension of geometrical transformations.

2. Learners:

As a result of the research, educators provided more effective, engaging, and needs-based instruction. Students explored several approaches to learning geometrical transformations by comparing interactive teaching methods and visual aids, which improved understanding and retention. As a result, students' academic performance improved, their interest in the subject grew, and their learning process was more pleasurable.

3. Regulators:

Policymakers profited from the research findings because they offered evidence-based perspectives on efficient geometrical transformation instruction. Policymakers can decide on curriculum development and educational policies using knowledge of the best teaching practices for pupils. As a result, optimal approaches for teaching geometrical transformations were put into reality, raising educational standards.

4. Ministry of Primary and Secondary Education:

By applying the research findings to improve instructional strategies in schools, the Ministry of Primary and Secondary Education profited from the study. Understanding the elements that contributed to efficacy of various teaching techniques, the Ministry gave teachers materials and support to use these tactics in the classroom. As a result, the educational system became more practical, teacher satisfaction rose, and student outcomes improved.

1.6 Delimitations

The research project aimed to compare how St. Eric High School in the Mashonaland West Province taught geometrical transformations using interactive instruments against visual aids. The study did not cover other conventional teaching techniques; instead, it only looked at these particular techniques. Data from St. Eric High School was gathered. The study's focus was restricted to the opinions of instructors and students regarding these techniques' efficacy during a given period. This boundary allowed for a thorough analysis of the efficiency of instructional strategies for geometrical transformations in a particular educational setting and region, yielding insightful information while preserving clarity and focus.

1.7 Limitations

A small sample size, an inability to control external variables, self-report bias, time restrictions, resource limits, subjectivity in data collection, and ethical considerations were among the study's limitations on training approaches for geometrical transformations. These elements affected the study's validity, generalizability, dependability, and overall efficacy in comparing various approaches to teaching geometric transformations. By expanding the sample size, putting control measures in place for outside variables, using a variety of data sources, obtaining more funding, employing objective data collection techniques, enlisting the help of multiple observers, and abiding by ethical standards, the researcher was able to overcome the limitations in the study on geometrical transformation teaching methods. These tactics have several limitations that should be taken into account, but they can improve the study's quality, reliability, and validity.

1.8 Chapter summary

This chapter outlined the history of the study that motivated the researcher to conduct the investigation at St. Eric High School, the problem statement, and the purpose of the study. The researcher emphasized the value of conducting action research at St. Eric High School and identified several stakeholders who stand to gain from the study, such as curriculum planners who will be formulating policies, school heads who oversee

day-to-day operations, the Ministry of Education and math teachers who are directly involved in the teaching and learning process because they constantly engage with students, as the person in charge of all department personnel, the HOD can create departmental regulations and requirements based on input from parents, students, and researchers. Research topics and study objectives were displayed. The study's assumptions, significance, limits, delimitations, and definitions of important words were also provided. The following chapter provided a thorough analysis of relevant research on the subject of comparing interactive tools and tangible visual aids in the context of teaching geometric transformations at the general education level in order to determine which approach is superior.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter offered a thorough analysis of the body of research on the subject, stressing the most important discoveries, knowledge gaps, and ongoing discussions regarding the comparative evaluation of geometrical transformation teaching methods at the ordinary level. In order to identify opportunities for future research, this literature review aims to critically analyze the current state of knowledge about the Comparative Evaluation of Geometrical Transformation Teaching Methods at the Ordinary level. By consolidating the results of earlier studies and pinpointing areas in which more investigation is required, this literature review seeks to fill these gaps. Along with looking at methodology and theoretical frameworks from earlier research, the study will also look at best practices and opportunities for development.

2.2 Literature Review:

Studies have examined students' performance in geometrical transformations and identified critical factors influencing their understanding of this topic. Geometrical transformations are an essential part of mathematics education because they help students develop spatial reasoning skills and an understanding of the properties of shapes. Here are potential literature review comparing physical visual aids and interactive tools in geometrical transformation teaching at the ordinary level. This literature review aimed to summarize the existing research on using physical visual aids and interactive tools in teaching geometrical transformation at the ordinary level.

According to Okeke (2013), visual aids are any visible materials or equipment employed while teaching to aid learning. Devries (2017) explains that visual aids such as pictures and photographs facilitate learning by supplementing the teacher's verbal information. Graphs, charts, diagrams, and models are tangible materials used to teach mathematical concepts. These are referred to as physical visual aids. Students can use these tools to see and comprehend complex geometric transformations.

Research has shown that physical visual aids can effectively improve students' understanding of geometrical transformation Mayer. (2019). For example, a study by Wang and Zhang (2013) found that students who

used physical visual aids to learn about rotations and reflections showed significant improvement in their problem-solving skills compared to those who did not use these aids. According to Freudenthal (2023), visual learning is a powerful tool that involves skills such as observation, recognition, interpretation, perception, and self-expression. These skills allow the learner to see and examine something and then visually recall and interpret information, leading to comprehension and understanding of mathematical concepts Freudenthal, (2023). Similarly, Žakelj and Klančar (2022) reiterated that visual tools allow learners to analyze concepts, make conjectures and convey ideas to others (externalization of ideas). These visualization-related characteristics demonstrate how learners' attention can be quickly captured and piqued, which allows for increased learning engagement.

This underlied a well-founded theoretical underpinning that pictures, images and other visible aids promote better understanding to students than words alone (Mayer, 2019). Over generations, teachers have used different kinds of visual aids to enable meaningful learning. Some new forms constantly emerge due to improvements in educational science and technology (Krukru, 2015). All the ideas about visualization are confirmed by Edgar Dale's (1969) theory, which theorized that people understand 20% of what they hear, 50% of what they see and hear and 90% of what they do as a task. Therefore, using visual aids in the classroom helps students understand mathematical ideas by giving them concise explanations and illustrations. However, since most teachers train pupils to memorize and recall facts rather than effectively grasp concepts, the use of visual aids is essential.

One study by Smith et al. (2015) examined the impact of hands-on activities on students' ability to visualize and apply geometrical transformations. The researchers found that hands-on activities significantly improved students' spatial reasoning skills and understanding of transformational geometry.

Computer simulations, online games, and interactive whiteboards are a few examples of digital resources referred to as interactive tools that afford students an engaging and dynamic approach to interact with mathematical topics. Research has shown that interactive tools can effectively enhance students' understanding of geometrical transformation. Mayer, (2019) found that students who used an interactive

computer simulation to learn about geometric transformations showed significant improvement in their spatial reasoning skills compared to those who did not.

Although teaching geometrical transformation can be achieved with physical visual aids and interactive technologies, there is limited research comparing the effectiveness of these two approaches.

However, few studies have examined the distinctions between interactive gadgets and tangible visual aids. For example, a study by Wang and Zhang (2013) found that students who used interactive tools showed higher levels of engagement and motivation compared to those who used physical visual aids. On the other hand, a study by Yang and Chen (2015) found that students who used physical visual aids showed a better understanding of complex geometric transformations than those who used interactive tools.

Another study by Jones and Brown (2018) investigated the role of problem-solving tasks in promoting students' critical thinking and problem-solving abilities in geometrical transformations. Researchers discovered that the best way to improve students' comprehension of the subject was to give them problem-solving exercises that needed them to use transformative principles in practical settings.

Additionally, a meta-analysis by Žakelj (2022)analyzed the effectiveness of different teaching methods in promoting students' learning in transformational geometry. The researchers found that combining hands-on activities, problem-solving tasks, and collaborative learning strategies was most effective in improving students' performance in geometrical transformations.

Johns & Brown (2018) argue that poor performance in mathematics is a global phenomenon. Research has shown that even in the United States, principals and teachers complain about poor performance in mathematics, particularly in geometrical transformation by the learners.González et al (2022)argues that issues central to improving mathematics teaching and learning are those of equity, the content of textbooks and graduate education.

The research indicates that improving students' comprehension of transformational geometry requires a multimodal approach to teaching geometrical transformations, including practical exercises, problem-solving exercises, and cooperative learning techniques.

2.3Conceptual framework

The conceptual framework of this study revolved around the triad of teaching instruction. Education is a multifaceted, dynamic process with many interrelated parts. Curriculum, instruction, and assessment are vital trinities that influence the creation of successful teaching and learning environments. The purpose of this study was to compare the two approaches of teaching geometrical building utilizing interactive tools and physical visual aids using the triad of teaching instruction. (Figure1).

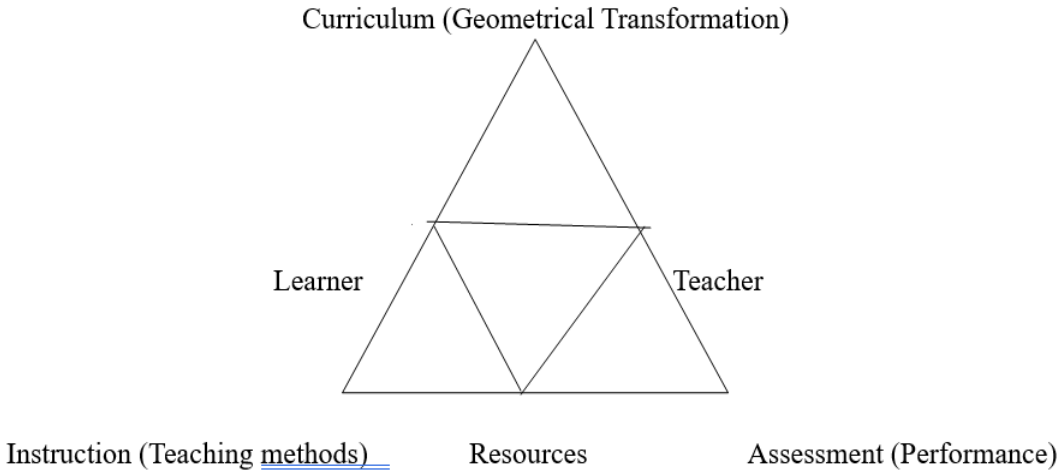

Figure 2. 1: Triad of Teaching Instructions

The basis for both teaching and learning is the curriculum included all of the knowledge, abilities, and content that students should learn which, in this case, is the geometric transformation. The researcher used the curriculum to create learning objectives, choose resources, and arrange classes.

The gap between student knowledge and the curriculum is closed by effective instruction. It includes instructional techniques, classroom procedures, and pedagogical strategies. By placing a strong emphasis on pertinent knowledge and abilities, effective teaching gets students ready for exams.

Assessment is used to evaluate students' progress, inform instruction, and guarantee accountability, among other things. Assessment results indicate areas of strength and weakness, which lead to curricular modifications.

2.4 Theoretical framework

Mukamba (2020) defines a theoretical framework as a collection of theories, concepts, ideas, and assumptions that provide a conceptual framework for understanding a research problem. It provided a framework for a study, directing the formulation of research questions, hypotheses, techniques for gathering data, and procedures for analyzing that data. Using theoretical frameworks, researchers could better organize their ideas and concentrate their efforts on particular subjects and the relationships between variables. It aided in giving the study's justification and directing how the findings are interpreted. A study by Žakelj (2022) highlights the effectiveness of visual aids and interactive teaching in geometry. Incorporating digital resources and promoting visualization can enhance student learning outcome. This study aimed to investigate how interactive instruction and visual aids affect geometry learning at the ordinary education level.

2.5 Chapter Summary

Various authors had different perspectives on comparing the use of physical visual aids and interactive tools for teaching geometrical transformation at the 'O' level. There were specific differences arising from students, authors, and researchers. In the upcoming chapter, the researcher concentrated on the research methodology.

CHAPTER 3: Methodology

3.0 Introduction

This chapter outlined the research methodology, detailing the approaches and processes that were utilized to compare the effectiveness of physical visual aids and participative tools in teaching geometrical transformation at St Eric High School. It delineated the planned data collection methods, encompassing research design, research instruments used for gathering information from participants, action research, action plan, target population, and the delineation of geographical, conceptual, and temporal boundaries to define the research scope. The methodology also specified the utilization of pre-tests, post-tests, questionnaires, and interviews.

3.1 Research Methodology:

The methodical process of gathering, evaluating, and interpreting data to address a research topic or test a hypothesis is known as research methodology. It entailed the methodical planning, organizing, and carrying out research operations to meet study objectives. Research methodology also included selecting appropriate data collection methods, sampling techniques, and data analysis procedures to ensure the validity and reliability of the research findings. Brown (2019) .

3.3.1 A Quasi-mixed method

A mixed methods approach combining both qualitative and quantitative research techniques was used in this study. Using both quantitative and qualitative data (numerical and narrative) achieved the collection and analysis data to provide a more thorough and nuanced picture of a study problem. White and Sabarwal (2019) outlined that the researcher selects the sample of subjects, determines the treatment, decides which groups to receive the treatment, controls variables other than the treatment, and ultimately assesses the effect of the treatment on the groups. Hence, the two classes (A and B) of learners were selected, and the participants wrote the same pre-test and then achievement test (post-test) after being taught the same topic using different methods. In this study, the researcher prefers a teacher-made achievement post-test to other types of tests because it reflects instruction and curriculum, is sensitive to learners' abilities and needs,

provides immediate feedback about learners' progress, and can reflect minor changes in knowledge O'Malley (2020). As a result, the items on the teacher-made accomplishment examination were created using the curriculum's "O" level mathematics lesson and learning objectives as a guide. This tool's objective was to offer an achievement measurement. The two groups' post-test findings determined whether the dissonance and outcome would be related to the treatment.

The Researcher used qualitative interviews, focus groups, or content analysis in addition to quantitative surveys, experiments, or observational data in the design of a quasi-mixed method. A more comprehensive comparison of the two teaching approaches was possible by including both data sets.

Additionally, questionnaires, interviews, and pre and post test were used in this study with both students and teachers.

3.3Methodology research design

The overall research project or program plan is called the research design. It laid out the main points of the work to be done, the methods for gathering and analysing data, how the research strategy addressed the particular study objectives, and whether the research issues are theoretical or policy-oriented.

3.4Research Instruments

Mukumba (2020) defined research instruments as tools used to collect or gather information. These are the methods or materials that the researcher needs to gather, store, and process the data that will be important for the investigation. This comprises analysis-ready papers, interviews, and questionnaires.

A questionnaire is characterised as a series of written or printed questions with multiple choice responses created for a statistical study or survey or as a list of survey questions sent to respondents to gather particular data. For this study, questionnaires were perfect since they let the researcher gather much information from many respondents, teachers in the school system. Because respondents completed the questionnaires on their schedule, their responses were more accurate.

The questionnaires comprise both open and closed-ended questions. The questionnaires were administered to 46 learners and 6 St. Eric High School teachers. An interview is a two-way dialogue or exchange of ideas where both parties have the same objectives, or it can be a face-to-face meeting, particularly for consultation. Interviews are appropriate for the study because they allow the interviewer to ask the interviewee any question, allowing for sufficient data collection. All mathematics teachers and form four students were interviewed for this project. The target population and the study's goal are considered when selecting the interview subjects. The information acquired was utilized to make inferences and suggestions regarding the learners' subpar geometrical transformation performance. There are open-ended questions in the interview guide. Questions were developed based on the study goals were served as the basis for the instruments. Two distinct interview guides one for the teachers and another for the form four students were utilized.

Gol (2023) explains that a document study is an analysis of any written material that contains information about the phenomenon being studied. Avcu (2021) says that document study allows the researcher to access the and document study physically has little or no reactivity from the respondents, particularly when the document under study was written for some particular purpose.

3.5Target population

Any collection of people who share one or more traits the researcher is interested in is referred to as a population. In the two standard O-level classes at St. Eric High, the head of the mathematics department and all mathematics teachers comprised of the study's population. Since the head of the department oversees all activities related to teaching mathematics, he was included in the research. The department head also gave details on their collaboration with math teachers.

The math teachers are the main people responsible for the mathematics topic program. Any changes in how mathematics is taught and learned must be accommodated and adopted by them.

Learners: The actual teaching and learning experience in the classroom has a direct positive impact on learners. They are the ones who are exposed to various teaching modalities regularly.

3.6Sampleand sampling techniques

Using stratified random sampling, according to the school population 55% are boys and 45% are girls, so the researcher calculated the number of students to be used using the proportion.46 secondary school students were chosen as a sample for this study, 25 boys and 21 girls, comparing the use of interactive tools and physical visual aids in geometrical transformation instruction at the Ordinary Level. This sampling strategy was considering variables like gender, age, and academic standing to guarantee that the sample is representative of the population. Data on the efficiency of tangible visual aids and interactive technologies in teaching geometrical transformations was gathered using the chosen sample strategies, which include simple random sampling, systematic sampling, convenience sampling, and quota sampling. The results of this study helped in comprehending how these instructional strategies affect students' learning outcomes at the Ordinary Level.

3.7Data Presentation:

In order to gauge a sample of high school students' comprehension of geometrical transformations before and after a series of instruction sessions, the research involved giving them pre-and post-tests. The information gathered comprised of test results for the students and any extra data seen during the teaching sessions, such as engagement and behaviour patterns.

3.8 Data Analysis:

The Number Crunching Statistical System was utilized to examine the gathered data and evaluate how well the education sessions have improved the geometrical transformation skills of the pupils. The pupils' test results were compiled using descriptive statistics, which was also, be utilized to find trends in their answers. The investigator intends to employ the Number Crunching Statistical System (NCSS), 2024 software. This software, which has an intuitive interface and a wealth of data analysis and visualization features, is made

specifically for teaching and learning statistical approaches. The researcher planned to do a hypothesis test to compare the two instructional approaches.

3.9Validity and reliability ethical considerations

For the research to produce accurate and reliable results, validity and dependability are essential components. Assuring the construct validity of the measures employed, considering the findings' external validity, and resolving risks to the study's internal validity was the researchers' main priorities. Measures were taken to guarantee that the instruments employed accurately assess the efficacy of interactive tools and physical visual aids in teaching geometrical transformations to maintain the research's validity. A pilot study was conducted by the researcher, who also gave some instruments to a few depressed people.

The researcher conducted the study with transparency, honesty, and integrity, according to ethical norms, and promotes the rights and well-being of study participants, guided by ethical considerations linked to validity and reliability. The researcher respected the participants. Before beginning the research, the investigator secured consent from pertinent authorities or individuals.

3.10 Chapter Summary

This chapter focused on the research methodology of the study, outlining how the research was conducted. It presented the research design, which outlined the plan of action for conducting the research program, as well as the research instruments to be used to collect data, including a questionnaire, interviews with learners and teachers. The chapter also detailed the structure of the questionnaire and targeted population. Additionally, it explained the nature of the interviews and target group, highlighting the specific documents that were analyzed in this research project. This chapter also described the use of action research and the steps followed in carrying out the research. In this chapter, the target population was discussed and the instruments used to collect data were identified. The subsequent chapter focused on data presentation, analysis, and interpretation. The chapter described how data was analyzed and presented results of findings

from data collected in the previous chapter through tables and graphs, as well as how data was analyzed and interpretations drawn from the results to inform conclusions and recommendations.

CHAPTER 4: Data Presentations, Analysis and Interpretation

4.1 Introduction

This chapter discussed the data gathered using methods and techniques highlighted in the previous chapter. To address the research questions, the Researcher offered the data gathered from the study in this chapter and analysed the findings. By comparing the pre-and post-test results, the Researcher specifically looked at how each instructional strategy affected St. Eric High School students' comprehension of geometrical transformations. Additionally, the researcher lookedat how well students apply geometrical transformations utilising interactive technologies or tangible visual aids in relation to their past knowledge. A descriptive analysis of the findings, including means, standard deviations, and frequencies, were included in the data presentation. Inferential statistics was used to compare the difference between the group means. Finally, The Researcher discussed the findings' significance for teaching geometrical transformations in educational contexts in light of the research questions and theoretical framework. The researcher intended to provide a thorough knowledge of the usefulness of tangible visual aids and interactive tools in teaching geometrical transformations and guidance for teaching practices in mathematics education through the presentation and analysis of the data in this chapter.

4.2 Demographic Profile of Participants

Table 4. 1: Demographic Profile of Participants

Participants	Sex	Teaching Experience	Qualifications	Marital Status
Teacher 1	Male	26years	Bachelor of education	Married
Teacher 2	Male	32years	Diploma of education	Married
Teacher 3	Female	18years	Bachelor of education	Married
Teacher 4	Female	21years	Bachelor of education	Married
Teacher 5	Female	14years	Bachelor of education	Married
Teacher 6	Female	7years	Bachelor of education	Married

Source: Own construct (2024)

Table 4:1shows that 1(17%) possessed a diploma in education and 5(83%) of the participants possessed a bachelor in education. Because of their educational background, all teachers can demonstrate that they are knowledgeable enough about the subject to potentially avoid difficulties when instructing students in geometric transformation.

Responses to the question:

4.3 What instructional resources are utilised to teach geometrical transformations at the Ordinary level, such as translations, rotations, reflections, and shear?

Table4. 2: Responses from teachers on the methods they used to teach geometrical transformation

Teaching instruction	Number of teachers
Physical visual aids(graph paper and geo boards)	1
Interactive tools(khan academy geometry and GeoGebra)	2
Online resources	1
Textbooks	6

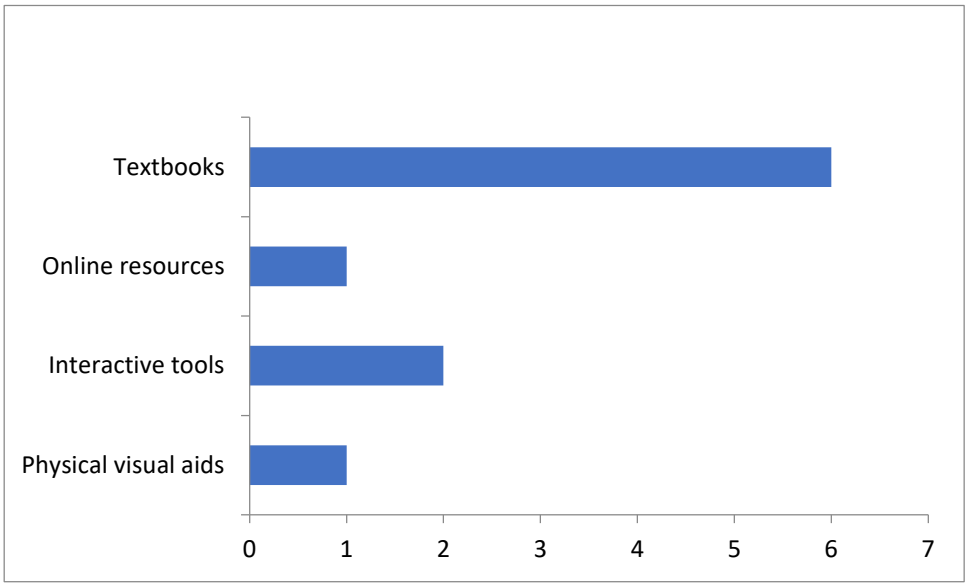

Figure 4. 1: Responses of teaching methods used by teachers

Figure 1 shows that more teachers used textbooks alone when teaching geometrical transformation. All six teachers said they used textbooks to teach geometrical transformations. One Teacher used physical manipulative, such as geometric shapes cut out of cardboard, to help students visualise and understand the

transformations, and two teachers used interactive tools to teach geometrical transformation. Only Teacher 4 said she used online resources and examples to illustrate the importance of geometrical transformations, such as in architecture or engineering.25 learners were taught using physical visual aids, whilst the other 21 were taught using interactive tools. During their free time, learners said they used other online resources like Khan Academy and GeoGebra to learn about geometric transformations. They also worked on problems and exercises from textbooks to practice and reinforce their understanding. Most learners learned geometrical transformations through lectures, online resources, and group activities.

Responses:

4.4 How do interactive tools and tangible visual aids compare when teaching and understanding geometric transformations?

Table 4. 3: Learners performance in pre-test

Learners scores (out of 20)	0-4	5-9	10-14	15-19	20	Mean Mark	Total
Frequency Class A	18(72%)	5(20%)	2(8%)	0(0%)	0(0%)	3.8(19%)	25
Frequency Class B	14(66.7%)	6(28.6%)	1(4.76%)	0(0%)	0(0%)	3.90(19.5%)	21

4.4.1 Analysis of the Pre-Test

Learners in both classes A and B wrote a 30-minute pre-test to ascertain their level of understanding before treatment. The pre-test was marked out of 20. The scores obtained by learners in the pre-test for classes A and B were examined and compared in Table 4:3. This suggested that Class A has more students who performed poorly or just above average. Class B had a higher frequency of students with scores in the range of 10-14 (8% vs. 4.76%), indicating that more students in Class B performed relatively well. The mean mark is lower in both classes, indicating that the overall performance is below average. This entailed that the

treatment (post-test) was applied to students who were at the same level of understanding of Geometry, which is likely to enhance the validity of the results.

Table 4. 4: Learners performance in post-test

Learners' scores (out of 20)	Frequency and Percentage	
	Class A(Physical Visual Aids)	Class B (Interactive tools)
0-4	0(0%)	1(4.76%)
5-9	3(12%)	5(23.8%)
10-14	10(40%)	10(47.6%)
15-19	10(40%)	4(19.04%)
20	2(8%)	1(4.76%)
Total(N)	25	21
Mean Mark	14.04(70.2%)	11.7(58%)

4.4.2 Analysis of the post-test

Table 4:4 showed the post-test scores of the learners in both classes A and B. Physical visual aids were used to teach geometry to class A whilst class B was taught the same topic using the interactive tools. Both classes have a similar distribution of scores, with most students scoring between 10-14 and 15-19.The scores of two classes, A (Physical Visual Aids) and B (Interactive tools), were compared, with Class A having a higher mean score (14.04, 70.2%) and a more even distribution of scores. Class B had a lower mean score (11.7, 58%) and a more skewed distribution, with more learners scoring between 10-14. The results suggested that Class A may be more effective in terms of teaching and learning, but further analysis is needed to determine the specific reasons for the differences between the two classes.

Table 4. 5: Analysis of Pre and Post -test

	Number of participants	Pre-test mean	Post-test mean	Difference /increase	Method used for the post-test
Class A	25	3.8	14.04	269.5%	Physical visual aids
Class B	21	3.9	11.7	200%	Interactive tools

4.4.3 Analysis of pre and post-test results

The difference between the pre and post-test scores for both classes showed that both methods positively affected the learners' understanding of the topic, as shown in Table 3. Table 4 tests the difference between the post-test means of the two classes, A and B. H_0: $\mu 1 = \mu 2$ where H_0 was the Null hypothesis, and H1: $\mu 1 \neq \mu 2$ were H1 was the alternative hypothesis. Since the critical t-value = 2.021< 2.24 that is the calculated t value, we rejected H_0 and concluded that there is no sufficient evidence at a 95% confidence interval to claim that class A mean ($\mu 1$) is equal to class B mean ($\mu 2$). Hence, testing at the 5% significance level, the t-test results confirmed a significant difference between the two means. The difference could be ascribed to the teaching methods used to teach the topic. Thus, physical visual aids seemed to positively impact learners' performance in the post-test more than the interactive tools. This suggested that the observed difference is unlikely due to chance alone. Therefore, the researcher concluded that Physical Visual Aids in Class A have a statistically significant positive effect on learner performance compared to using Interactive tools in Class B.

From the interviews, 43.48% of the learnersfound interactive tools helpful for learning about geometrical transformations. It allowed them to visualise and interact with the concepts in a way that was easy to understand. A few teachers expressed those interactive technologies can effectively teach geometric transformations, providing a dynamic and engaging way for students to explore and understand the concepts. For example, GeoGebra allows students to create and manipulate their geometric shapes, which can help them develop a deeper understanding of the transformations. Some of the pupils' responses resonate with

Hohenwarter and Preiner's (2017) view that GeoGebra is a flexible mathematics tool that enhances the visualisation of mathematical concepts. Thus, the software gives learners a vivid view of simple and complex mathematical constructions (Hohenwarter&Preiner, 2017).

Most teachers said that tangible visual aids like manipulatives can be very effective in helping students understand the concrete aspects of geometric transformations. For example, using a physical shape to demonstrate a transformation can help students see the relationship between the original and transformed shapes. Also, 56.52% of the learners highlighted that physical visual tools were more effective.

Teachers and learners respond when answering the question:

4.5 Which of the two geometrical transformation teaching approaches is considered adequate?

Teacher 2, being the most experienced teacher at St Eric High in the mathematics department, said,

> *In my experience, combining both approaches can be very effective. For example, I might use GeoGebra to introduce a concept and then have students work with manipulatives to apply the idea.*

Most teachers said a blended approach combining digital tools with hands-on activities is often the most effective way to teach geometrical transformations. This approach allows students to engage with the material differently and can help them develop a deeper understanding of the concepts.

Teachers 5 and 6 indicated that by combining digital tools with hands-on activities, students can explore and understand the abstract concepts of geometric transformations while developing their problem-solving skills through hands-on activities. Teachers 2, 4, and 6 highlighted that a blended approach can help cater to different learning styles and abilities, as some students may prefer digital tools while others may prefer hands-on activities.

Table 4. 6: Learners responses on the most adequate method when teaching geometrical transformation

The most adequate Teaching method	Number of responses	Percentage
Physical visual aids	26 out of 46	56.52%
Interactive tools	20 out of 46	43.48%

The data collected showed that 56.52 % of the learners indicated that physical visual aids are the most effective method when teaching geometrical transformation.

One learner said that,

I think it would be helpful for educators to use visual aids like graphs and diagrams when teaching geometric transformations. This can help students visualise the concepts better.

43.48 % of the learners said that using interactive tools, like GeoGebra, can be an excellent way for students to practice their understanding of geometric transformations and provide opportunities to work on problems. Exercise can help them develop their spatial reasoning skills.

4.6 Chapter summary

In the chapter the researcher presented findings in tabular form and this helped to interpret or enhance better understanding of the findings. The findings were discussed in line with research questions. The researcher gave reasons for some of the findings and reasons that may have contributed to the results of the findings. The next chapter gave summary of the whole project, conclusions and recommendations to all the concerned parties such as the parents, learners, teachers and the ministry of Primary and Secondary Education.

CHAPTER 5: SUMMARY, CONCLUSSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focused on summary, conclusions and recommendations. The chapter gave an overview of the whole project, and the researcher looked into all the chapters of the research.

5.2 Summary

Chapter 1 laid out the background of the study that led to the statement of the problem and purpose, whereby the researcher highlighted the importance of carrying out action research at St Eric High School. Study objectives and research questions were shown, and assumptions, significance of the study, limitations of the study, delimitations, and definition of key terms were also given.

To solve the problem, the next chapter provided, a thorough analysis of the literature on teaching geometrical transformational transformation using interactive tools and tangible visual aids. It also connected the current research project and the literature to pinpoint any gaps that needed to be filled. Its main objective was to review relevant material and present scholarly opinions on linked subjects. This aided in contextualizing the issue under study. This chapter examined some research conducted on the subject by other academics. It included details on connected concerns that have been addressed and research outcomes.

Chapter 3 focused on research methodology that showed the means and procedures applied to investigate the study comparing the physical visual aids and interactive tools to teach geometrical transformation at St Eric High School in 2024. It covered the research design and research instruments which the researcher used to gather information from participants. Action research, action plan, target population, and geographical, conceptual and temporal delimitations were shown. Pre-test and post-test questionnaires and interviews were employed. Data analysis was the platform for data analysis, and tables were used in this research.

Chapter four focused on data presentation, analysis and presentation.

5.3 Conclusion

Conclusions were drawn based on the findings of the study. Hence, a hypothesis test was performed on the pre-test, and a post-test given. Testing the difference between the two means, testing at the 5% significance level, the t-test results confirm a significant difference between the two means. The difference could be ascribed to the teaching methods used to teach the topic. Thus, physical visual aids seemed to have a more significant positive impact on learners' performance in the post-test than the interactive tools. This suggests that the observed difference is unlikely due to chance alone. Therefore, we can conclude that Physical Visual Aids in Class A have a statistically significant positive effect on learner performance compared to using Interactive tools in Class B.

The interviews and questionnaires given to teachers show that teachers mainly use books when teaching geometrical transformation.

5.4 RECOMMENDATIONS

From the findings derived from this research, the author provided the following recommendations based on the research findings and conclusions of this study, and several recommendations are made on all stakeholders involved in the research to try to improve learners' performance on geometrical transformation in the future.

Teachers should priorities physical visual aids in their teaching practices, as they have shown the highest favours among learners. This is because physical visual aids are more tangible and hands-on, allowing learners to engage with them in a more immersive and interactive way.

Learners are recommended to take an active role in suggesting and selecting physical visual aids that cater for individual learning styles and needs. This can help to increase learner engagement and motivation and ultimately lead to better learning outcomes.

Regulators can consider the following recommendations: curriculum guidelines, teacher training, resource allocation, assessment and evaluation, monitoring and evaluation and policy development. By implementing these recommendations, regulators can promote the effective use of physical visual aids and interactive tools in education, improving learner engagement, motivation, and achievement.

Ministry of Primary and Secondary Education should consider incorporating more physical visual aids into the curriculum and providing resources for teachers to develop their skills in using these skills effectively. This could include funding for teachers or training sessions on using physical visual aids or providing access to online resources.

Additionally, cooperating technology-based interactive tools can enhance the learning experience. Still, balancing physical and digital tools is crucial to ensure learners receive a comprehensive education.

5.5. Summary

The chapter discussed significant findings from the research. The discussions on major findings were highlighted, and conclusions were drawn from these findings. The researcher makes several recommendations from various stakeholders, including the Ministry of Primary and Secondary Education, the heads of the school, the teachers, the learners, the regulators, and the researcher.

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APPENDICES

Appendix 1

QUESTIONNAIRE INSTRUMENT FOR THE LEARNERS

Thank you for participating in this study. My name is Chinyika Nyengeterai H. I am a student in the faculty of Science Education at Bindura University of Science Education pursuing bachelors' degree in mathematics. I am carrying out a study on the comparison of physical visual tools and interactive tools in teaching geometrical Transformation at O level at St Eric High School, Chegutu District .Your responses will help us understand how teachers and educators utilize instructional resources to teach geometrical transformations at the Ordinary level. Please answer the questions honestly and to the best of your ability**.**

- The data gathered will be used solely for the purpose of study.
- Your responses are highly confidential and would be treated with confidentiality
- Please do not write your name on this questionnaire
- Where options are given please tick ☐ the appropriate response and write your opinion where spaced are provided.

1. Gender

☐ Male ☐ female

Section 1: Instructional Resources

1. What instructional resources do you use to learn geometrical transformations at Ordinary level? (Select all that apply)

	Online sources

	Hands-on activities
	Physical Visual aids
	Software or apps
	Textbooks
	Online simulations
	Podcasts
	Video tutorials

Other (please specify)

_____

2. How would you rate the effectiveness of the following resources in teaching geometrical transformations?

(Scale: Good, Very Good, Excellent, Bad)

	Good	Very Good	Excellent	Bad
Textbooks				
Online resources				
Hands-on activities				

Visual aids				
Manipulative or physical models				
Online simulations				
Video tutorial				
Podcast				

Section 2:

Interactive Tools and Physical Visual Aids

1. How would you rate your experience with interactive tools in learning geometrical transformations? (Scale: Good, Very Good, Excellent, Bad)

Good	Very Good	Excellent	Bad

2. How would you rate your experience with physical visual aids in learning geometrical transformations? (Scale: Good, Very Good, Excellent, Bad)

Good	Very Good	Excellent	Bad

3. Which one do you find more effective in the teaching and understanding of geometric transformations?

Physical Visual Aids	
Interactive tools	
Both	

Section 3:

Teaching Approaches

. Which one of the two teaching approaches do you find more adequate in teaching geometrical transformations?

Physical Visual Aids	
Interactive tools	
Both	

Thank you for taking the time to complete this questionnaire!

APPENDIX 2

QUESTIONNAIRE INSTRUMENT FOR THE TEACHERS.

Thank you for participating in this study. My name is Chinyika Nyengeterai H. I am student in the faculty of Science Education at Bindura University of Science Education pursuing bachelors' degree in mathematics. I am carrying out a study on the comparison of physical visual tools and interactive tools in teaching geometrical Transformation at O level at St Eric High School, Chegutu District .Your responses will help us understand how teachers and educators utilize instructional resources to teach geometrical transformations at the Ordinary level. Please answer the questions honestly and to the best of your ability.

- The data gathered will be used solely for the purpose of study.
- Your responses are highly confidential and would be treated with confidentiality
- Please do not write your name on this questionnaire
- Where options are given please tick ☐ the appropriate response and write your opinion where spaced are provided.

1. Gender

☐ male ☐ female

2. Professional Qualifications

☐ C.E in Education ☐ Diploma in Education

☐ Bachelor of Education ☐ Others

3. Teaching Experience

☐ Below 2 years ☐ 2-5 years

☐

6-10 years ☐ 11th and above

Section 1: Instructional Resources

1. What instructional resources do you typically utilize to teach geometrical transformations at the Ordinary level? (Choose one or more)

	Online sources
	Hands-on activities
	Physical Visual aids
	Software or apps
	Textbooks
	Online simulations
	Podcasts
	Video tutorials

Other (please specify) _____

2. How often do you use each of the above resources to teach geometrical transformations?

	Always	Frequently	Rarely	Never

	Online sources				
	Hands-on activities				
	Physical Visual aids				
	Software or apps				
	Textbooks				
	Online simulations				
	Podcasts				
	Video tutorials				

Section 2: Interactive Tools and Tangible Visual Aids

1. How effective do you find interactive tools (e.g., GeoGebra, Geometer's Sketchpad) in teaching and understanding geometric transformations?

Good	Very good	Excellent	Bad

2. How effective do you find tangible visual aids (e.g., blocks, pattern blocks, geoboards) in teaching and understanding geometric transformations?

Good	Very good	Excellent	Bad

3. Do you find that interactive technologies and tangible visual aids complement each other in teaching geometric transformations? If yes, how? If no, why not?

_____

_____

_____

_____

Section 3: Teaching Approaches

1. Which teaching approach do you consider adequate for teaching geometric transformations at the Ordinary level?

Physical Visual Aids	
Interactive tools	
Combination of both	

Other (please specify) _____

2. What factors influence your decision when choosing between these two approaches?

Is there anything else you would like to share about your experience teaching geometrical transformations at the Ordinary level?

APPENDIX 3

Interview guide for learners

1. What types of teaching methods have you used to learn about geometrical transformations? For example, did you use textbooks, online resources, or hands-on activities?

2. Can you describe any specific teaching resources that you found helpful or memorable? (e.g.,software, manipulatives, etc.)

3. Have you ever used digital tools or online simulations to learn about geometrical transformations? If so, what were your favourite features or tools?

4. Can you explain how you think about and understand geometrical transformations? Do you have any favourite examples or real-world applications that helped you understand the concept better?

5. How do you think geometrical transformations are relevant to your everyday life or future career? Can you give an example of a time when you used or applied what you learned about geometrical transformations?

6. What do you think were the most challenging parts of learning about geometrical transformations? Were there any specific concepts or topics that gave you trouble?

APPENDIX 4

Interview questions for teachers

Question 1:

Can you describe your current approach to teaching geometrical transformations at Ordinary level? What resources do you typically use?

Question 2:

How do you think interactive technologies (e.g., digital tools) compare to tangible visual aids (e.g., manipulatives) in terms of teaching and understanding geometric transformations? Can you give an example of a time when you used both approaches?

Question 3:

What do you think is the most effective way to teach geometrical transformations at Ordinary level? Do you think a blended approach (combining digital tools with hands-on activities) would be more effective? Why or why not?

Question 4:

Can you describe any challenges you face when teaching geometrical transformations at Ordinary level? How do you think technology could help address these challenges?

Question 5:

How do you assess student understanding of geometric transformations? Do you use any specific assessment tools or strategies?

APPENDIX 5

PRE – TEST /POST TEST

1.Draw triangle ABC, A(2,3) ,B(2,1) ,and C(4,1).

2. A triangle ABC must go under enlargement using centre (0; 0)

ai) Find the coordinates of its enlargement A1B1C1 scale factor 2.

ii) Draw triangle A1 B1 C1.

bi) Find the coordinates of the Enlargement of triangle ABC scale factor ½ to give

A2 B2 C2.

ii) Draw triangle A2B2C2

C i) Find the coordinates of the enlargement of triangle ABC scale factor -1/2 to give A3B3C3.

ii) Draw triangle A3B3C3

iii) What happens to the enlargement image when the scale factor is negative?

THE END

APPENDIX 6

Raw marks for class A

(Taught using physical visual aids)

	Pre test	Post test
A	1	7
B	0	13
C	0	10
D	0	12
E	0	10
F	2	13
G	4	10
H	1	18
I	1	9
J	7	20
K	10	17
L	1	19
M	3	10
N	4	17
O	1	18

P	1	13
Q	7	19
R	0	14
S	1	19
T	4	16
U	7	17
V	8	17
W	1	7
X	5	20
Y	10	13

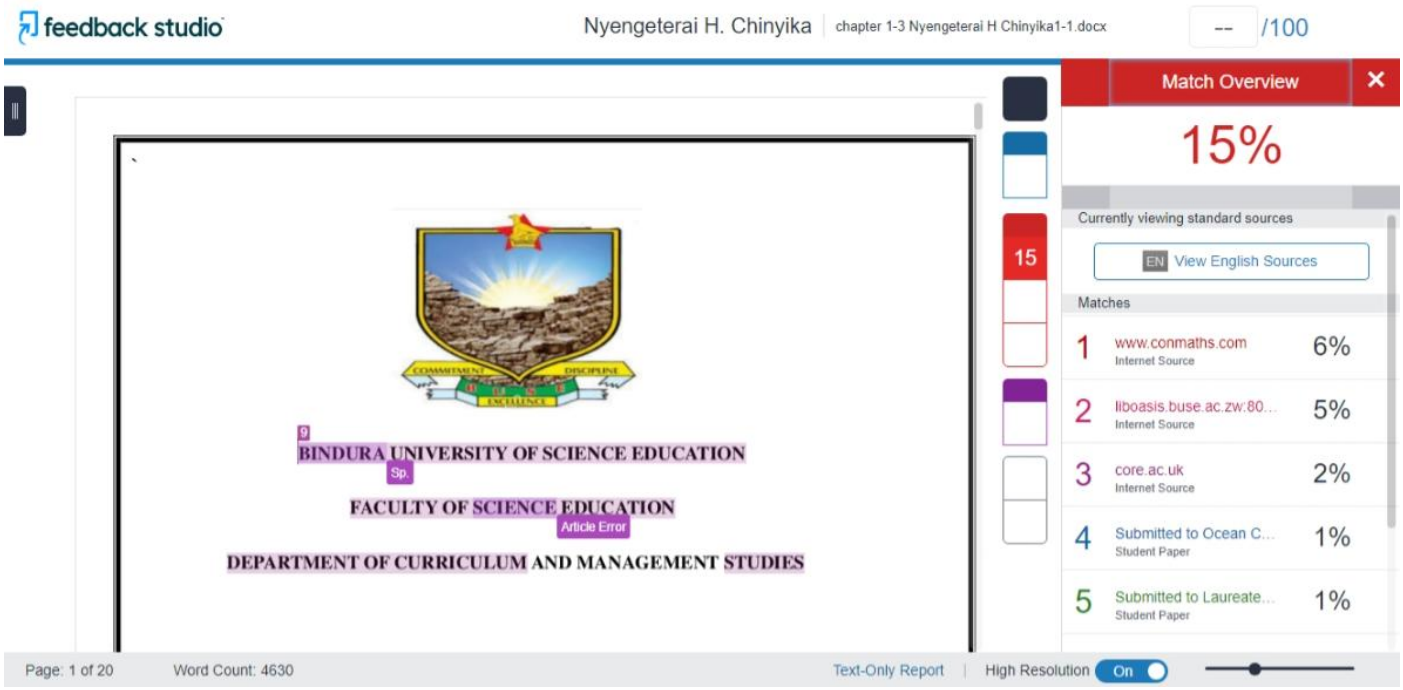
Raw marks for class B

(Taught using interactive tools)

student	Pre test	Post test
1	0	3
2	0	7
3	0	13

4	1	13
5	1	7
6	1	10
7	3	13
8	4	10
9	7	15
10	7	15
11	3	10
12	1	17
13	0	7
14	0	13
15	0	9
16	10	20
17	10	17
18	5	10
19	4	9
20	7	17
21	5	15

Turnitin Report



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BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 9 April 2024

TO WHOM IT MAY CONCERN

NAME: CHINYIKA NYENGETERAI .H REGISTRATION NUMBER: B225532

PROGRAMME: HBScEdMt 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 HBScEdMt programme. The research topic is:

A Comparison of physical visual aids and interactive tools in geometrical transformation teaching at ordinary level. A case study of Mashonaland west province.

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

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DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2024
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