BINDURA UNIVERSITY OF SCIENCE EDUCATION

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DEPARTMENT OF SCIENCE AND MATHEMATICS

AN ASSESSMENT OF FACTORS AFFECTING THE EFFECTIVE TEACHING AND LEARNING OF ORDINARY LEVEL PHYSICS PRACTICAL WORK.

BY NDEBELE PRINCESS

B1438160

SUPERVISED BY DR ZEZEKWA

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Registration Number: B1438160

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Permanent Address: Chevecheve High School
PO Box 682, Gokwe

DEDICATION

I dedicate this research to my husband, my children and all my relatives and friends who worked tirelessly in trying to uplift my academic status.

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ABSTRACT

Practical work is a vital component of physics education at the secondary level, as it allows students to develop essential hands-on skills and deepen their conceptual understanding of physical phenomena. However, the effective implementation of physics practical work at the ordinary level faces a variety of challenges. This study aimed to assess the key factors that influence the teaching and learning of physics practical work in ordinary level classrooms.

The research employed a quantitative approach. Factors investigated included the availability and condition of laboratory equipment and materials, the preparedness and pedagogical approaches of physics teachers, student engagement and motivation, time constraints, and curricular demands.

The findings of this study are expected to provide valuable insights for policymakers, school administrators, and physics educators on how to optimize the delivery of practical work and enhance student learning outcomes in ordinary level physics. Recommendations addressed strategies for improving resource availability, strengthening teacher professional development, and fostering an engaging practical work experience for students. The results of this study informed efforts to improve the quality of physics education and better equip students with critical scientific skills.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Introduction

The main purpose of this research is to assess factors that affect the effective teaching and learning of ordinary level physics practical work at secondary school. The purpose of this research was to find out if the use of practicals affects student performance and attitude. A Quasi Experimental Design was used for this research. A census of the class 3G with 47 students was used, dividing them into two groups the control and the experiment. The control group was taught using the traditional lecture method with textbooks and charts. The experiment group was taught using intensive practicals in laboratory. Both groups of students were given a Physics Achievement Test (PAT) after the delivery of lessons. The results were analyzed using the correlation analysis.

According to Masingila and Gathumbi (2012), many science teachers in developing countries are mainly trained in theoretical content aspects, hence their poor handling of Physics practical lessons. The use of practical work is an important approach in teaching and learning physics due to its potential to promote the acquisition of practical skills, engage, and arouse interest and attitudes of learners towards sciences learning (Score, 2018). Chapter 1 contains background of the study, statement of the problem, research questions, purpose of the study, hypothesis, significance of the study, delimitations, limitations and definition of terms.

1.2 Background of the study

Science is an integral part of everyone's life. Scientific knowledge and skills provide practical assistance in helping people make informed decisions and choices concerning life that best suit them (Hirschfeld, 2012). Physics generates fundamental knowledge needed for future technological advances that will continue to drive the economic engines of the world (Amunga, et al. 2014). It contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries (Kuhn et. al, 2012; Freeman, 2012).

Nowadays there is a global change in teaching and learning methods. Methods that support learners' participation and construction of their own knowledge have been emphasized in all academic activities. Science theories are mastered in practices in teaching and learning activities. Practical work may be considered as engaging the learner in observing or manipulating real or virtual objects and materials. Appropriate practical work enhances learners' experiences, understanding, skills and enjoyment of science and enables them to think and act in a scientific manner. The scientific method is thus emphasized (Millar, 2014). Physics, according to Josiah (2013), is a practical subject. While students of Physics in secondary schools have found it extremely difficult to perform well in the subject (Al-Rawi, 2013), the development of any nation, which depends on science and technology, hinges on science education.

The study of science cannot thus be complete without experimental work, but some few years back, we could see that Physics has always been taught in most of our secondary schools, as a body of theoretical knowledge and little or no attempt has been made to approach the teaching and learning of Physics in practically oriented way.Since course, materials, equipment, laboratory facilities and appropriate experiments are necessary for the effective teaching of physics practical,one is astonished to find students at a particular secondary school perform lower than others in different district secondary schools. Judging from these facts, it could be stated that science laboratory and experiments are success determinants in the school Physics practicals and therefore the importance of laboratory equipment cannot be over emphasised. Olubu (2017) opined that lack of appropriate apparatus and inability of teachers to improvise hinder effective teaching of science. Many Physics teachers tend to resort to theoretical teaching of the subject, neglecting the practical approach, leading to students having negative perceptions and attitude towards the subject and hence disliking it. According to Masingila and Gathumbi (2012), many science teachers in developing countries are mainly trained in theoretical content aspects, hence their poor handling of Physics practical lessons.

1. 3Statement of the problem

The current situation of teaching and learning of Physics practicals in Zimbabwe is aconcern to all including the government and the society at large. Research indicates that practical work is an essential aspect to improve teaching and learning physics. Scanlon etal (2014) believe that practical work has an obvious effect on students' academic achievement.The effective teaching of Physics practicals at a particular secondary school is the purpose of this study.

1. 4Main research question

1. How do the academic achievements of students compare, before and after using practical work to teach selected topics?

1.5Sub-questions

1. What are the challenges faced by teachers in integrating practical work and activities during the teaching and learning of physics?

2. How does the performance of students differ when taught using practical work method?

3. What can be done to enhance the teaching and learning of physics using practical work method?

1.6 Purpose of the study

The purpose of this study is to identify problems that are associated with the teaching and learning of physics practical in secondary school at B secondary. Having identified such problems, the researcher hopes to suggest possible solutions, which might help to the barest minimum of such problems. It is hoped that the study would assist in future other researchers who might be interested in conducting study in this field.

1.7Hypothesis

There will be a significant difference between the performance of students expose to more practical work than those who are only taught towards examination.

There will be a significant difference between the performance of students with laboratories and those who do not have laboratories.

There will be a difference between the performance of students with adequate laboratory apparatus and those without.

1.8Significance of the study

It is the hope of the researcher that the research will help the Physics teachers with the problems of physics practicals teaching. It will also be of immense use to other teachers in Chemistry, Biology and Agricultural Science who are faced with similar problems. Furthermore, it will make the physics students know where emphasis should be laid to further enrich the study and learning of Physics

The outcomes of this study will educatestakeholders in the education sector and the general public on the state of infrastructural facilities and quality of teaching and learning at Chevecheve secondary school. Furthermore, this research will help school administrators and educational planners with what must be done to give students a progressive education and also serve as a resource base to other scholars and researchers interested in this field.

1.9Delimitations

This study will focus on a school within the, Mapfungautsi zone, Midlands Province, Gokwe South rural district Zimbabwe which for the purpose of this research was called B Secondary School. This school is located in the heart of Mapfungautsi which has 7other schools in this Zone. Chevecheve secondary school is a school which is not very large with 436 students. There are only two classes which study Physics at O level in this school, which are form 3G and 4G. All the other classes study combined science. One class studying physics will be selected at this school.

1.10 Limitations

This study will cover the level infrastructural facility and personnel available for teaching Physics at B secondary school.

Financial Constraint

The efficiency of the researcher in sourcing for the relevant materials, literature or information and in the process of data collection may be impeded by insufficient funds.

Time constraint

The researcher will simultaneously do this research with other academic work. This consequently may reduce the time devoted to the research work.

1.11Definition of terms

Teaching and learning-is an educational setting environment of instructors who providecontent, objectives, and goals.Learners who receive knowledge,performance and produce outcomes.

Physics-a subject that is learnt at secondary schools.

Practical work- Practical work includes the physics experiments or demonstrations selected for the science students to do or observe at laboratory sessions. It also includes the hands-on activities used to teach and learn the concepts and theories of physics.

Classroom teaching- Teaching the theories and concepts in classrooms.

Lecture method- Teachers present the lessons only through verbal statements.

1.12Chapter summary

This chapter introduce the research that was conducted by stating the reasons that drove the research to conduct this research, questions that will be answered by this research. The boundaries within which this research was conducted were stated and the key terms to be used in the research were defined. Chapter 2 will be a review of literature related to this research so as to help clarify findings and gaps that need to be filled relating to the topic. Chapter 3 will look at and describe the research design to be used, the target population, sample and sampling techniques, research instruments to be used and the data analysis to be used in detail. In chapter 4 the researcher will present the results, analysis and discussion of the findings with reference to literature review in chapter two. Finally, chapter 5 will focus on the summary of the study, conclusion arrived at and recommendations of the study.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

A literature review is an account of work which has been published on a topic byaccredited scholars and researchers (Kombe & Tromp, 2015). It critically looks atthe existing research that is significant to the work that the researcher will be carrying out. This chapter reviews the Literature related to this study was reviewed which are the difference in academic achievements of students, before and after using practical work, Challenges faced by teachers in integrating practical work and activities during the teaching and learning of physics, Challenges faced by teachers in integrating practical work and activities during the teaching and learning of physics, Performance of students when taught using practical work method, and how to enhance the teaching and learning of physics using practical work method.

2.2 Theoretical framework

The theoretical framework for this study was based on Jean Piaget theory of cognitive development and Jerome Bruner theory of Cognitive Development. Firstly, Jean Piaget (1896-1980) studied the development of children's understanding and particularly the role of maturation in children's increasing capacity to understand their world.He talked of a scheme or schema which is a representation in the mind a set of perceptions, ideas, and or actions which go together. Piaget postulated that thereare 4 stages of cognitive development. These include the sensory-motor (birth-2years), pre-operational (2- 7 years), concrete operational (7 11 years) and formal operational (11 years and above). The sensory-motor stage is characterized by the child differentiates self from objects and achieves object permanency. In the preoperational stage, the child learns language and to represent objects by images and words. The concrete operational stage is characterized by the child been able to think logically about objects and events. Finally, in the formal operational stage, the child can think logically about abstract propositions and test hypothesis systematically. In this theory, Piaget argue, that there is a continuous reorganization of the child's mental processes as he grows and interacts with the environment. Children learn by manipulating the environment they build information in their minds which he called schemas. These schemas kept improving and growing as the child grows from one stage to the next stage. The importance of Piaget's theory to this study is that a child learning by doing things on his own. It is not easy to learn from the teacher just giving the child information. According to him, a child's meaningful learning is through manipulation of the environment. Children are able to construct their own knowledge by manipulating the objects in the environment. This theory of cognitive development was used to anchor the study because practical work in Physics involves manipulation of the apparatus in order to understand concepts. The role of the teacher is that of a facilitator but the child and his peers systematically construct their own knowledge through manipulation of the apparatus in Physics practicals.

The second theory on which the study is anchored on is the Cognitive development theory by Jerome Bruner (1962). According to him, the goal of education should be intellectual development and not memorization of facts. He insisted that learning should entail the acquisition of the process of knowledge but not mere memorization of facts. Instruction should therefore teach the learner how to participate in the process that makes possible the establishment of knowledge. It should not be a matter of getting the learner to commit the results to mind. The aim of teaching a discipline is to get learners to take part in the process of knowledge. According to him, acquiring knowledge is a process rather than product. Bruner advocated organizing concepts and learning by discovery. He believed that learners can be able to construct knowledge by interacting with the world around them. He identified three stages of cognitive development, the enactive, iconic and symbolic representations. Enactive, which is the representation of knowledge through actions while iconic, which is the visual summarization of images. The last one is the symbolic representation, which is the use of words and other symbols to describe experiences. The enactive stage appears first. This stage involves the encoding and storage of information. There is a direct manipulation of objects without any internal representation of the objects.

2.3Difference in academic achievements of students, before and after using practical work.

The review examines relevant studies that investigate the difference in academic performance before and after the implementation of practical work. Scholarly references are utilized to identify trends, research methodologies, and outcomes in this field. The findings of this review highlight the potential benefits of practical work in enhancing students' academic achievements.Practical work, also known as hands-on learning or experiential learning, involves engaging students in active learning experiences that connect theoretical concepts to real-world applications. This approach is widely recognized for its potential to deepen students' understanding, promote critical thinking, and develop practical skills. This literature review examines the existing body of research to assess the impact of incorporating practical work on students' academic achievements.

The reviewed literature consistently suggests a positive impact of practical work on students' academic achievements. Several studies have reported significant improvements in students' performance, particularly in science, technology, engineering, and mathematics (STEM) subjects. For instance, a study by Anderson et al. (2018) found that incorporating practical work in physics education significantly improved students' conceptual understanding and test scores.

Moreover, research has shown that practical work enhances students' problem-solving skills, critical thinking abilities, and retention of knowledge. For instance, a study by Smith et al. (2019) demonstrated that students who engaged in hands-on activities in chemistry exhibited higher levels of critical thinking and performed better on subsequent assessments compared to their peers who did not participate in practical work. Furthermore, practical work has been found to increase students' motivation and engagement, leading to improved academic performance. A study by Johnson and Johnson (2020) indicated that students who participated in hands-on learning activities showed higher levels of interest and intrinsic motivation, resulting in improved grades and overall academic achievement.

In a study conducted over duration of eight weeks on a group of 40 students from grade 5, from two different classes selected through purposive sampling, it was shown that students who were instructed through inquiry-based learning achieved higher scores than the ones who were instructed through traditional methods (Abdi, 2014).

While the literature reviewed consistently supports the positive impact of practical work on students' academic achievements, some limitations should be considered. Firstly, the reviewed studies spanned different educational levels, disciplines, and methodologies, making it challenging to generalize the findings. Additionally, the duration and intensity of practical work implementation varied across studies, which may have influenced the observed outcomes.Future research should focus on conducting longitudinal studies with larger sample sizes to further explore the long-term effects of practical work on students' academic achievements. Additionally, investigating the specific mechanisms through which practical work enhances academic performance would provide valuable insights for educators and curriculum developers.

2.4Challenges faced by teachers in integrating practical work and activities during the teaching and learning of physics.

The review examines scholarly articles that investigate the barriers, limitations, and difficulties encountered by educators when implementing practical work in physics education. The findings of this review highlight the key challenges related to resources, time constraints, teacher training, assessment, and curriculum constraints. Scholarly references are provided to support the identified challenges. Practical work and activities play a vital role in physics education, enabling students to engage in hands-on experiences and connect theoretical concepts with real-world applications. However, integrating practical work in the teaching and learning process can pose challenges for teachers. This literature review aims to explore the existing body of research to identify the challenges faced by teachers when incorporating practical work in physics education.

Insufficient availability of laboratory equipment, materials, and financial resources can hinder the effective implementation of practical work. Teachers may struggle to provide students with hands-on experiences due to the lack of necessary resources. Research by Sanger et al. (2015) identified resource constraints as a significant challenge faced by physics teachers when incorporating practical work. Olubu (2017) opined that lack of appropriate apparatus and inability of teachers to improvise hinder effective teaching of science. Students' discussion during the laboratory work is mainly centered on the procedures needed to carry out the experiment or how to manage lab equipment (Russell & Weaver, 2012; Sandi-Urena, Cooper, Gatlin, & Bhattacharyya, 2012). Science practical activities have been endorsed for its role in ensuring positive student attitudes about science and developing students' interest in science and ability to use equipment (Sneddon, Slaughter and Reid 2015)

Teachers may face challenges related to their own training and competence in conducting practical work. Lack of professional development opportunities and training programs that focus on practical work can impede teachers' ability to effectively incorporate hands-on activities. Research by Chabalengula et al. (2013) identified teacher training as a key challenge in integrating practical work in physics education. A challenge facing the Physics as a subject is inadequate content knowledge by the teachers of Physics. Fadaei (2012b) carried a research to find out the teachers' level of knowledge acquisition. Training in conducting school type science experiments is completely ignored inmany university teachers training curricula (Masingila & Gathumbi, 2012). The challenges faced by Physics as a subject include teachers' training and conceptualization of the subject, students' understanding of the subject, physical resources such as laboratories, teaching aids and text books. Research findings suggest that traditional lecture instruction is ineffective in dealing with students' misconceptions. Traditional lecture instruction does not consider the view of students. This technique is limited in helping a learner develop skills (Tarekegn, 2012).

Assessing practical work and activities can be challenging, as traditional assessment methods may not be suitable for evaluating students' skills and understanding developed through hands-on experiences. The development of appropriate assessment strategies and tools that align with practical work objectives can pose a significant challenge for teachers. A study by Bennett et al. (2017) highlighted assessment challenges faced by physics teachers in the context of practical work.The limited time available within the curriculum presents a significant challenge for teachers to integrate practical work effectively. The time required for setting up experiments, conducting observations, and analyzing results can be a barrier to incorporating practical work in physics classes. A study by Zitzewitz (2013) highlighted time constraints as a common challenge faced by physics teachers. Furthermore, strict curriculum guidelines and standardized assessments can limit the flexibility of teachers to integrate practical work into their instructional practices. Teachers may face challenges in finding opportunities to incorporate practical work within the constraints of the prescribed curriculum. Research by Chittleborough et al. (2017) emphasized curriculum constraints as a significant challenge faced by physics teachers.

While the literature reviewed highlights the challenges faced by teachers in integrating practical work in physics education, it is important to note that these challenges may vary across different educational contexts and regions. Additionally, the reviewed studies primarily focused on the challenges from the perspective of teachers, and further research could explore the perspectives of students and administrators.Future research should aim to identify strategies and solutions to address the challenges faced by teachers in integrating practical work. This may include exploring alternative resources, developing teacher training programs, designing effective assessment methods, and advocating for curriculum flexibility.

2.5 Performance of students when taught using practical work method.

This literature review examines the performance of students when taught using the practical work method. The review analyzes scholarly articles that investigate the impact of practical work on student performance in various academic subjects. The findings of this review highlight the positive effects of practical work on students' academic achievement, conceptual understanding, problem-solving skills, and retention of knowledge. Scholarly references are provided to support the identified outcomes.

Practical work has been shown to enhance students' academic achievement across various subjects. Studies by Hofstein and Lunetta (2018) and Lopatto (2015) found that students who engage in practical work outperform their peers in terms of grades and standardized test scores. Practical work provides students with opportunities to apply theoretical knowledge and develop a deeper understanding of concepts, leading to improved academic performance.

Practical work promotes students' conceptual understanding in different subject areas. By engaging in hands-on activities, students can observe phenomena, manipulate variables, and draw connections between theory and practice. Research by Lazarowitz and Tamir (2013) and Windschitl et al. (2018) demonstrated that students who participate in practical work show better conceptual understanding and knowledge retention compared to those who rely solely on traditional instruction.

Practical work fosters the development of problem-solving skills in students. By engaging in hands-on experiments, students learn to formulate hypotheses, design experiments, collect and analyze data, and draw conclusions. Studies by Barrows and Tamblyn (2012) and Bell et al. (2018) showed that students who engage in practical work demonstrate improved problem-solving abilities and critical thinking skills.

Practical work enhances students' long-term retention of knowledge. The active engagement and experiential learning involved in practical work help students retain information for extended periods. Research by Prince (2014) and Tanner (2012) indicated that students who engage in practical work demonstrate better knowledge retention and are more likely to recall and apply learned concepts in future contexts.

According to Woodley (2013), effective practical work can develop important skills in understanding the process of scientific investigation, and can also develop students' grasp of concepts. Similarly, Scanlon, Morris, Di Paolo and Cooper (2014) believe that practical work has an obvious effect on students' academic achievement.

The study by Sabri and Emaus (2015) revealed that there is a strong positive relationship between the total number of science practical work conducted in secondary schools and the academic achievement of Palestinian students in science theory and practical courses. Abrahams and Millar (2014) suggest that the minds-on aspects of practical work must be increased in order to make it more effective in developing students' understanding of scientific ideas. According to Hofstein and Mamlok (2018), practical work, when well organized, can increase students' sense of ownership of their learning and can increase their motivation. Talisayon (2018) also found out that learners developed improved attitudes towards science as a result of practical courses. Luketic and Dolan (2013) assert that practical activities foster positive attitudes and interest in science. Practical work provides motivational benefits such as interest and enjoyment, development of skills and science knowledge, learning about scientific method and developing scientific attitudes. Thus this enhances student performance.

The reviewed studies encompassed various disciplines and educational levels, making it challenging to draw universal conclusions. Additionally, factors such as the quality of instructional materials, teacher expertise, and students' prior knowledge can influence the outcomes of practical work.Future research should explore the specific mechanisms through which practical work enhances student performance, investigate the optimal design and implementation of practical work activities, and examine the long-term effects on students' performance beyond immediate assessments.

2.6How to enhance the teaching and learning of physics using practical work method.

This literature review explores the effectiveness of using practical work as a method to enhance the teaching and learning of physics. The review examines relevant scholarly articles that investigate the benefits and outcomes of incorporating practical work in physics education. The findings of this review highlight the advantages of practical work in promoting conceptual understanding, improving problem-solving skills, and fostering student engagement and motivation. Scholarly references are provided to support the key findings. Practical work, also known as laboratory work or hands-on experiments, plays a crucial role in physics education. It provides students with opportunities to engage actively with the subject matter, develop practical skills, and reinforce theoretical concepts. This literature review aims to explore the existing body of research to determine how the use of practical work enhances the teaching and learning of physics.

Practical work provides students with concrete experiences that help them develop a deeper understanding of abstract physics concepts. By engaging in hands-on experiments, students can observe phenomena, collect data, and analyze results, which enhance their conceptual understanding. Research by Hake (2013) and Thornton and Sokoloff (2012) showed that students who participate in practical work outperform their peers in conceptual understanding assessments.Practical work enables students to apply theoretical knowledge to solve real-world problems. Through hands-on experiments, students learn to formulate hypotheses, design experiments, analyze data, and draw conclusions. This process fosters critical thinking and problem-solving skills. A study by McDermott and Shaffer (2019) demonstrated that students who engaged in practical work showed significant improvements in their problem-solving abilities.Practical work creates an interactive and engaging learning environment that motivates students to actively participate in the learning process. The hands-on nature of experiments arouses curiosity, stimulates interest, and increases motivation to learn physics. Research by Potvin et al. (2017) indicated that students who experienced practical work in physics reported higher levels of motivation and engagement compared to those who relied solely on traditional instruction.Practical work allows students to develop essential practical skills, such as experimental design, data collection, measurement techniques, and data analysis. These skills are valuable not only in physics but also in scientific research and various STEM disciplines. A study by Wieman et al. (2015) demonstrated that students who engaged in practical work showed significant improvements in their laboratory skills and techniques.

Teaching and learning of Physics can be enhanced by teaching teachers practical methods of teaching.(Buckley 2023) It is essential that science teachers can be provided with opportunities to learn how to transform traditional practical work in scientifically grounded experiments at a conceptual, epistemological, and procedural level.(Wei and Li, 2017)

Suggest that courses, modules, and teacher training programs should focus on how real scientific experiments are developed, what scientists actually do when conducting these experiments, and how the scientific experiments are performed in different social contexts. Self-evaluating for teachers to know their abilities and motivating them to be more active in teaching. Recognizing the necessity and planning for teacher training projects have to be emphasized.

The reviewed studies encompassed different educational levels, settings, and methodologies, making it challenging to draw universal conclusions. Additionally, the effectiveness of practical work may depend on factors such as the quality of instructional materials, teacher expertise, and available resources.Future research should focus on investigating the optimal integration of practical work into physics curricula, exploring the impact of different types of experiments on student learning outcomes, and examining the role of technology in enhancing practical work experiences.

2.7 Research Gaps

Zimbabwe's educational system specifically at Chevecheve secondary may face specific resource limitations when it comes to physics practical work. Research should explore the availability and accessibility of laboratory equipment, materials, and infrastructure in schools across the country. Identifying resource-related challenges and finding innovative solutions to overcome them can significantly impact the effectiveness of physics practical work in Zimbabwe. Despite the significance of practical work in physics education, there is a lack of comprehensive research specifically focused on the factors influencing the effective teaching and learning of ordinary level physics practical work in Zimbabwe. While studies in other contexts have explored various aspects of practical work in physics education, there is a need for research that specifically investigates the unique challenges and opportunities faced by teachers and students in Zimbabwean classrooms. Understanding these factors is crucial for designing targeted interventions and instructional strategies that can enhance the quality and effectiveness of physics practical work in the Zimbabwean educational system. Therefore, an in-depth investigation into the factors affecting the effective teaching and learning of ordinary level physics practical work in Zimbabwe would fill a significant research gap and contribute to the improvement of physics education in the country.

2.8chapter summary

The chapter has reviewed literature related to the current study. Specifically, the study looked at the difference in academic achievements of students, before and after using practical work, Challenges faced by teachers in integrating practical work and activities during the teaching and learning of physics, Performance of students when taught using practical work method, and how to enhance the teaching and learning of physics using practical work method. The study established that the effects of practical approach as an instruction on students' achievements in physics and availability and accessibility of laboratory equipment, materials, and infrastructurehave not been explored at least in Zimbabwean Secondary school. The study was designed to address this gap.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter focused on the methodology that was used in this study. The following issues were addressed; research design, location of the study, target population, sample size and sampling procedures, research instruments, pilot study, data collection methods and procedures, methods of data analysis and ethicalconsiderations

3.2 Research design

The research design is the conceptual structure within which the research was conducted, it constitutes the blueprint for the collection, measurement and analysis of data, it can also be defined as a master plan for the determined methods, structure, and strategy of a research to find out alternative tools to solve the problems, and to minimize the variances (Mohajan, 2017).

The study adapted a quasi-experimental pretest-posttest design. Quasi-experimental design is a research approach that allows for the investigation of causal relationships between variables when true experimental control is not feasible or ethical . Quasi-experimental design is a research design that resembles true experimental design in many ways but lacks random assignment of participants to groups. In quasi-experimental studies, the researcher manipulates an independent variable to observe its effects on a dependent variable(s) while accounting for pre-existing group differences. Unlike true experiments, quasi-experiments often rely on pre-existing groups or naturally occurring conditions. They are characterized by their focus on cause-and-effect relationships and the use of comparison groups, but they lack the strict control over assignment to groups that distinguishes true experiments (Shadish, Cook, & Campbell, 2016). : Quasi-experimental designs have the advantage of being conducted in real-world settings, allowing for a high degree of ecological validity. This means that the findings can be more easily generalized to real-world educational contexts. Quasi experimental designs are often more practical to implement than true experimental designs, as they make use of existing groups or naturally occurring conditions. This can save time, resources, and logistical challenges associated with random assignment.

It involved a school, with a particular physics class. There were two groups from category A and from category B.Each category had one experimental and one control group making a total of two groups. The two groups set for the pre-test achievements test at the start of the study. The experimental groups were then taught using the practical approach while the control groups were taught using the conventional method. This was done for one full-term. Then the post-test achievement testwas administered and the results analysed.

The use of a quasi-experimental design in assessing the factors affecting effective teaching and learning of ordinary level physics practical work offers several advantages, including ethical considerations, ecological validity, and practicality. However, researchers must also be mindful of the potential disadvantages, such as threats to internal validity, selection biases, and limitations in establishing causal relationships. By carefully controlling for confounding variables and employing appropriate statistical techniques, researchers can mitigate these limitations and draw meaningful conclusions from their quasi-experimental studies.

3.2.1 Research paradigm

Here we will delve into the research paradigm underlying the quasi-experimental design used in this study. A research paradigm refers to the overall framework and set of assumptions that guide the researcher's approach to studying a particular phenomenon. The chosen paradigm influences the selection of research methods, data collection techniques, and data analysis procedures.

The research paradigm employed in this study is primarily positivist in nature. Positivism is characterized by its emphasis on objectivity, empirical observation, and the scientific method. It assumes that there is an objective reality that can be studied and understood through systematic observation and measurement. In the context of the quasi-experimental design, the primary focus is on determining cause-and-effect relationships between variables.

However, it is important to acknowledge that research paradigms are not mutually exclusive, and elements of other paradigms, such as interpretivism or critical theory, may be incorporated into the study as appropriate. These paradigms place more emphasis on subjective interpretation, context, and power structures.

3.2.2Research methodology

A Quasi Experimental Design was used for this research. Quasi-experiment research is conducted in field settings in which random assignment is impossible or absent, and is often conducted to evaluate the effectiveness of a treatment or an educational intervention (Price, Jhangiani & Chiang, 2015; White & Sabarwal, 2014). A census of the class 3G with 47 students was be used, dividing them into two groups the control and the experiment. Quasi experimental design involves selecting groups, upon which a variable is tested, without any random pre selection processes. For example, to perform an educational experiment, a class might be arbitrarily divided by alphabetical selection or by seating arrangement. The division is often convenient and, especially in an educational situation, causes as little disruption as possible. After this selection, the experiment proceeded in a very similar way to any other experiment, in this case a class was be divided according to their seating positions in the laboratory, part of the class comprising of 23 students which sat on the right was taught using the traditional method of teaching using textbooks and diagrams, this was the control group. The other part comprising of 24 who sat on the left side were taught using intensive practicals in the laboratory this was the experimental group. A pre-test was given. After the pre-test, the experimental group was taught physics by intensive practical activities while the control group was taught by conventional teaching methods. This design was chosen because the mode of assigning participants involves non equivalent whole class groups. The two groups sat for the pre-test achievements test at the start of the study. The experimental groups were then taught using the practical approach while the control groups were taught using the conventional method. This was done for one full-term of three months. Then the post-test achievements tests were administered and the results analysed. Both groups of students were be given a Physics Achievement Test (PAT) after the delivery of lessons. The results of the test were then recorded and analysed.

#	**Traditional Way of Teaching**	**Practical Method of Teaching**
1	Relies mainly on textbooks	Relies on hands-on materials approach
2	Presentation of materials is from parts to the whole	Presentation of materials is from whole to parts

3	Assessment is a separate activity	Assessment is an integrated activity
4	Emphasis on basic skills	Emphasis on big ideas
5	Testing is the major mean of assessment	Portfolios and observation are major means of Assessment
6	Use homeroom for the science instruction	Use another classroom/lab for Science Instruction

Table 1. Traditional Verses Modern/Hands-On Approaches in Teaching Science

Group	Control Group	Experimental Group
Pre test	Ability regarding science content understanding	Ability regarding science content Understanding
Duration	Three weeks	Three weeks
Post test	Change in ability regarding science content understanding	Change in ability regarding science content Understanding

Table 2. The Pre-Test and Post-Test design for both groups

3.2.3 Research strategy

The research strategy employed in this study is centered around assessing the factors that influence the effective teaching and learning of ordinary level physics practical work. Quasi-experimental design is chosen as the research design due to its suitability for investigating causal relationships in situations where true experimental control is not feasible or ethical.

The study will involve the manipulation of an independent variable, which is the introduction of a new teaching approach or intervention aimed at enhancing the effectiveness of physics practical work. The dependent variable will be the learning outcomes of students in terms of their understanding of physics concepts and their performance in practical assessments.

To gather data, the study was conducted amongst multiple learners, with some students receiving the intervention (experimental group) and others not receiving it (control group).

Pre- and post-test measurements were conducted to assess the impact of the intervention on the students' learning outcomes.

The sample size was determined using appropriate statistical techniques, and efforts were made to ensure that the sample is representative of the target population. Statistical analyses, such as co relational analysis was employed to determine the statistical significance of any observed differences between the experimental and control groups.

Throughout the study, it is crucial to consider ethical considerations, such as obtaining informed consent from participants and ensuring the confidentiality and anonymity of the collected data. The study should also adhere to any relevant institutional or ethical guidelines.

By employing a quasi-experimental design, this research strategy aims to provide valuable insights into the factors that influence the effective teaching and learning of ordinary level physics practical work. It allows for the examination of causal relationships and provides a basis for evidence-based recommendations to improve physics education practices.

3.3 Population

Cooper and Schindler (2014) observed that when conducting research, the first step is to define population to be studied in terms of its geographical, demographic and other boundaries to decide whether it should be fully or partially covered. A study population or target population, therefore, refers to the group about which the researcher wants to gain information and draw conclusions (Tuckman, 2015). According to (Babbie, 2018), a population is a group of units or objects considered potentially useful in the dissemination of required information for the research understudy. In other words, a population is the entire pool of possible subjects that have some common characteristics that are of interest to the researcher (Berg, 2017).

The target population was at a secondary school in Zimbabwe which has a population of 300students, two classes which study physics which are 3G and 4G. The target population is the 3G class which consists of 47 students.

3.3.1Sample

A sample size is the number of respondents who are required to participate in the survey in order to ensure statistically valid conclusions (Saunders et al, 2016). Best and Kahn (2014) say the ideal sample should be large enough to serve as an adequate representation of the population about which the researcher wishes to generalize and small enough to be selected economically in terms of subject availability and expense in both time and money.

The selected school and class was selected purposefully by the researcher as they are the only level that learns Physic at the school and are not preparing for their zimsec exams. The participants in the study were selected using purposive sampling method and simple random sampling method. Purposive sampling was the best because it involved selecting participants who possessed the required characteristics and qualities according to the researcher's interests Gay, 2015). Simple random sampling made it possible for every member to have an equal chance of being selected The class consists of 47 students; 23students were chosen to be the control group according to how they seat on the right side in thelaboratory. The other 24 who seat on the left became the experiment group. A census was donesince all the students of this class were involved in this research as only 3G students wereinvolved and it is a small group it was feasible to use the census.

GROUP	NUMBER OF STUDENTS
CONTROL	24
EXPERIMENTAL	23
TOTAL	47

Table 3 Study Sample distribution

3.3.2Sampling techniques

Leedy and Ormrod (2014) note that sampling procedures are steps used or followed when selecting subjects in a study. There are two major types of sampling techniques. These are the probability and non-probability sampling techniques. Probability sampling technique is a technique which involves every unit in the population to have a chance of being selected in the sample (Maree 2016). According to Neuman (2013) non- probability sampling refers to sampling methods where some elements of the population have no equal chance of being selected, examples of non-probability techniques include snowballing, purposive, convenience and quota sampling. In this study the researcher used purposive and simple random sampling techniques.

De Vaus (2014) mentions that purposive sampling or judgmental sampling permits one to use personal conclusions to select cases that make it easy for them to address the research question and to realize the set research objectives. Therefore, all the teachers and Head of Departments were selected using the purposive sampling technique. These were selected using this technique by the virtue of being the key informants in this study.The main relevance of this technique is that the researcher can reach a targeted sample quickly (Muller & McLeod 2014).

In selecting school learners, the researcher employed simple random sampling technique. A simple random sample is an unbiased surveying technique (McLeod, 2014). Simple random sampling is a basic type of sampling, since it can be a component of other more complex sampling methods. The principle of simple random sampling is that every elementary unit has the same probability of being chosen. In simple random technique every member has an equal chance of being selected to become the study participant.

3.3.3 Research instruments

Research instruments are vital in the progression of any research. Neuman (2013) defines research instruments as tools for collecting data from human subjects.

Pre-Test Achievement Test

Pre-test was used to measure the performance of the learners in Physics of both theexperimental and the control group before the treatment is administered (AppendixI). This aimed at ensuring that, both groups were of relative same ability in performance in Physics. The achievements test was composed of11structuredquestions which took forty minutes.

Post-test

The Physics Achievement Test (PAT) was administered to both experimental and control groups (Appendix VII). A Physics Achievement Test (PAT) was used as an instrument. The reason for the PAT is to see if your manipulation, the thing you're looking at, has caused a change in the participants. So the students in the target population who are the control group wrote the PAT after being taught using the traditional method with textbooks and diagrams on the board. The students who are the experimental group wrote the PAT after the intensive practical work. In trying to gauge how far the students know the researcher gave a test to both the experimental group and the control group. The instrument used in this study is a self designed Physics Achievement Test (PAT). The (PAT) contains 11 questions with different questions.The PAT has a total of 30 marks and has been included in the appendix section.

The PAT was used to measure the achievement of students in both the control and experiment groups. Some intervening variables extraneous to the study such as teacher effect, group interaction effect was be controlled by the presence of one of the Physics teachers in the schools used for the study.

3.3.5Procedures of data collection

The researcher had asked permission from school administrators so that the research can be conducted in their school. The researcher administered the pre-test to the selected learners. After completing the pre-test, the experiment started where the groups were taught separately. The researcher made an appointment with HODs the administrators for review, then at appointed times the researcher administered the post test. After the tests data was recorded with selected groups the researcher was recording data in a notebook and made use of the voice recorder.

3.3.6 Data analysis method

Cooper and Schindler (2014) describe data analysis as an attempt to organize, account for and provide explanations of data so that some kind of sense could be made of them. This allowed the researcher to move from a description of what is the case to an explanation of why that is the case. According to Kumar, (2019) the analysis of data is an important phase of any research process because it is at this point that the researcher can assume that the results obtained are valid and trustworthy. In this study, data was analyzed using the frequency tables, bar graphs, pie charts and line graphs. According to Bless and Higson, (2015) presenting data in visual tools like graphs and pie charts make it easier for information to be understood and analyzed.

The data collected will be classified, analysed and interpreted. Tables and graphs will be used to present the data. Tables are to be used to present the results of the students with each group having its own table containing range of pass rates, frequency and percentage pass rate will be presented on graphs. Correlation analysis will be used to analyse the results of both the control group students and the experiment group students. A comparison will be done between the two groups using pie charts and graphs. The results will be analysed with reference to the research study and theories from other authors.

3.4 Reliability and validity

It is the time measurement of a variable and estimates the consistency of such measurement over time from a research instrument. According to Best and Kahn (2016) reliability is the extent to which the same findings will be obtained if the research was repeated at another time by another researcher. Lahey, (2014) concurs by postulating that reliability refers to the consistence of scores obtained that is how consistent they are for individual from one administration of instruments to another and from one set of items to another. Therefore, it can be defined as a measure of the degree to which a research instrument would yield the same results or data after repeated trials. In order to ensure reliability the researcher issued questionnaires to the respondents and collected them to check on the responses.

Validity refers to how accurately a research instruments measures what it is intended to measure (Crest 2014).

Piloting

A pilot study was undertaken for purposes of validation and testing the reliability ofthe research instrument that was used. Two mixed day Schools in the neighbouringarea were purposively chosen for piloting so as to capture the keycharacteristics of the study. The pilot study helped to identify and rectify themistakes in set questions. It also helped to determine the suitability and theappropriateness of the language used in both pre-test and post-test. It also helped inmaking any adjustment to the practical set up and write ups.

Validity of the Instruments

Content and construct validity of the research tools were initiated at the design stage.Most of the items used in the achievements tests were adapted from ZIMSEC syllabus (2015-2022). The test items were constructed using the O level syllabus.These strengthened both content and construct validity. This stage was followed bythe pilot study whose main purposes were to check the appropriateness of thelanguage used in the tools and to conceptualise them for predictability andreliability. The pre-test and post-tests were developed with the assistance of twoexperts in Science Education in Department of Mathematics and Science at Bindura University and three ZIMSEC Physics Examiners in 4023 /3-paper one.

Reliability of the Instrument

The reliability of the assessment test was determined using the split-half method. This is where the total number of items were divided into halves by assigning the odd numbered items to one half and even numbered items to the other half. Correlation between the two halves was determined. Spearman-brown prophecy formula was used to estimate the reliability of the whole test. The Spearman–Brown prophecy formula adopted from Elzinga, et al., (2021) was used.

$$PXX^{11} = \frac{2pxx^{1}}{1+pxx^{1}}$$

Where PXX^{11} is the reliability co-efficient for the whole test and PXX^{1} is the splithalf correlation if it was 0.7 and above then the test was considered reliable. A reliability coefficient of 0.83 and 0.87 were obtained for the Pre-test and posttesttests respectively.

3.5 Ethical issues

Evans, (2015) views research ethics as principles of right and wrong that govern the operation of the researchers during the process. Therefore, ethics are standards, codes of conduct or principles that govern the research process.

The researcher sought a research permit to carry out the research from Ministry of Primary and Secondary education (Gokwe district). The sampled schools were visited to seek permission to carry out the research from the schools administration. A meeting with Form 3 and 4 teachers of Physics was organized so as to induct them into the study. They filled consent forms to participate in the study. The students also filled the consent forms before being engaged in the study. The participants filled a consent form before participating in the study. They were also assured of confidentiality and that the information provided would be used for the purposes only.

3.6 Chapter summary

This chapter describes the research procedures used by the researcher in gathering data. The chapter describes in detail the research design used, the target population used including how the population is sampled that is the technique. The research instruments used were described which was a test which was described fully in this chapter. Lastly the method to be used in chapter 4 to analyse and interpret data was also described.

CHAPTER 4 DATA PRESENTATION,ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents, interprets and discusses the findings generated from this studyand reported using mainly tabular mode. The chapter specifically considers and tests the following Hypothesis,there will be a significant difference between the performance of students expose to more practical work than those who are only taught towards examination, there will be a significant difference between the performance of students with laboratories and those who do not have laboratories and there will be a difference between the performance of students with adequate laboratory apparatus and those without.

4.2 Bio data

This section provides background information about the study participants, which is crucial for comprehending the emerging issues and subsequent findings presented in this research. It includes details about the participants involved in the study, which significantly influenced the outcomes of this research. A unique (code) identifier to each participant was assigned for easy anonymity and easy reference in the study.

4.2.1 Biographical information of learners

Forty-seven learners (age range 16-18, mixed gender) from a school in Gokwe south district participated in the study. The learners were in form 3. The table below shows the coding system used for learners.

Table

Student code	Age	Gender	Form
L1	16	Female	3
L2	17	Male	3
L3	17	Male	3
L4	18	Male	3
L5	16	Male	3
L6	17	Female	3
L7	17	Female	3
L8	17	Female	3
L9	17	Male	3
L10	17	Male	3
L11	18	Female	3
L12	17	Male	3
L13	17	Male	3
L14	17	Male	3

L15	17	Male	3
L16	18	Female	3
L17	17	Male	3
L18	17	Male	3
L19	17	Female	3
L20	18	Female	3
L21	16	Female	3
L22	16	Male	3
L23	17	Female	3
L24	18	Male	3
L25	17	Male	3
L26	17	Male	3
L27	17	Female	3
L28	17	Male	3
L29	17	Male	3
L30	18	Female	3
L31	18	Female	3
L32	17	Male	3
L33	18	Male	3
L34	17	Female	3
L35	17	Female	3
L36	17	Female	3
L37	17	Male	3
L38	17	Female	3
L39	17	Female	3
L40	17	Female	3
L41	16	Male	3
L42	16	Female	3
L43	16	Male	3
L44	17	Male	3
L45	17	Male	3
L46	17	Male	3
L47	17	Female	3

4.3 how do the academic achievements of students compare, before and after using practical work to teach selected topics?

In order to establish how do the academic achievements of students compare, before and after using practical in Physics, the respondents were first subjected to a pre-test todetermine their equivalence about ability in physics. The students' levels of acquisition of skills andcompetencies and hence their academicachievement during the pre-intervention phasewere recorded and analysed using the pre-test.A Physics Achievements pre-testwas used for this purpose.

4.3.1 Students' Performance on the Physics Achievement Pre-Test

The results of the students' achievements on the pre-test are presented in Table 4.

Table 4

Range of marks	Control group Frequency(24)	Experiment group (23)frequency	% Results for control group	% Results for experiment group
0-4	2	4	8	17
5-9	10	11	42	48
10-14	7	3	29	13
15-19	2	3	8	13
20-24	3	2	13	9
25-30	0	0	0	0

The data in the table above shows that for the experiment group 17 %of the students got markswithin the range 0-4 while 8% of the control group were within that range of marks. On therange of marks 5-9, there were 48% in from the experiment group and 42% from the control group. Only 13% of the experiment students were in the 10-14 range while 29% from the controlgroup were. 13% from the experiment got between 15 and 19 while 8% of the control group did.The 20-24 range, 9% of the experiment group were within that range while 13% of thecontrol group were within that range. Finally, none of the control group students were able toattain marks within the 25-30range and also 0% of the experiment group were v within thatrange.

Table 4 results show that the experimental and control groups are fairly equivalent in ability in Physics. This underscores the fact that both the experimental and control groups were starting on a fairy even ground. The above results will now be presented in fig 1 below using a graph.

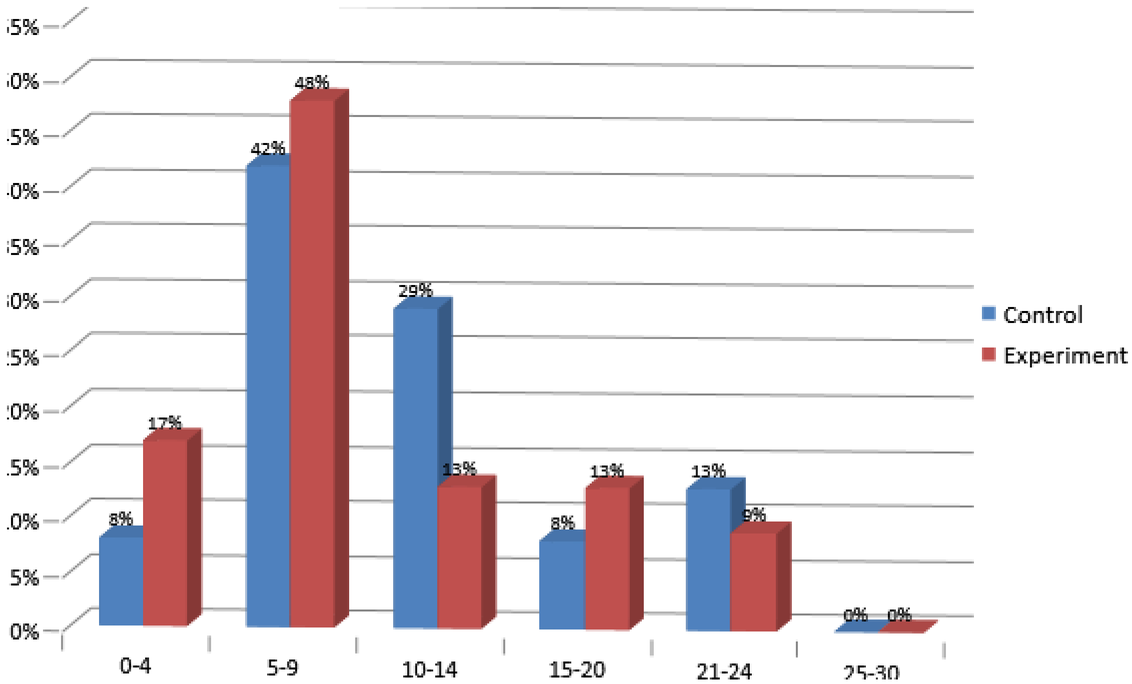


FIG 1 Chart showing performance of students in pre-test

The students' performance from both groups show that the students are beginning on fairground this is shown by the comparison of percentage pass rates of the two groups which is shown by the pie chart in Fig 2 below.

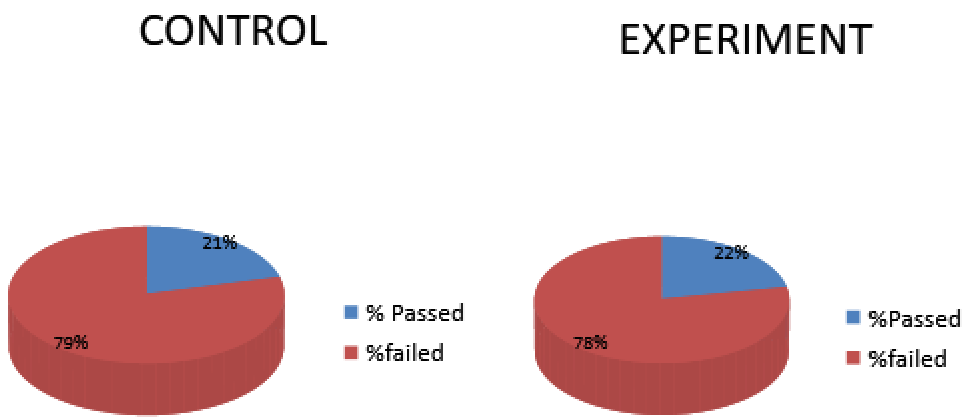


FIG 2 Pie Chart showing pass rates of students in pre-test

The above pie charts show that only 21% of students from the control group passed and also only 22% of the Experiment group passed. Those who failed from the experiment were 78 % while 79% of the control group also failed. These pass rates show that the students from both groups are equivalent in terms of academics, so the experiment started on fairground.

4.3.2 Students' performance on the Post-Test

The experimental group was taught for a full school term using a practical approach while the control group went on with the conventional approach which does not use many practical sessions. At the end, a post test was administered (see Appendix). The results are as in Table 5 below.

Table 5

Students' performance in the Post-Test Achievement Test

Range of marks	Control group Frequency	Experiment Group frequency	% Results for control group	% Results for experiment group
0-4	8	0	34	0
5-9	7	1	29	4
10-14	3	2	13	8
15-19	2	3	8	13
20-24	2	4	8	17
25-30	2	14	8	58

The data in the table above shows that for the experiment group 0% of the students got markswithin the range 0-4while 34% of the control group were within that range of marks. On therange of marks 5-9,there were only 4% in from the experiment group and 30% from the controlgroup. Only 8% of the experiment students were in the 10-14range while 18% from the controlgroup were. 13% from the experiment got between 15 and 19 while 9% of the control group did.The 20-24range, 17% of the experiment group were within that range while only 9% of thecontrol group were within that range. Finally, none of the control group students were able toattain marks within the 25-30range but 58% of the experiment group were very well within thatrange.

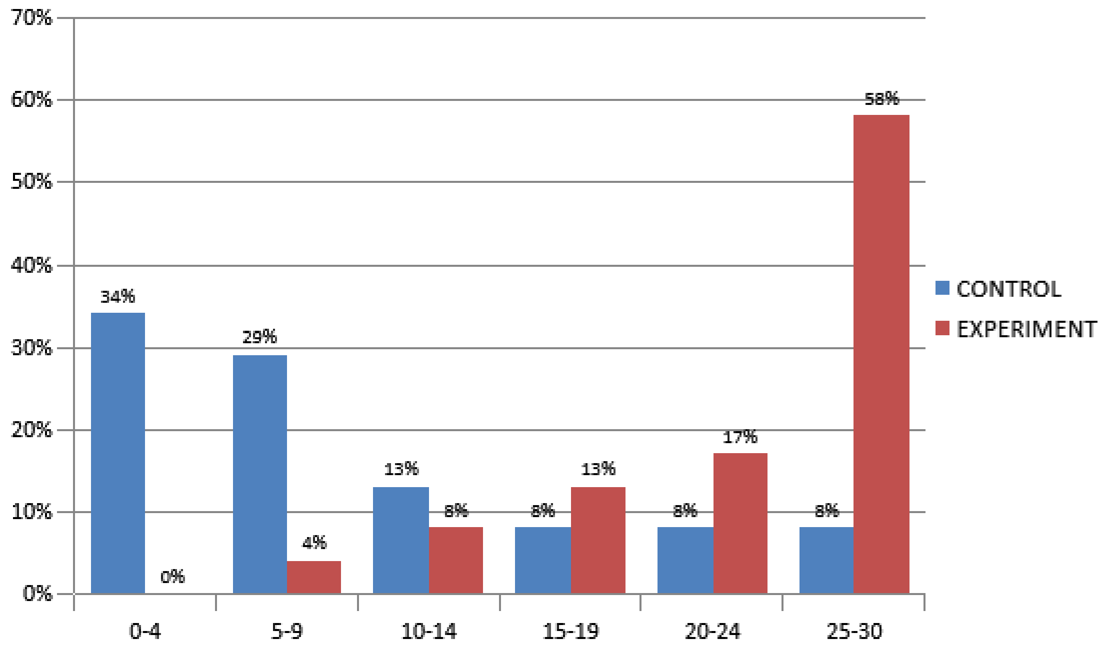
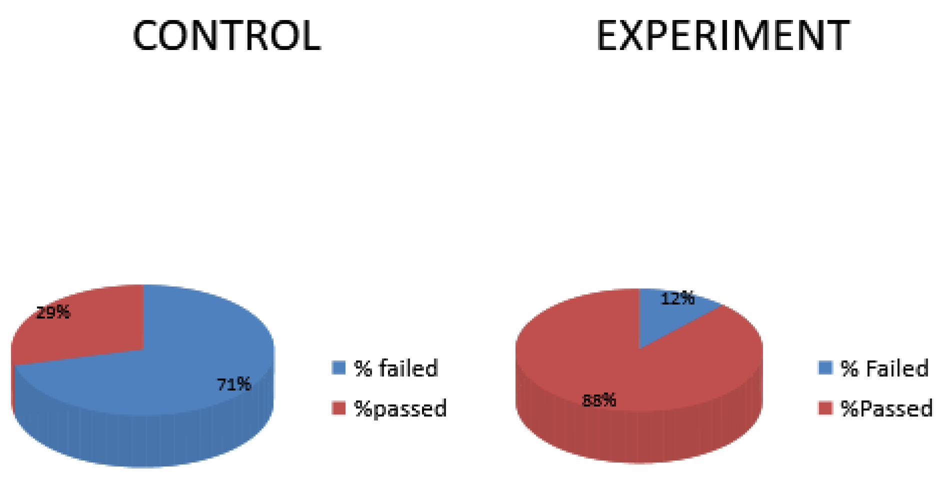


FIG 3 Chart showing performance of students in post test

The graph in Fig 3 above shows the performance of students in the experiment and control groups comparing each range of marks with the percentage of marks of the results between the twogroups. As shown by the graph at the range 0-4none of the experiment group students ranged within these marks while 8% of the control group were within this range. For the range 25-30, 8% of the control group scored marks within this range while 58% of the experiment scoredmarks between 25 and 30.

FIG 4 Comparison of pass rates using pie charts



From charts above in Fig 4 we can see that 71% of the control group failed while only 12% of theexperiment failed represented by blue on the pie chart. The red colour represents thepercentage passed and it shows that only 29% of the students in the control group passed while 88% inthe experiment passed. This is a very significant difference between the results of the twogroups.

Analysis

The data above was analysed using a correlational analysis scatter chart, with Y being theexperiment group percentage pass rates and X being the control group percentage pass rates.This method of analysis has been used so as to analyse if there is a relationship between resultsof the experiment and control groups.

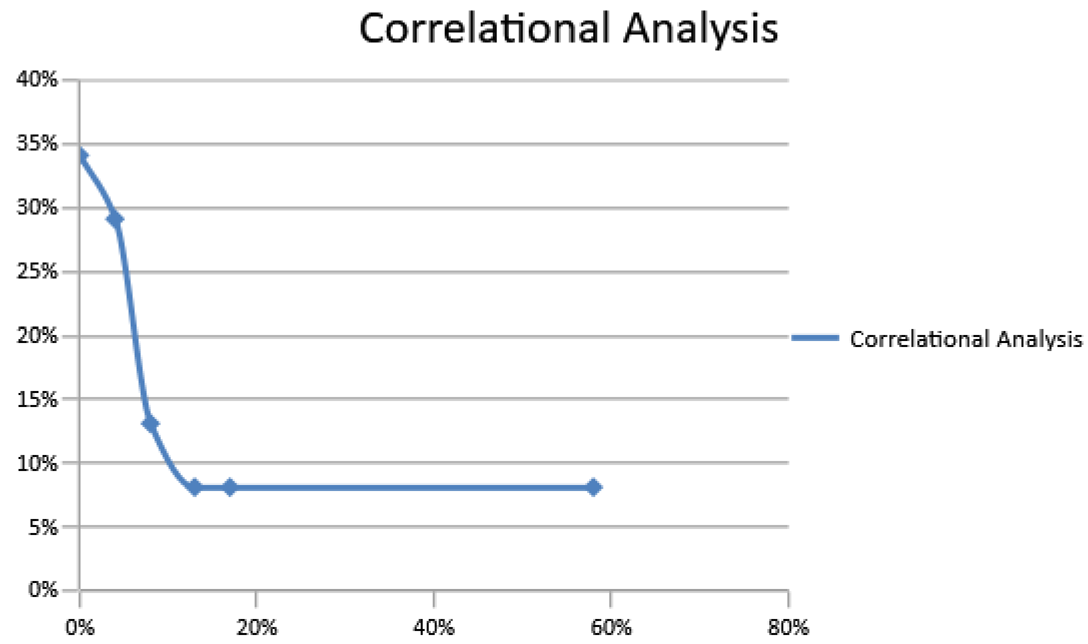


FIG 5

The scatter chart above shows the relationship between the results of the Physics AchievementTest of variable X, the control group and the variable Y, the experiment group. The chart aboveshows that there is a negative linear correlation between X and Y, the results show that as theresults of students in the control group decrease, the results of students in the experiment groupincrease. This means that more students in the experiment group passed as they had been taughtintensive practicals, while the students in the control group havedecreasing marks as they were taught using the lecture method which was not hands on.

From the given data, we can see that there is a high correlation between the results. The datashows that students taught using traditional methods failed with 71% of the students failing whilethose taught using intensive practicals passed, with 88% passing. Omosewo (2018) ascertainedthat in a modern Science curriculum programme, students need to beencouraged to learn not only through their eyes or ears but should be able to use their hands andhead to manipulate apparatus. Thus, thismethod helped 88% of the students to pass. The results show that only 29% of the students passed and the other 71% failed.Cahyadi, 2017) Physical activities have received increasing emphasisparticularly hands on activities.

4.3.2 How does the performance of students differ when taught using practical work method?

Presentation of Physics Pre-test

In order to establish if there is a difference in performance of students taught using practicals and those not in Physics, the respondents were first subjected to a pre-test to determine their equivalence about ability in physics. A Physics Achievements pretestwas used for this purpose. Table 6 below shows the results of the test.

Table 6 Physics Pre-test results

Range of marks	Control group Frequency(24)	Experiment group (23)frequency	% Results for control group	% Results for experiment group
0-4	2	4	8	17
5-9	10	11	42	48
10-14	7	3	29	13
15-19	2	3	8	13
20-24	3	2	13	9
25-30	0	0	0	0

Table 6 results show that the experimental and control groups are fairly equivalent in ability in Physics. This underscores the fact that both the experimental and control groups were starting on a fairy even ground. The pass rates as shown by the pie charts below prove the equivalence in students' ability in Physics. The differences in means were not significant.

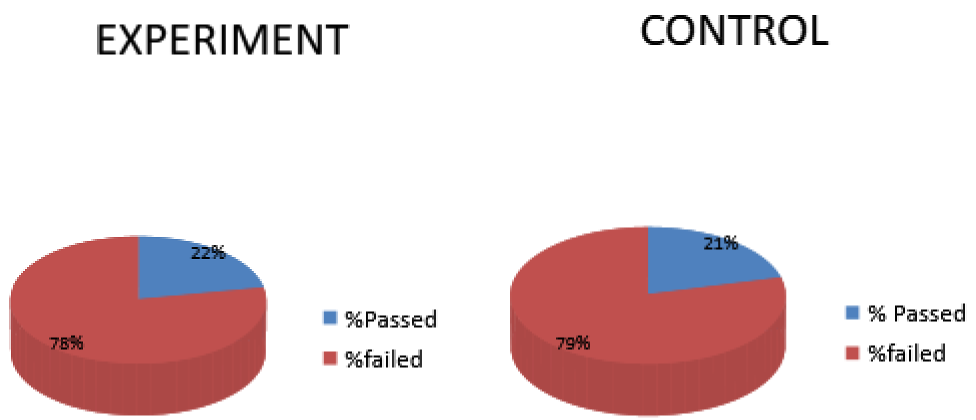


FIG 6

Presentation of Physics Achievement Test (PAT) results

Students from the experiment group were taught using practical while students from the control group were taught using conventional methods, so as to observe if there will be a difference in performance. A Physics post test was then administered after the intervention. The results of the physics achievement test written of both the control group and the experiment are presented in table 7 below and described in detail.

Table 7 Physics Achievement test (PAT) results

Range of marks	Control group Frequency	Experiment Group frequency	% Results for control group	% Results for experiment group
0-4	8	0	34	0
5-9	7	1	29	4
10-14	3	2	13	8
15-19	2	3	8	13
20-24	2	4	8	17
25-30	2	14	8	58

The table above shows the performance of students in the experiment and control groupscomparing each range of marks with the percentage of marks of the results between the two 2 groups. As shown by the table at the range 0-4none of the experiment group students rangedwithin these marks while 34% of the control group were within this range. For the range 25-30, 8% of the control group scored marks within this range while 58% of the experiment scoredmarks between 25 and 30.

Comparison of pass rates using pie charts

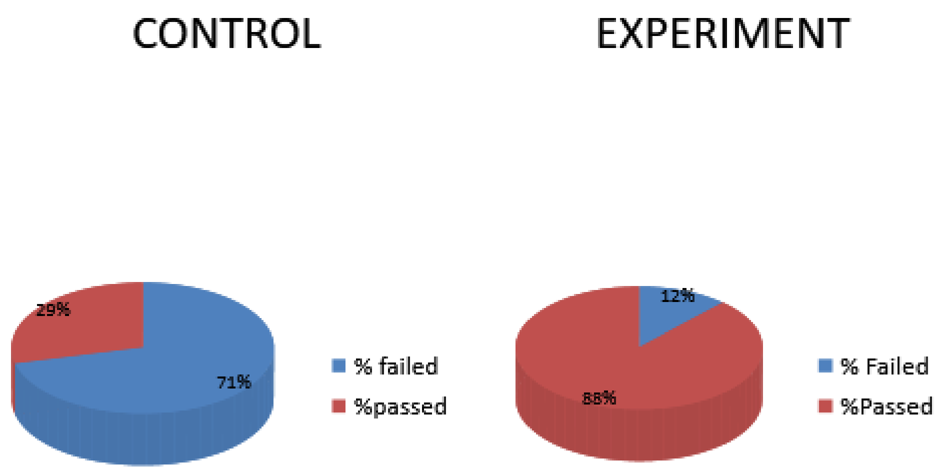


FIG 7

The comparison chart above of pass rates shows that the experimental group performed higher than the control group. For the experimental group had a pass rate of 88% while the control group had 29%. On the other hand, the experimental group had 12% failure while the control group had 71%. This clearlyshows that the intervention was effective and that practical approach is moreeffective. The study may attribute the significant difference in pass rates to practical work which enhanced acquisition of skills resulting in better achievements.

Analysis of Post Test Results

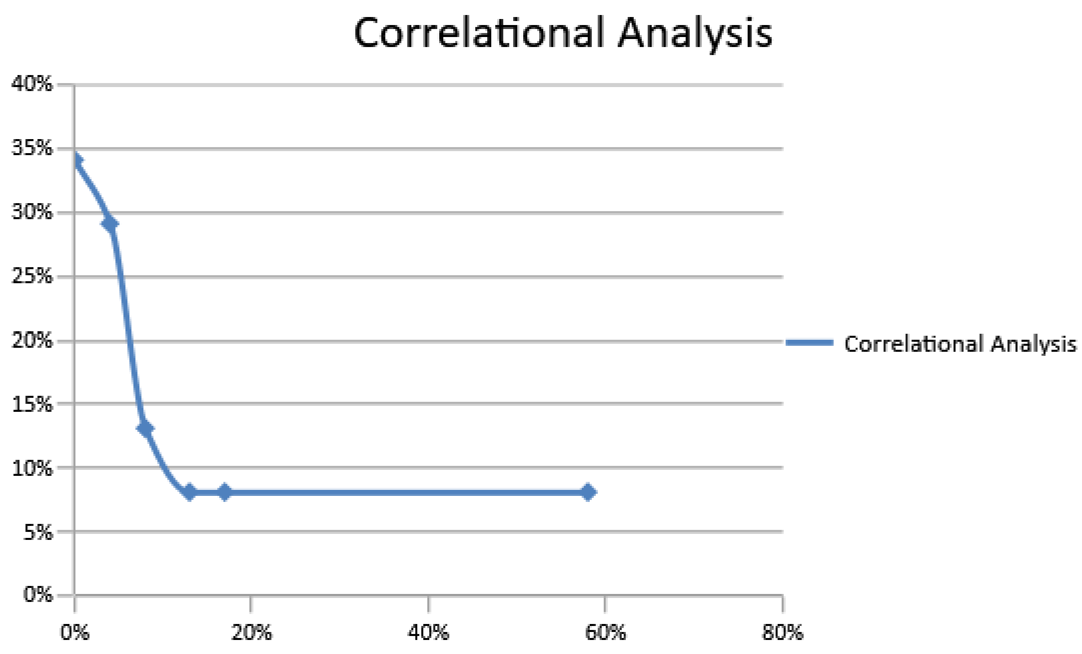


FIG 8

The above analysis shows that there is high correlation between results of experiment group and control group. The study concluded that the students exposed to practical work in Physics performed better than those taught through conventional method. Wasanga (2012) also found a similar correlation between practical work and understanding of science subjects which leads to improved achievements in achievements tests. Amunga *et al.*, (2011a) demonstrated that practical work makes the students take learning science seriously. The determination to unravel the requirements of the objectives of the practical task leads the learners to take charge of the learning situation and to develop an insight in the requirements of the tasks involved in the practical work.

4. 4 Challenges

Participant Attrition, quasi-experimental studies often face the challenge of participant attrition, where some participants may drop out or be lost to follow-up between the pretest and posttest. This can lead to biased results and reduced statistical power. Also, the study was limited to one school and one science subject (Physics). Inaddition, the researchers did not have the freedom to choose what was to be taught but had to follow theoutline of the subjects' curriculum provided by the school. The number of lessons per week also had tobe limited to what was scheduled and planned by the school. It may suffer from factors such as being toopopulation-specific.Another challenge is that, intervention was done in a short period that should not be enough to measure the changes in students' performance.

4.5 Solutions

Strategies to minimize attrition were employed, this was done by providing incentives for participation, maintaining regular contact with participants, and addressing any barriers to continuedparticipation. Also researcher Employed statistical techniques, such as intention-to-treat analysis or multiple imputation, to handle missing data and account for the effects of attrition.

4.6 Discussion

Considering the first hypothesis, There will be a significant difference between the performance of students expose to more practical work than those who are only taught towardsexamination, hypothesis one was accepted. The study concluded that the students exposed to practical work in Physics performed better than those taught through conventional method. Wasanga (2012) also found a similar correlation between practical work and understanding of science subjects which leads to improved achievements in achievements tests. Amunga *et al.,* (2011a) demonstrated that practical work makes the students take learning science seriously. The determination to unravel the requirements of the objectives of the practical task leads the learners to take charge of the learning situation and to develop an insight in the requirements of the tasks involved in the practical work.

Lunetta *et al.,* (2017) suggested that engaging in scientific practical work providessimulationexperiences which situate students learning in states of inquiry thatrequire heightened mental and physical engagement. This engagement leads to betterunderstanding and improved achievements. However, Hodson (2012) castscautionary aspersions on the relationship between practical work and achievementsin secondary schools. The thrust of his argument is that experimental attempts in theaverage high schools are sterile and un-illuminating. According to him, the practicalwork is ill conceived, confused and unproductive. It does not translate into tangibleachievements bonuses for the learners.Omosewo (2018) ascertainedthat in a modern Science curriculum programme, students (male and female) need to beencouraged to learn not only through their eyes or ears but should be able to use their hands andhead to manipulate apparatus.

The results of our research show that there is a positive correlation between practical work and theacademic attainment of most students in science. The findings are directly in line with previous studies'findings such as a study by Abdi (2014), which stated that the experimental groups had a much greaterunderstanding of the information covered, especially regarding questions that required interpretation.Teachers were advised to consider how to prepare learning environments in which students will be moreactive and then present these environments to students.In fact, other research has generated similar results. For example, Hofstein and Lunetta (2016) andHofstein and Mamlok-Naaman (2017) mentioned that laboratory work plays an important role in scienceeducation and also helps in understanding the difference between observation and presentation of data.Hodson (2012) considered that practical work can motivate students and stimulate their interest inteaching and learning.

According to Millican, Richards & Mann (2015) Physics is an experimental subject.General principles and concepts are more easily understood if they are demonstrated in the laboratory. Laws and relationships are more fully appreciated if the studentinvestigates and verifiesthem at the laboratory bench. The study thereforeconcluded that practical work in Physics as an instructional strategy significantlycontributes to students' achievement in Physics.

Uwaifo (2012) found a statistically significant relationship between theory and practical scores onall science subjects. A similar correlation was also found between understanding science subjects and practicalwork which lead to improvement in achievement tests (Wasanga, 2012). Practical work makes the students takescience learning seriously as demonstrated by Amunga, et al (2011). The determination to meet physicsobjectives requirements of practical task leads the student to take charge of the learning situation and develop aninsight in the requirements of the task involved. Lunetta et al (2017) suggested that engaging in science practicalwork provides simulation experiences which situate students' learning in states of inquiry which needs highmental and physical engagement.This is evident that the interventionstrategy adopted (practical work) had improved theability of the students to acquire requisite scientificprocess skills needed for practical work in Physics.This is in congruence with the findings of the studyby Kim and Chin (2011), who indicated that practicalwork was a significant tool for developing students'scientific knowledge and habit of mind, andtherefore offered students a more realisticexperience in science and provided learners withmotivation.The findings buttressed theconclusion by Sabri and Emuas (2016) that therewas a strong relationship between the total numberof secondary science practical work in secondaryschools and their academic achievements.

On the other hand, Boyuk et. al. (2014) and Ayogdu (2015) put forward that some teachers havereservations in regard to laboratory work. They mentioned that laboratory work is vital for studyingsciences but there are certain problems encountered such as the lack of materials needed for the requiredexperiment, insufficient information for carrying out the experiment, the techniques followed during theexperiment, the glassware and the chemicals needed for the experiment, safety rules, what steps need to befollowed to avoid any accident during the experiment, and finally what should be done in case of anaccident during the experiment.

4.7 Summary

The findings from the pre-test and post test were presented in this chapter as tables, pie charts and summative descriptions. The results were discussed in line with the literature review. The next chapter summarizes, concludes and makes recommendations of the research

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

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5.1 Introduction

The chapter concentrates on giving the summary of the entire study, making conclusions and recommendations. This is done in line with the study' s reseach questions and objectives. The chapter is subdivided into the following sub headings; summary, conclusion and recommendations.

5.2 Summary of the study

The study set out to investigate thefactors affecting the effective teaching and learning of ordinary level physics practical work. The first chapter discussed the research problem and its setting. It focuses on the following subthemes; background of the study, statement of the problem, research objectives, research questions, importance of the study, Delimitations of the study, Limitations of the study and definition of key terms. The researcher faced some limitations in carrying out the study. The limitations included limited financial resources and network challenges in terms of internet. The researcher overcame the challenge of financial constrain by cutting unnecessary expenses.

Chapter two of this study is reviewed related literature. This was done in line with the research questions. In this study the concept of the factors affecting the teaching and learning of ordinary level physics were outlined as conceptual framework of the study. The study and reviewed literature regarding the topic in the light of each research question showed that pupils performed very well when taught using intensive practicals in the teaching and learning of Physics

Chapter three focused on methodological issues. The research design was quantitative. A Quasi experimental design was used. The researcher used a Physics Achievement Test to gather data. A sample of one form 3 class at a school in Gokwe south district studying physics was used and students in the class divided into two groups the experimental group and the control group.

Chapter 4 was centred on data presentation, analysis and discussion. Participation response rate was 100%. All the learners took part in the research. The findings proved that it is difficult to bring certain scientific concepts to reality without practical demonstrations. It is also clear from the findings that with practical all learners participate and hence learning takes place.

5.3 Conclusions

For the main research question, “How do the academic achievements of students compare, before and after using practical work to teach selected topics?”, the study concluded that practical work helped to enhance the academic achievement of students in Physics. This is indicated in the fact that students’ academic achievement after the inculcation of practical work was higher than the students’ academic performance before the introduction of frequent practical work. The students’ level of acquisition of the requisite scientific process skills needed for science practical work was greatly enhanced during the implementation of the intervention strategies of the study. Findings suggested that the lesson conducted by the use of text books, charts and diagrams on the board only can be boredom and pupils can easily fail Tests. The research study further indicated that no course in Physics can be considered as complete without doing practicals. This is to say Physics can only be taught best by using practical demonstrations. It can thus be concluded that it is difficult to bring certain scientific concepts and laws to reality without practical demonstrations for it will lead to pupils` failure as indicated by the findings. Findings further suggested that practicals are of paramount importance if any shortage arises or if there are no apparatus available for the teaching and learning of physics, as it helps to make learning to proceed. Therefore, it is clear from the findings that with practicals most learners participate hence learning take place and students’ achievement increases.

In spite of the merits of the methods of practical and demonstrations in teaching concepts in physics, teachers should worry of the shortcomings of these methods. These methods are time consuming to set up and they work well when the pupils themselves are intrinsically motivated. Also, the apparatus and chemicals used in most of the time in the experiments needs care especially where dangerous chemicals and breakables are used.

On the sub question, “how does the performance of students differ when taught using practical work method?” The second objective of the study was to establish how the performance of students differ when taught using practical work method in Physics. The study concluded that there was a significant difference in performance of students in Physics for students taught Physics through practical and those taught through conventional methods.

5.4 Recommendations

Following the above conclusions, the study made a number of recommendations to various stakeholders. They are divided into sections (1) for action and (2) for further study.

5.4.1 Recommendations for Action

1. The study has shown that practical approach improves performance of students. It istherefore recommended that teachers should use the practical approach in theteaching of the subject because it leads to acquisition of science process skills,enhances students' understanding and eventually better students' performancein the subject. However, the studyrecommends an evaluation by teachers of the science process skills as thepractical activities are being carried out by the learners.

2. Secondly, the study recommends that the school administrators and the Boardsof management should construct and equip Physics laboratories since the practical approach to teaching the subject demands such facilities.

5.4.2 Recommendations for Further Study

The study finally recommends areas for further research.

1. A laboratory is the key for practical approach. I therefore recommend that a study be conducted to find out the state of the laboratories in secondary schools in Zimbabwe.

2. Analysis of the impact of the Practical Approach in teaching Physics to a greater population or in other locales in Zimbabwe.

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APPENDIX 1 : An Example of a Marking Scheme for Practical Work in Physics

The Principle of Moments

By the end of the lesson the learner should be able to state and verify the principle of moments

Experiment:To verify the principle of moments

Apparatus:- metre ruler, known masses, string, retort stand

Procedure

1. Balance a meter ruler at its center using the string

2. Place a known mass W1, on one end of the metre ruler and balance the metre ruler by placing a different known mass W2 on the other side of the metre ruler as shown in the diagram.

3. Record the distance d1 and d2

4. Repeat using different known masses for W1 and W2

5. Complete the table below

W_1	W_2	d_2	d_2	$W_1 \times d_1$	$W_2 \times d_2$
10	100				
20	80				
40	50				

6. Compare the value of W1Xd1 and W2Xd2

7. Conclusion

A Marking Scheme (Confidential)

1. 2 marks for balancing the metre at its centre (manipulative skills)

2. 4 marks placing the masses as instructed (manipulative skill, observation,interpretative skills)

3. 4 marks for being able to make correct reading (observation reading)

4. 4 marks for being able to (manipulate the masses, recording, reporting)

5. Table 6 marks (½ x 12) = 6 work for each reading and ½ work for working out the product. (observation skills, recording, manipulation, reporting, reporting,measurement, accuracy)

6. 2 marks for correct answer and correct comment (reporting)

7. 2 marks for correct conclusion (interpretation inferring)

In a ZIMSEC examination, 10 marks awarded are those for correct readings on thetable and conclusion. However, the prototype marking scheme has an overall marks of 24. This shows the need to recognize the observation, recording and measurementskills which are not usually considered during ZIMSEC examination marking.This type of assessment which can be called performance assessment is moreeffective for science subjects. It assesses the student as he/she performs theexperiment and it is more comprehensive and rewarding to the student.

Appendix II: PRE-TEST

Answer all the questions in the paper   Time: 40 minutes

To be administered to all Groups before Experiment Begins

1. Fill in the table below the basic quantities measured in Physics, their SI units and symbol (3mks).

Quantity	S.I Units	Symbols
Length		
	Kilograms	Kg
Time		
Weight		N

2. A thin thread 100cm wraps round a cylinder 20 times with the windings

touching and not overlapping. Find the radius of the cylinder.(give your answer

to 2 decimal places) (2mks)

....

....

....

3. Convert the following

a) 0.75m2 into cm^2 (1mk)

....

....

....

b) 0.005mm2 into cm^2 (1mk)

....

....

....

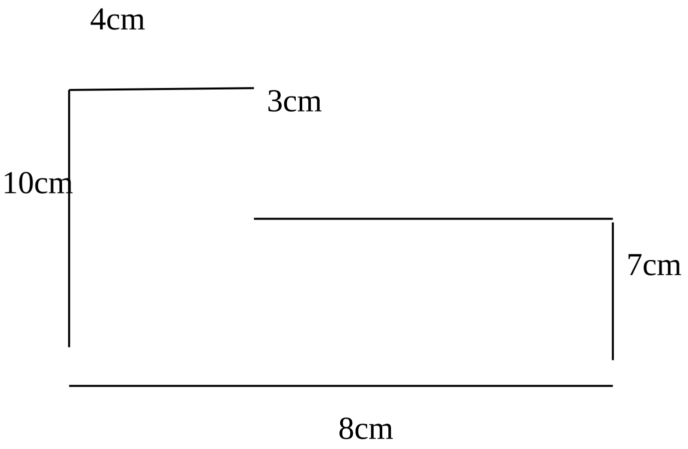
c) 250km2 into m^2 (1mk)

....

....

....

4. Find the area of the figure below in m^2 (2mks)



5. Briefly describe how you could determine the volume of a stone which has irregular shape. (4mks)

....

....

....

6. Define density (1mk)

…………………………………………………………………………………

…………………………………………………………………………………

7. A block of glass of mass 187.5g measures 5.0cm x 2.0cm x 7.5cm. Calculate the density of the glass in SI units. (3mks)

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

8. The mass of an empty bottle is 20g. its mass when filled with water is 40.g and 50.0g when filled with liquid X. Calculate the density of liquid X given that the density of water is $1000kg/m^3$ (4mks)

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………………

9. 250cm^3 of liquid (A) of density 0.5g/cm^3 is mixed with 150cm^3 liquid (B) of density 1.2g/cm^3. Determine the density of the mixture. (4mks)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

10. Define force and state SI units (1mk)

…………………………………………………………………………………………

…………………………………………………………………………………………

11. State 3 effects of forces (3mks)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

TOTAL 30 MARKS

Appendix III: POST TEST

Answer all questions in this paper Time: 40minutes

To be administered to both Groups at the end of every topic

SECTION A: MOMENT AND FORCE

1. Define the moments of a force and state its SI units. (2mks)

………………………………………………………………………………………

………………………………………………………………………………………

2. (a) Explain why it is easier to loosen a tight nut using a spanner with a long handle than one with a short handle (1mk)

………………………………………………………………………………………

………………………………………………………………………………………

(b) The handle of a door is usually placed as far as possible from the hinges. (1mk)

………………………………………………………………………………………

………………………………………………………………………………………

3. A uniform meter ruler is balanced at its centre point. An object weighing 20N is placed 10cm from the ruler's midpoint on the right. Calculate the force that can balance the metre ruler as from zero mark (2mk)

………………………………………………………………………………………

………………………………………………………………………………………

4. Two masses weight 200N and 500N are suspended at the end of a rod 5m long. Determine the position of the pivot from the 200N mass (3mks)

………………………………………………………………………………………

………………………………………………………………………………………

5. State the principle of moments (1mk)

………………………………………………………………………………………

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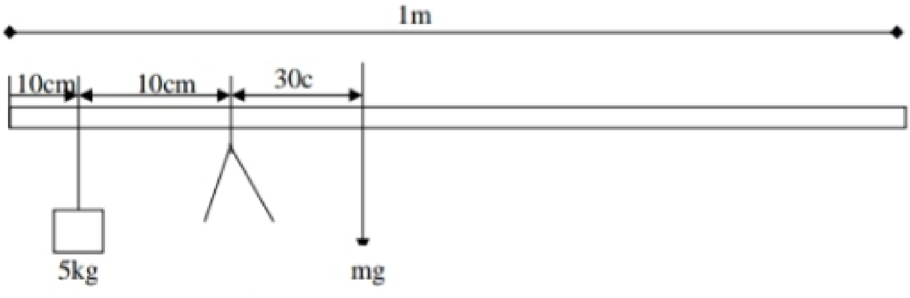
6. Calculate the weight of the uniform beam, assuming that its weights acts through the centreof the beam which is in equilibrium (2mk)



7. (a) State four application of antiparallel forces (2mks)

………………………………………………………………………………………

………………………………………………………………………………………

(b) Define the term antiparallel forces (1mk)

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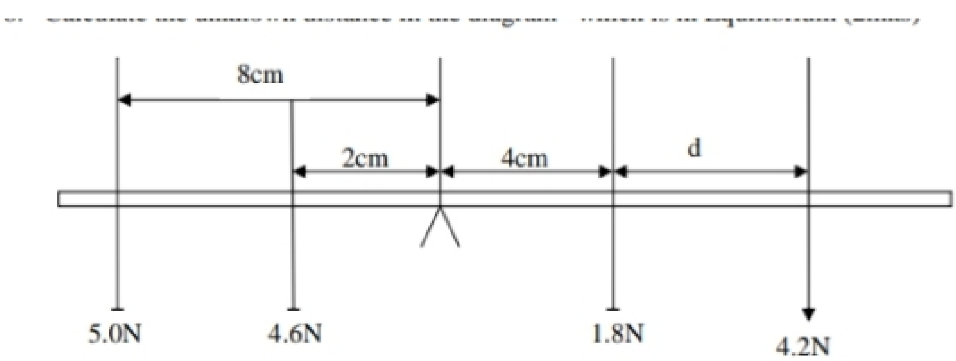
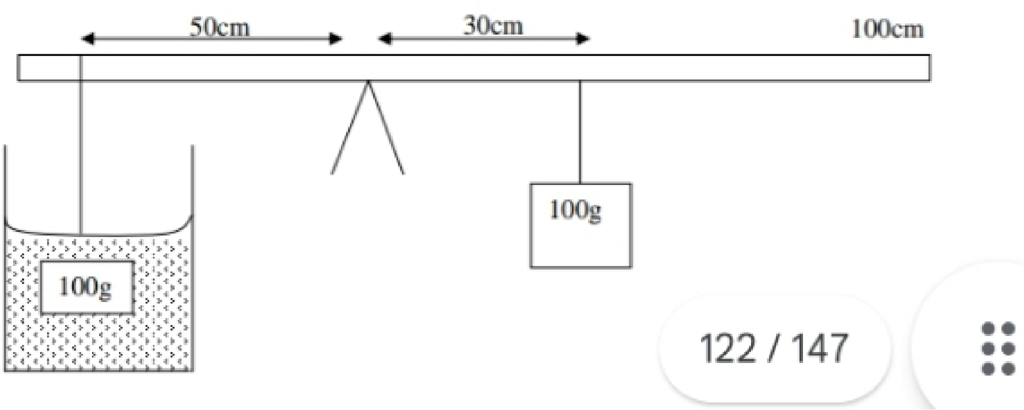
8. Calculate the unknown distance in the diagram which is in Equilibrium (2mks)



9. (a) A student wanted to investigate up thrust in a liquid and set-up the apparatusas shown in the figure below



2 masses of 100g each are suspended on either side of the pivot. One of the massesis immersed in a liquid and balances 50cm from the pivot while the other one is suspended in air and balances at 30cm from the same pivot. Determine the upthrustof the liquid. (3mks)

……………………………………………………………………………………………

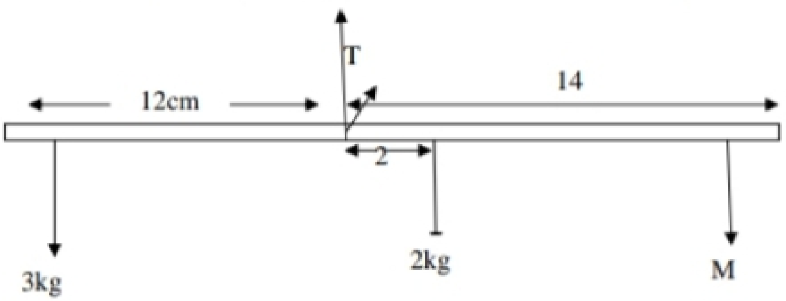
………………………………………………………………..;……………………

10. Sewe weighs 600N and sits 4m from the pivot of a see saw. Silvia weighs 900Nsits 3m from the pivot. By calculation who of the 2 will move up (2mks)

…………………………………………………………………………………….

…………………………………………………………………………………….

11. (a) The figure below shows a wooden block of mass 2kg balanced by 3 forces. Determines the value of mass M 3mg and the tension T (3mks)



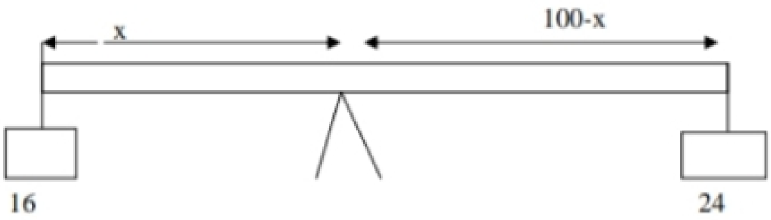
(b) What is the tension T of the string suspending the system (2mks)

………………………………………………………………………………….

…………………………………………………………………………………

…………………………………………………………………………………

(c) A wooden block is balanced from both ends by 16N and 24N. Determine where the pivot will be. (3mks)



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TOTAL 30 MARKS

Appendix IV: Marking Scheme for Pre-Test

MARKING SCHEME Time: 1½ hours

1.

Quantity	S.I Units	Symbols
Length	Metre	M
Mass	Kilograms	Kg
Time	Seconds	S
Weight	Newton	N

2.

20times = 100cm
I time – 100 x 1 = 5cm
2π D=5 =D=5/2 π
=0.796cm
R=0.796/2
=0.398cm

3. (a)

0.75m^2 into cm^2

1m^2= 10000cm^2

0.75m^2= 0.75 x 10000

=7500cm^2

(b) 0.005mm^2 into cm^2

100mm^2=1cm^2

0.005mm^2 = 1x0.005/100

=0.00005cm^2

(c) 250km^2 into m^2

1km= 1000m
1km^2=1000 x1000m^2

$250km^2 = 250 \times 1000 \times 1000$

$= 250\ 000\ 000$

4. $8cm \times 7cm = 56\ cm^2$

$3cm \times 4cm = 12cm^2$

Total= $68cm^2$

5. Fill a Ureka can with water and let the water settle. Tie the irregular body with a light string; place a measuring cylinder at the spout. Gently lower the irregular body into the can until it is totally immersed. Collect the water in the measuring cylinder and read the column of water collected. This is the volume of the object.

6. Mass per unit volume

7. Density = mass/ volume

$= 187.5g/5 \times 7.5$

$=2.5gkm/cm^3$

= 2.51000

=2500

8. Mass of water = 40g- 20g = 20g

Mass of liquid = 50g-20g = 50g

Volume of water = $20g/1gkm^3 = 20cm^3$

Density of liquid = $30g/20cm^3$

$= 1.5gkm^3$

9. Mass of A = $250cm^3 \times 0.89g/cm^3$

Mass of B= $150cm^3$x $1.2g/cm^3$

Mass of mixture= 380g

Volume of mixtures = 250 +150 = 400

Density = 380/400

=$0.95gkm^3$

10. Force is a push or a pull and the SI unit is Newton

11. 3 effects of forces

· Can cause motion
· Stop motion
· Increase speed of motion
· Reduce speed of motion

Appendix V: Marking Scheme   Post Test

MARKING SCHEMES ***Time: 40 Minutes***

1. It is the product of force and the perpendicular distance from the turning point to the line of action of the force, NM.

2. (a) The longer arm provides a higher moment as compared to the shorter one
(b) To produce high moments to make the door easy to open and use less force.

3. 50W = 20 x 10

W= (20 x 10)/ 50 = 200/50

= 4N

4. 200x – 500 (5 –x)

200x = 2500 - 500x

700x = 2500

x = 25/7

=3.57

5. For a system at equilibrium the sum of clockwise moments about a point equals the sum of anticlockwise moment about the same point.

6. (5kg x 10m)/ 30cm = (30m x m)/30

M = 5/3 kg = 1.667kg x 10N/kg = 16.67N

7. (a)Application
- Opening and closing a water tap
- Opening a nut using a spanner
- Steering wheel
- Bicycle handle

(b) These are forces acting parallel, equal and in opposite direction

8. Distance = (5 x 8) + (4.6 x 2) = (4 x 1.8) + 4.2 (d + 4)

40 +9.2 = 7.2 +4.2d +16.8

49.2 – 24.0 = 24 +4.2d = 25.2/4.2

d = 252/42

d = 6c

9. 50m x 1N x 30m + (50mx v)
50Ncm= 30Ncm +50cmv
50Ncm- 30Nm = 50cmv
20Nm/50m = 50cmv/50cm
V= 0.4N

10. (a) cm = 600N x 4m = 2400NM

ACM = 900N x 3m = 2700NM
Silvia moves up

11(a). 3 x 12 = 2 x 2 + 14m

36 = 4 + 14m
40 = 14m

m = 40/14 = 2.857

(b). T = (3kg +2kg + 2.857kg) x 10N

= 7.85kg x 10 = 78.5N

(c). 16x = 24(100- x)

16x = 2400 – 24x

40x = 2400
x= 60

APPENDIX VI

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 3/06/24

TO WHOM IT MAY CONCERN

NAME: NDEBELE PRINCESS REGISTRATION NUMBER: B1438160

PROGRAMME: HBSCEd PHYSICS 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 HBSCEd (Physics) programme. The research topic is:
AN ASSESSMENT OF FACTORS AFFECTING THE EFFECTIVE TEACHING AND LEARNING OF ORDINARY LEVEL PHYSICS PRACTICAL WORK.

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

Your co-operation and assistance is greatly appreciated.

Thank you

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

Z Ndemo (Dr.)
CHAIRPERSON - SAMED