AN INVESTIGATION INTO THE USE OF EXPERIMENTS IN THE TEACHING AND LEARNING OF PHYSICS AT 'O'LEVEL; A CASE STUDY OF BINGA DISTRICT

BY

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APPROVAL FORM

The undersigned certify that they read and recommended to the Bindura University of Science Education the project tilted ‘an investigation into the use of experiments in the teaching and learning of physics, a case study of Binga District in Matebeleland North province submitted by Nyathi Oncemore (B213341B) in partial fulfillment of bachelor of science education (honours) degree in physics.

SUPERVISOR …… DATE ……

CHAIRMAN ……DATE…….

STUDENT……..DATE……

DECLARATION

I declare that this research project is my own independent work and has not been copied without the acknowledgement of the source.

…… …….....

(Signature) (date)

DEDICATION

I dedicate this project to my loving mother, wife and other family members for their unwavering support throughout my research

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ABSTRACT

The study was aimed at finding out the extent to which experiments are integrated in the teaching and learning of physics. A case study was employed and the study was carried out in Binga district. The researcher used an observation schedule, interviews for the teachers, focus groups and questionnaires for the learners to gather data on the use of experiments in the teaching and learning of physics and results indicated that motivation and performance improved when experiments are used. The researcher used a sample of all the form three physics in Binga district. Data gathered signified that experiments are very effective for the conveying of data during lesson delivery and therefore the researcher recommended the ministry responsible to formulate policies that make it a mandatory to use experiments during physics lesson delivery.

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CHAPTER 1: **INTRODUCTION**

In this chapter the researcher is going to highlight issues like background of the study, importance of the, delimitations of the study, sub problems, objectives of the study, definitions of key terms and summary of the chapter.

1.1 BACKGROUND OF THE STUDY

The types of classroom interactions created by the teacher and the types of questions he/she uses to structure the teaching play an important role in the kinds of thinking skills learners employ, the range of information to be covered and the thinking skills they may learn (Smart & Marshall, 2012). This suggests that teacher' abilities to create an enabling atmosphere that allows meaningful classroom interaction with students cannot be underestimated. Students can meaningfully build upon their knowledge and understanding of science through the process of scientific inquiry and therefore commended countries that have been engaging students in this process (International Association for the Evaluation of Educational Achievement [IEA], 2012). This is a wake-up call for our educational institution to place considerable emphasis on teaching and learning of science through inquiry based processes. Science with physics in particular, is best practiced through active engagement and inquiry into the physical phenomena in the world. Effective learning of physics (learning with understanding) is described as a type of learning in which learners take responsibility for their own learning through active construction and reconstruction of their own meanings for concepts, events and experiences. Africa as a continent which is behind economically need to prioritize science education so that the young generation will participate in the economic development of their countries (SCORE, 2013). Many countries in Africa, and the world at large embraced the use of Science, Technology, Engineering and Mathematics (STEM) as a way of improving their economies. Physics is a part of STEM subjects. Gadzirayi C.T., Bongo P. P., Ruyimbe B., Bhukuvhani C. and Mucheri T (2016) postulates that "the socio-economic future of Southern Africa lies in the region's ability to embrace Science, Technology, Engineering and Mathematics (STEM). Education as the main drivers of economic development should put a greater emphasis on hands on activities to ensure that learners are able to marry theory to practice. The ability to use STEM related knowledge innovatively, depends upon an adequately capacitated and scientifically literate population. The provision of a sound STEM education in all institutions of learning is therefore imperative crucial for all countries.

Sotiriou, Bybee and Bogner (2017) state that: “While solving a scientific problem, students should act like a scientist and follow scientific processes.” The goals of practical work are to improve students’ understanding, develop their skills in solving problems and understanding the nature of science, by replicating the actions of scientists. Tsakeni (2018) explored access to effective practical work for physical sciences learners in two South African high school schools. The results revealed that the absence of practical examinations resulted in underestimating practical work in physical sciences classrooms, and thus marginalised learners. Tsakeni indicated that the limited access led to a social justice agenda due to the high expectations linked to studying physical sciences. Tsakeni recommended supporting practical work through the processes of assessment and tools for instructional leadership.

Zimbabwe is on the verge of improving its industrial power. To achieve industrialization a country must have a well skilled workforce for example in developed countries like Japan.The Japanese government has prioritized the development of creative approaches to science education. Some of their initiatives have been in partnership with Miraikan, Japan's National Museum of Emerging Science and Innovation, which works with schools at all levels and to help teachers motivate their science students (Isozaki, 2017). For countries like Japan, which have limited natural resources, science education is also important to train human resources like scientists and engineers and physics practicals help them to have such skills (Ozawa, 2014). Japan also prioritized use of practical lessons in schools to inculcate skills in learning which are necessary for science initiatives and innovation. To accelerate industrialization for

socio economic transformation, the Government of Zimbabwe pronounced the ‘Second Science, Technology and Innovation Policy’ framework, which provided the two Ministries of Primary and Secondary Education and Higher and Tertiary Education, Science and Technology Development with the opportunity to implement the relevant spellings out of that policy document (Chitate H, 2016). The former launched an update review of the national curriculum, in 2014, which culminated, in the crafting of the Zimbabwe Education Blueprint (2015-2022). That education-design plan has many facets. Chief among them is a deliberate emphasis on the teaching of Science, Technology, Engineering and Mathematics, subjects that are now known popularly by the acronym ‘STEM’. The STEM subjects include physics which the researcher is of interest in this research process. The National ZIMSEC physics syllabus lists practical activities that should be done with

each curriculum item listed. It also recommends that the teaching of all topics listed in the syllabus should be practical based. According to Chitate H (2016) states that, "suggestions for practical activities or demonstrations that are considered essential and which all learners should have been exposed to, either through coursework for example in this case through CALA or preparation for the practical examination, are included at the end of each topic"

Mandina (2012) investigated an Evaluation of Advanced Level physics Teaching in Gweru District Schools, Zimbabwe. The study established that the important factors that limit the quality of physics teaching and learning include overloaded curriculum content and inadequate time for teaching; inadequate resources, apparatus, equipment and consumables. The practical aspect was not well established. Furthermore, in this study the researcher will exploit challenges faced by teachers and learning in physics experiments.

Physics is one of the subjects that is offered in o'level schools in Binga district and is characterized as the most utilitarian of all the experimental sciences because for example, in Zimbabwe, a good Advanced level pass grade in physics is a prerequisite for joining engineering professional courses. Poor performance in the subject means fewer students are able to join such professions, therefore lack of enough professionals leading to low number of mechanical engineers thereby increasing the country's imports and less exports, for example most weapons and machinery systems are bought from abroad yet we have an education system as well as a country. Improvement of physics teaching and learning will help in the achievement of country's vision of STEM education. Learning of physics at ordinary level provides background for the professional studies in the tertiary education for example in polytechnics. The teaching of physics therefore, as a scientific discipline must help students gain scientific literacy abilities and to grow into scientific literate citizens

1.2 STATEMENT OF THE PROBLEM

Physics and technology are the key drivers of national economic development, hence the education sector should provide tertiary institutions with clients with such subjects. There is global concern about the number of students pursuing physics at both secondary and tertiary levels and the number of graduates although governments especially the Zimbabwean government has tried by the means

possible to establish rehabs in tertiary learning institutions to promote innovation. Due to this, teachers are expected to device ways of motivating their students to develop positive attitudes towards science and science related disciplines and in order to facilitate the process of knowledge transmission, teachers are expected to apply appropriate teaching methods that best suit specific objectives and level exit outcomes (Hightower, 2011). Quit regularly, regular poor academic performance by the majority of students in physics is fundamentally linked to application of ineffective teaching methods by teachers to impact knowledge to learners (Adunola, 2011). Teacher variables, student's variables and environment-related variables contribute greatly to poor performance of students in physics. These teacher variables and students' variables are almost always intricately linked to teaching methods used to impart knowledge to students (Adunola, 2011).Use of experiment as a teaching methodology for Physics in secondary school is crucial for successful concept delivery by the subject teachers and concept mastery by the learners. Therefore, science and technology course efforts to make students capable of using scientific process in solving problems, making decision, understanding the nature of science and technology, critically analyzing of recently provided scientific knowledge and its role in human society (Özkal et al., 2010). Scientific knowledge is identified as two broad domains: content knowledge and process skills. Content knowledge includes the facts, principles, conceptual models, theories and laws which students are expected to understand and remember. In the other hand, process skills are the techniques used in science, for example, observation, measurement, and developing hypotheses, which students are to master. Both domains are considered necessary in order for students to fully understand science concepts and be able to apply them. To Susi (2011), today the teaching of science has insufficient results, leading us to consider that one of the problems is linked to the model of teacher training, ranging from disciplinary specificity to generality. In the South African context teachers mostly use the lecture method which is perceived as status quo in the environment and has been used for many years and also in use up to date (Hamm, Cullen and Ciaravino, 2013). The study was underpinned by the constructivist theory and cognitive apprenticeship model. The reason is that students must be active participants and engaged in their own learning in order for meaningful learning to occur. Constructivism as a theory, has evolved from not only learning about declarative knowledge but also knowing how and when to learn in different ways. Accordingly, the teacher acts as a facilitator or mediator of learning rather than someone who only takes on the role of imparting knowledge. The cognitive apprenticeship model also presumes that learners

should be exposed to the teaching methods that give students the chance to observe, engage in, invent, and discover expert strategies in context. Accordingly, the teaching methods should systematically encourage student exploration and independence. The convergent parallel design (Creswell & Clark, 2011) of this study used mixed methods, including a national survey of physics teachers throughout Binga, a student survey, as well as classroom observations and interviews with high school physics teachers, high school students and initial teacher educators who were coordinating the physics education programmes. The aim of the study is to find out the extent to which experiments are integrated in the teaching and learning of physics.

1.3 RESEARCH QUESTIONS

Which teaching methods are used in the teaching and learning of physics?

Why do teachers fail to use experiments?

What strategies can be employed to ensure that experiments are used in the teaching and learning of physics?

1.4 ASSUMPTIONS

Students have a problem in conducting A' level experiments

Respondents are giving answers to the best of their knowledge

The sample used will give a representation of the entire population

Respondents are not harmed by questions asked

1.5 SIGNIFICANCE OF THE STUDY

The research is importance in that it provide researched solutions to the problems affecting the education system. It is also important in providing and assisting teachers, learners and all other stake holders in the education sectors in efficient lesson delivery in various subject areas. It provides teachers with motivational skills which enables pupils to have positive attitudes towards learning physics as a subjects. The research is vital in adopting interactive teaching methodologies in the teaching and learning of physics and other subjects in Binga cluster.

1.6 LIMITATIONS

The chosen sample might not give a good representation of the entire population

Ensuring the validity of chosen instruments might be difficult

Research was confined only to certain schools due the in availability.

1.7 DELIMITATIONS

The research was carried in Binga cluster and it concentrated on experimentation as a teaching and learning method at Manjolo High, Binga high, Siachilaba secondary and Siansundu secondary school in the teaching and learning of physics.

1.8 DEFINITION OF KEY TERMS

For the purpose of this research, the following terms will be taken to mean:

Demonstration involves showing students the correct use of science apparatus, illustrating a technique used in performing an experiment which is dangerous, risky, difficult or expensive for individual students to use

Motivation refers to the internal and external factors which cause and sustain behaviours to achieve specific objectives and goals. It is what energise a person and direct his or her activities. It can be also be defined as the process of making someone feel encouraged to do something. Motivation is of two types, intrinsic motivation and extrinsic motivation. Intrinsic motivation involves internal driving factors while extrinsic motivation external factors.

1.9 SUMMARY OF THE CHAPTER

This chapter focused on the background of the study, statement of the study, research questions, limitations of the study, and delimitations of the study, importance of the study and definitions of key terms.

CHAPTER 2: LITERRATURE REVIEW

2.0 **INTRODUCTION**

In the previous chapter the researcher examined research questions, importance and objectives of the study. This chapter will focus on the literature review which will consider various views different authorities pertaining use of experimentation as an interactive teaching and learning methods. This chapter will enable the researcher to have an insight of the research problem since the research will utilize what other researchers had written on the same subject area under investigation. Over the years, physics education has been tainted with persistent low enrolment figures and low numbers of physics teachers coming through the education system. Investigation into the teaching and learning of physics is therefore necessary for raising awareness of the issues canvassed, which may indicate issues to be addressed, perhaps through policy, as well as leading to an improvement in physics instruction/teaching and achievement. The review is thus presented and discussed under sub-headings as follows: theoretical framework; beliefs and conceptions of physics teachers about physics; nature of physics classroom practices; teaching and learning of physics – conceptual change and problem solving; preparing physics teachers for high/secondary schools; initial teacher education effectiveness; professional development for teachers; and purposes and practices of assessment in teaching and learning

2.1.0 **THEORETICAL FRAMEWORK**

According to Labaree (2013) the theoretical framework is the structure that can hold or support a theory of a research study. It introduces and describes the theory that explains the research problem under study. This study is underpinned firstly by the theory of constructivism because it deals with learning.

2.1.1 **CONSTRUCTIVISM**

According to Woolfolk (2015) one of the major principles of the constructivist view of learning is that the learner has to take an active role in building understanding and making sense of information. This implies that knowledge is not passively received but actively built up by a thinking individual. However, experiment-based learning is rarely undertaken by most teachers in developing countries due to the scarcity of resources, inadequate practical skills, large class size in secondary schools, and inadequate infrastructures. The constructivist teacher is a facilitator who

encourages students to discover principles and construct knowledge within a given framework or structure (Ahmad, 2009; Kalra & Gupta, 2012). In addition, teachers' attitudes to teaching physics through practice is critical based on the above-described factors. The teacher learner interaction becomes meaningful when the teacher allows the learner to independently construct their own knowledge and skills, and in turn, the learner may need assistance from the teacher, thus, becoming a facilitator. Through the observation, critical analysis, and curiosity of learners, the sense of creativity is likely to be developed which in turn constitutes the fundamental of solid knowledge and skills. Moreover, learners are expected to discover and understand materials that are seemingly abstract to their perception. Constructivists also point out that meanings are conceptual structures that influences the individual's construction and organization of his/her experiential world. 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. Learning by doing is far more advantageous in terms of knowledge and skills acquisition in any educational institution for example the newly introduced competence based curriculum whereby learners are using hands on approach and when they finish school each and every learner has something to contribute as a way of earning a living as well as bringing national development. The remarkable improvement in learning has been witnessed in an academic environment that allows interactive learning through inquiry processes as discussed in previous studies by Zittleman and Sadker (2015). Progressivism, social reconstructionism, and existentialism theories among others focused on training the mind through their own knowledge and skills acquisition, and these trending approaches have become the center of the educational processes. The practice-based teaching and learning approach is far more understood as a suitable approach to impart in learners long-lasting knowledge and skills (Bonnell et al., 2011). The widespread of technological tools coupled with vibrant discoveries and rapidly changing living styles due to high societal demand has concurrently pushed science educators to direct their teachings towards practical work, thus, allowing beneficiaries of knowledge and skills to gain practical skills that of course could be easily applied in a real-life situation. The theory of constructivism was chosen because it supports the practical method on science teaching. People are active constructors and creators of their knowledge by asking questions and exploring and assessing what they know.

2.2.0 **TEACHING METHODS USED BY PHYSICS TEACHERS IN TEACHING AND LEARNING OF PHYSICS**

A teaching method has been defined by Afolabi and Adesope (2010) as a specific instructional process which differs from any other by the diversities of specialized activities. Although, the methods used in teaching vary from one country to another depending on the information or skills that is being taught and also influenced by the aptitude and enthusiasm of the student. The choice of a particular method of teaching used by teachers is determined by a number of factors which includes the content to be taught, the objectives which the teacher plans to achieve, availability of teaching and learning resources and the ability and willingness of the teacher to improvise if conventional teaching aids are not available, evaluation and follow-up activities and individual learner differences (Adunola, 2011; Emendu & Udogu, 2013; Kitti, 2014). Furthermore, the methods of teaching are dictated by the medium of instruction for example, where English is used, the method of instruction has to be more interactive than passive (Ibrahim, Hamza, Bello & Adamu, 2018). This is because the method adopted by the teacher may promote or hinder learning as it may sharpen mental activities which are the basis of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult.

Although, there are different types of teaching method, the commonly used methods especially in Zimbabwe is teacher centered which is viewed to be somewhat ineffective in the impartation of knowledge (Guloba, Wokodola, & Bategeka, 2010). The adoption of lecture method by most teachers in order to overcome bulky physics syllabus before the SSCE affects students' performance. The lecture method is also known to cause lack of interest and poor performance in physics as this redundant type of teaching is limited exclusively to telling, reciting and testing of information which does not convey either the meaning or intent of physics.

On the other hand, discussion method is a variety of forums for open-ended, collaborative exchange of ideas between a teacher and students and among students for furthering students thinking, learning, problem-solving, understanding or literary appreciation (Kitti, 2014). Larson (2009) in Kitti (2014) reported that discussion is thought to be a useful teaching technique for developing higher-order thinking skills that will enable students to interpret, analyze and manipulate information. This is because during the discussion process, the teachers and students are actively involved in the learning activities.

Despite these arrays of teaching methods being advocated in literature, there is no one universally accepted method. There is still uncertainty on which of these teaching methods contribute to failure or success of students' performance especially in developing countries like Zimbabwe where the causes of poor performance in secondary school physics is not well understood. Teaching methods are very important in the impartation of knowledge in teaching-learning processes and the type adopted determines to a great extent what the student assimilate. In actual fact if the appropriate method is adopted, knowledge acquired can be accelerated. People opined that no educational system can rise above the quality of its teacher, nor can a nation rise above the quality of her educational system. Various teaching and learning methods are used in the teaching and learning of physics at ordinary level and these are classified into teacher centered and child centered teaching methods. Pupil-centred include question and answer, brainstorming, discussions, group work, demonstration and practice, role plays, problem solving, Field trips, Educational visits, experiments and observations. Teacher-centred include lecture method and demonstration. With regards to effective methods of instruction in the teaching of physics, a number of methods can be used. Prominent among them are inquiry-based teaching, activity-based teaching, guided discovery, demonstration and expository teaching. Though all these methods, and many others, are recommended, inquiry-based learning and guided discovery have been praised for requiring the students to do more than just report on a topic (Bencze, Alsop & Bowen, 2011). Furthermore, the 2011 TIMSS report stressed that students can meaningfully build upon their knowledge and understanding of science through the process of scientific inquiry and therefore commended countries that have been engaging students in this process (International Association for the Evaluation of Educational Achievement [IEA], 2012). This is a wake-up call for other countries to place considerable emphasis on teaching and learning of science through inquiry based processes. Science with physics in particular, is best practiced through active engagement and inquiry into the physical phenomena in the world. Effective learning of physics (learning with understanding) is described as a type of learning in which learners take responsibility for their own learning through active construction and reconstruction of their own meanings for concepts, events, experiences and phenomena (Brass, Gunstone, & Fensham, 2013). Thus, learning with understanding recognises the extent to which students engage with and maintain constructivist ways of learning, i.e. through active participation, learners take control of their own learning. Research findings suggest that much of students' learning in physics does not involve them in

developing conceptual understanding (Brass et al., 2013; Freitas, Jiménez, & Mellado, 2004; Gunstone, Mulhall, & McKittrick, 2009). For example, Brass et al. (2003) found that, in Victoria, Australia, some high school and university teachers were more focussed on what their students could not do, hence the idea of effective learning being students taking control of their own learning was rejected. Also, Freitas et al. (2004) concluded in their study, conducted in Portugal that some teachers still see their role as transmitting the knowledge they have to their students. Hence most often, teachers presented solutions to students rather than asking questions. Memorization of what the teacher has previously transmitted was prevalent and that students write down in their daily notebooks everything that the teacher says. In the physics learning area, students are expected to explore both how the natural physical world and science itself work so that they can participate as "critical, informed and responsible citizens in a society in which science plays a significant role" (Ministry of Education, 2007, p. 17). In addition, the NZC describes five key competencies as dispositions for learning – thinking; communication (using language, symbols and text); managing self; relating to others; and participation and contributing which align with the 21st century learning skills - integration of information technology, and developing children's skills in collaboration, communication, critical thinking and creative problem solving (Conner, 2014).

Research has found that if students do not exercise control or responsibility over their own learning, their understanding of concepts and their attitude to learning are negatively affected

(Brass et al., 2013). Effective learning thus occurs when learners have knowledge of their own learning, are aware of their own learning and seek to control their own learning and relate the knowledge acquired to the physical world. Learning by inquiry engages students actively in the construction of their own knowledge. The teaching methods can be further classified into interactive and non-interactive teaching methods. The use of interactive teaching methods in the teaching and learning of physics is another most significant change in teaching methodology. One notable feature of these approaches is providing an environment where students are motivated to construct knowledge by themselves, rather than the knowledge being transmitted to them by their instructor as in the traditional approach (Hake, 2010). These methods have various labels such as interactive engagement, active learning and guided inquiry, and the constructivist theory of learning informs the philosophy behind the methods (Hake, 2010; Mazur, 2011).

2.2.1.0 **WHAT FACTOR INFLUENCE THE USE OF EXPERIMENTS IN TEACHING PHYSICS**

2.2.1.1 **POOR LABORATORY EQUIPMENT AND SUPPLY**

Physics as a science subject requires hands on activities and for these to occur there must be enough supply of apparatus. As stated by Chala (2019) who asserted that working in science laboratory can only be possible if there are sufficient pieces of equipment for experiment. Laboratory equipment are the key to any practical work, which promotes long term memory in students, enhances pupil's development of the ethical dimension of science, inspires the spirit of collaboration and active participation among learners, exposes learners to scientific experiences that could ultimately help them in developing scientific attitudes and skills and inculcate in the students the spirit of inquiry and scientific mode of thinking. Oyoo (2013) stated that "creative use of equipment in teaching science increases the probability that students will learn and improve their performance that they are to develop". Watts (2013) showed that instructional or laboratory materials when appropriately used, enhance learning, improve the competence of teachers and make learning more meaningful to learners

In general, most literature shows that practical work implementation need basic laboratory equipment so that hands-on practical come to be evident.

2.2.1.1 **LACK OF LABORATORY TECHNICIANS**

Trained and experienced technicians have a detailed knowledge of practical techniques and often greater expertise (than do the science teachers) in matters of technique, health & safety, efficiency and economy. They also enable teachers to offer varied and stimulating science lessons. Whilst technicians should not be used instead of teacher assistants, their support can help to make science teachers workloads more manageable. Inadequate levels of technician support can often be linked to underachieving science departments. Soares & Lock (2007), states that the service provided by technicians is to support the work of teachers and improve their efficiency. Teachers need to plan for the experiments with the help of technicians so that less time is consumed during planning and teaching. As the lack of technicians in schools, teachers are forced to assume the role of technicians, as such laboratory practice and instruction is compromised due to time constraints in balancing between teaching and being a technician (Kapting'ei and Kimeli, 2014).

2.2.1.2 **TEACHER'S UNDERSTANDING ON PRACTICAL WORK**

Teachers must understand that students with limited strength or mobility can have a full laboratory experience with appropriate accommodation, such as a lab assistant (Tenaw, 2015). Higher institutions in Nigeria charged with the responsibility of training science teachers at all levels, are increasingly turning out teachers without requisite laboratory experience. Otherwise, science teachers usually lack the necessary confidence to conduct practical classes with their students (Millar, 2014).

2.2.1.3 **LACK OF TEACHERS' MOTIVATION**

Maslow motivational theorist, created a "hierarchy of needs" in his theory of worker motivation. Teacher performance and attitude, which directly aligns with student learning and achievement, is closely connected to job satisfaction (Tenaw, 2015). Teacher motivation comes through salary and that is the initial need for them. Hence, teachers who are dissatisfied within the profession are not likely to produce quality lessons and deliver engaging instruction in the classroom (Baker & Smith, 2011). Teachers that are satisfied with their jobs tend to produce more in the classroom and yield better instructional results with their students. Hence, job satisfaction of science teachers can have direct relationship with teaching science and also can affect the implementation of practical work in different secondary schools. But they are a number of determinants for job satisfaction.

2.2.2.0 **STRATEGIES THAT CAN BE EMPLOYED TO ENSURE THAT EXPERIMENTS ARE CARRIED OUT WHEN TEACHING PHYSICS**.

2.2.2.1 **PROVISION OF LABORATORY MANUALS**

Physics teachers should be supplied with laboratory manuals which can assist them in setting out experiments. Effectiveness in chemistry laboratory instruction requires that learners be provided with practical guides (SCORE, 2008). These resources give a wide range of practical activities together with detailed procedures to be followed in which as a consequence boost practical instruction

2.2.2.2 **ENSURING THAT EVERY SCHOOL IN THE COUNTRY HAS A LABORATORY TECHNICIAN**.

Technicians in science have an essential role to play in current and future science education. They have considerable skill and expertise not available anywhere else. Trained and experienced technicians have a detailed knowledge of practical techniques and often greater expertise (than do the science teachers) in matters of technique, health & safety, efficiency and economy. They also enable teachers to offer varied and stimulating science lessons. Recently, there has been much discussion about reducing the workloads of teachers by increasing the role of teacher assistants.

2.2.2.3 **Ensuring use of learner centered teaching method**

The teacher should present lessons that are student-centered (teacher builds on knowledge students bring to or develop from the learning situation; teacher helps students construct meaning from experiences; focus on student as active inquirer rather than passive receiver of knowledge). He or she has focus on one or more questions as the active mode of inquiry (lesson, many guiding questions; lab, one guiding question), encourages student thinking and questioning , engenders debate and discussion among students, provides a variety of levels and paths of investigation, is a mentor and guide, giving as little direction as possible , shows an active interest in students and promotes an active quest for new information and ideas, avoids appeals to authority and avoids acting as an authority figure, maintains a classroom atmosphere conducive to inquiry, places emphasis on "How do I know the material of this course?" rather than "What must I know in this course?" ,uses appropriate questioning skills such as wait time, variety, distribution, and formulation, responds appropriately to what students have to say or do that contributes to lesson to encourage active involvement of learners

2.2.3.0 **INTRODUCING SCIENCE TEACHER DEVELOPMENT PROGRAMS**

These will be meant to equip physics teachers with science education so that they well equipped relevant pedagogies for the teaching and learning of physics. Most teachers in secondary schools who teach science are not trained to teach physics and as a result these will be learning with students during lesson delivery which demotivate learner as it is frustrating. For this to occur schools should be encouraged to incorporate a science fee as part of the school fees to ensure that teacher development programs are financially catered for

2.2.3.1 **PROVIDING SCHOOLS WITH TRAINED PHYSICS TEACHERS**

Most teachers who teaches sciences in particular lack subject matter as they will be trained for different learning areas. As a result such are not aware of how to carry out physics experiments and when given the platform to teach they simple impart knowledge making the learners more passive and mere absorbers of knowledge.

2.**4 SUMMARY**

This chapter looked at literature review that is, the views of various authors pertaining the topic under study. The chapter also reviewed theoretical and conceptual frameworks underpinning the study. The next chapter will present the methodology.

CHAPTER 3: METHODOLOGY

3.0 **INTRODUCTRION**

In the previous chapter, the researcher looked at the secondary information on the sub problems. The research concentrated on what other writers said on the topic under study. The researcher also identified the knowledge gaps created by the lessons possibilities in the schools under concern.This chapter covers the research design and methodology, including sampling, population, establishing rigor during and after data collection, ethical considerations and data analysis.

3.1.0 **RESEARCH METHODOLOGY/APPROACH**

The approach used in this study is the mixed approach and it uses both qualitative and quantitative approach. According to Lincoln, lynham and Guba (2011) qualitative approach offers the benefit of possibility of outlining facts which allowed the researcher to identify aspects of a phenomenon more accurately by approaching it from different points using different methods and techniques. The use of this approach was necessitated by the need to look at the research question from different angles, and clarify unexpected findings and potential contradictions (Mertens, 2007). There was also need to elaborate, clarify and build on findings from other methods.

3.1.1 **RESEARCH DESIGN**

Polit et al (2011:167) define a research design as "the researcher's overall for answering the research question or testing the research hypothesis". A research design is a plan that describes how, when and where data are to be collected and analysed. In this study, an attempt was made to investigate and describe the policies and practices in Binga district physics education by looking at initial teacher education programmes, the current state of physics teaching and learning in secondary schools and what supports physics teachers to be successful. The study therefore followed a mixed method design using both survey and case study techniques. A survey is a systematic method of collecting data from a population of interest. It involves identifying a specific group or category of people and collecting information from some of them in order to gain insight into what the entire group does or thinks. It tends to be quantitative in nature and aims to collect information from a sample of the population such that the results are representative of the population within a certain degree of error. A survey method was used in the first stage in which questionnaires were administered to physics students throughout Binga district. The teachers' survey interviews were intended to identify their views of initial teacher education, typical practices in curriculum delivery, their perceptions of the factors limiting the quality of physics teaching and learning and ways to improve upon the situation, if any.

The researcher opted to use a survey because it has the following advantages; can complete structured questions with many stakeholders within a relatively short time frame, it is quantifiable and generalizable to an entire population if the population is sampled appropriately, Standardized and structured questionnaire minimizes interviewer bias, can be completed by telephone, mail, fax,

or in-person, tremendous volume of information can be collected in short period of time and can take less time to analyze than qualitative data.

The research aims at the improvement of some aspects the total educational program. The researcher carried out his survey using form three science pupils selected from four schools above and seven pupils were selected from each school, as well as all their respective teachers. In this regard the researcher conducts observation of lessons on interactive teaching methods. The researcher prepared. The second stage of this study was designed to examine the realities of the matter under investigation in more detail to provide depth of information through specific case studies. Bogdan and Biklen (2007) assert that a case study is useful for inquiry which entails "detailed examination of one setting, or a single subject, a single depository of documents, or a particular event" (p. 59). Creswell (2007) however, views a case study as both a methodology and a product of inquiry in which the researcher investigates one or multiple cases "over time through detailed, in-depth data collection involving multiple sources of information" (p. 73). Yin (2009) also defined a case study as an "empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context" (p. 18). Collection of quantitative data from students and classroom observations. As noted by Cohen et al., (2007), observation enables the researcher to understand the situation being described, see things that might otherwise be unconsciously missed in the first stage and discover things that respondents might not freely talk about in the questionnaire and interview situations. Observation also provides specific examples of teaching and learning in action. Cohen et al. extolled that observations enable the researcher to gather data on: "physical settings (e.g. the physical environment and its organization); the interactional setting (e.g. the interactions that are taking place, formal, informal, planned, verbal, non-verbal etc.); and the programme setting (e.g. the resources, pedagogy styles, curricula and their organization)" (p. 397). The survey and case study approaches, for this study, presented above have the advantage of describing thoroughly how physics is taught in the secondary schools for specific teachers and situations. First of all, survey questionnaires are difficult to construct and secondly, the success of using questionnaires lies in getting respondents to answer questions thoughtfully and honestly (Fraenkel et al., 2012). Another significant drawback is the time and effort of delivering and collecting the questionnaires and getting sufficient numbers of participants to respond (Gray, 2009). The main drawback of the case study method is that the subjectivity of respondents, their opinions, attitudes and perspectives together contribute to a degree of bias (Ampiah, 2004;

Creswell, 2007). More so, results are also related to the unit of analysis and do not allow "inductive generalisation" (Sarantakos, 2005, p. 216). In this study, the case study was used to substantiate and expand the findings from the quantitative measures. Though case study findings were not meant to be generalized, they serve as indicators of what might be happening in other places.

3.1.1 **POPULATION**

Sign and Masuku (2014) defined population as the totality number of units from which data can be collected. Population is a group of people in which the researcher intends to gather information. Five physics teachers and fifteen physics learners in Binga district will be afforded the opportunity to participate in this research process

3.1.2.0 **SAMPLING**

Cresswell, (2014) define sampling as a technique of selecting individual members or a subset of the population to make statistical inferences from them and estimate characteristics of the whole population. Simple random sampling is used in this research. It is extremely important to choose a sample that is truly representative of the population so that the inferences derived from the sample can be generalised back to the population of interest. Improper and biased sampling is the primary reason for erroneous inferences about populations (Bhattacherjee, 2012). This means that sampling must be done correctly. Sampling techniques can be grouped into two broad categories: probability (which is also called scientific) sampling and non-probability sampling (Bhattacherjee, 2012). Probability sampling methods involve sampling techniques in which every member of the population has an equal and known chance of being selected into the sample. This means that every case in the population has a chance of being selected. The sample is unbiased and representative of the population and the types of probability sampling include simple random sampling, systematic random sampling and stratified random sampling. Non-probability sampling methods is sampling technique in which not every member of the population has an equal chance of being selected. Indeed, some units or cases of the population have zero chance of selection (Bhattacherjee, 2012). A sampling technique which targets certain individuals (Magwa & Magwa, 2015). The technique is usually used when generalisation to the population is not the major issue. Types of non-probability sampling include convenience, purposive sampling and quota. Convenience or accidental sampling which include choosing cases which are easily accessible to the researcher (Castillo, 2009), for example choosing the nearest individuals until the required

sample size has been obtained ((Magwa & Magwa, 2015). Purposive or expert sampling involves choosing individuals who can provide deep, rich, significant data on the subject being investigated (Oliver, 2010 and Saunders, et al. 2009). The researcher handpicks the sample on his/her judgement of the knowledge expertise of the individuals chosen. Quota sampling is a sampling technique in which the population of interest is segmented into mutually exclusive subgroups such as administrators, teaching staff, non-teaching staff and students in Binga district. Cases are selected from each subgroup. For each subgroup, the cases are then selected using any of the non-probability sampling methods discussed above.

3.1.2.1 **SAMPLING PROCEDURES**

The researcher used random sampling to give all pupils a fair chance of being selected to avoid favoritism and bias. The researcher opted to use twenty-eight pupils for his research and seven pupils were chosen from each of the above mentioned schools. Random sampling is one of the best probability sampling techniques that helps in saving time and resources. It is a reliable method of obtaining information where every single member of a population is chosen randomly, merely by chance. Each individual has the same probability of being chosen to be a part of a sample. From each form three physics class, the researcher allowed pupils to pick a paper from a box with either ‘yes or ‘no’ responses and those were an yes to represent the population under study. The researcher divided the selected sample into two groups, one for group A which was used as the control group and the other one group B, used as the experimental group. The researcher used simple random sampling in choosing the physics class and used purposive sampling technique in choosing physics teachers.

3.2.0 **RESEARCH INSTRUMENTS**

The research instruments used for data collection for this study were: survey questionnaires for teachers and classroom observational guides

3.2.1 **SURVEY QUESTIONNAIRE**

It has been noted that closed and open-ended questionnaires are useful to elicit both quantitative and qualitative data (Best & Kahn, 2005; Fraenkel et al., 2012). In this research a questionnaire is research instrument consisting of a series of questions and other prompts for the purpose of gathering information from the respondents. One form of both closed and open-ended

questionnaire was developed and used for data collection and this was the Physics Students' questionnaire. The questionnaires were directed to students to find out how often they use interactive teaching methods and how these relate to the performance of pupils and their participation during lesson delivery. Therefore the research opted to use a questionnaire in collecting data due to its advantages. One advantage of using a questionnaire is that, the information can be directly obtained from the respondents. In this scenario the researcher easily distributed the questionnaire to the teachers in the schools mentioned above and the needed information was quickly obtained. The research instrument is cheap and time serving and the information gathered by questionnaires tends to be more reliable since the respondents were answering questions freely without interference and also it gave respondents much time to think and answer the questions correctly. Being pre-planned it has standardised working, language, sequencing of the questions and syntax of the questions secures uniformity of the responses. The other advantage associated with the use of questionnaire is that, large volume of information can be obtained at one move for instance the age, sex and educational level of the respondents (Walcott and Harry 2000). In spite of the advantages given above, questionnaire have some drawbacks for example, when using questionnaires some respondents may not answer questions truthfully and not answer some questions at all. As the questions from the questionnaire are answered without the researcher's interference, the respondents may not understand the questions. The response rate is slow as respondents may not be interested in the topic or methodology used. Some questions limit the respondents from fully expressing their views by choosing between alternatives without fully explaining. There is self-selection bias because those who return the questionnaires may have attitudes, motives that may be different from those who do not.

3.2.2.0 **OBSERVATION**

Observation is the systemic data collection approach. The researchers use all their senses to examine people in their settings or naturally occurring situations (www, qualres.org, m/homesobse-3594hti.). Observation can be also defined as watching people what they do. It would seem an obvious method of carry of carrying a research (www.simply. Psychology.org). Direct observations were done by the researcher to gather data from pupils during the delivery of lessons where by the rearcher directly got into the class where the lessons were conducted.

3.2.2.1 **ADVANTAGES OF OBSERVATION**

It is a very direct method of gathering data. It is best for studying human behaviour. Also data collected is very accurate and reliable in nature. It can also improve the precision of research results. The problems of depending on respondents are reduced. Also it is less demanding in nature which makes it less bias. In this research study the researcher managed to personally study by observing the behaviour of pupils with parents in the abroad and came up with authentic facts about their behaviour. Observations aided the researcher to gather first-hand information about the behaviour of pupils during the lessons, promoted critical thinking to the researcher , thus affording him to create solutions relevant to some problems encountered by both teachers and learners. The observations helped the researcher to make objective conclusions on each individual activity because they were directly involved.

3.2.2.2 **DISADVANTAGES OF OBSERVATIONS**

The effects of varying interactive teaching methods are not noticeable from every student and therefore the researcher could be tempted to just generalise the findings. During this research, the researcher however used a manageable and sizeable sample to increase the particular attention on each pupil and avoid overgeneralization which leads to subjective results. Sometimes the respondents might behave in a particular way because they are being observed. The researcher however did not inform pupils that they are being observed so they participate in a common environment as if nothing was happening.

3.3.0 **INTERVIEWS**

An interview is generally a qualitative research technique which involves asking openended questions to converse with respondents and collect elicit data about a subject (Polit and Hungler, 2010:234). The interviewer is usually taken as the subject matter expert who intends to understand respondent opinions in a well-planned and executed series of questions and answers. The researcher interviewed the teachers soliciting information on whether their school environments promote the use of experiments in the teaching and learning of physics. The researcher recorded the audios for the interviews conducted

3.3.1.0 **ADVANTAGES OF INTERVIEWS**

Interviewers can establish rapport with participants to make them feel more comfortable, which can generate more insightful responses – especially regarding sensitive topics. Interviewers have greater opportunity to ask follow-up questions, probe for additional information, and circle back to key questions later on in the interview to generate a rich understanding of attitudes, perceptions, motivations, etc. Interviewers can monitor changes in tone and word choice to gain a deeper understanding (Cresswell, 2014). (Note, if the in-depth interview is face-to-face, researchers can also focus on body language.) There is a higher quality of sampling compared to some other data collection methods. Researchers need fewer participants to glean useful and relevant insights (Dillon, 2008). There are none of the potential distractions or peer-pressure dynamics that can sometimes emerge in focus groups. Because in-depth interviews can potentially be so insightful, it is possible to identify highly valuable findings quickly.

3.3.2.0 **DISADVANTAGES OF INTERVIEWS**

Interviews are quite time consuming, as interviews must be transcribed, organized, analyzed, and reported. In addition, if the interviewer is not highly skilled and experienced, the entire process can be undermined (Cresswell, 2014). Moreover, the process can be relatively costly compared to other methods. (However, telephone in-depth interviews vs. in-person can significantly reduce the costs.) Participants must be carefully chosen to avoid bias, and this can result in a longer vetting process (Dillon, 2008). Participants typically expect an incentive to participate, and this must be carefully selected to avoid bias.

3.4.0.0 **FOCUS GROUPS**

A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs and attitudes towards a product, service, concept, advertisement, idea, or packaging. The main purpose of focus group research is to draw upon respondents' attitudes, feelings, beliefs, experiences and reactions in a way where other methods are not applicable (Cresswell, 2014)

3.4.1.0 **ADVANTAGES OF FOCUS GROUPS**

The focus group discussion has several advantages: it is relatively inexpensive. Individuals are more likely to provide truthful responses (Dillon, 2008). Through facilitated discussion, participants build on each other’s ideas through discussion in this way, the focus group is very

useful for needs assessment and project evaluation purposes. Given their qualitative nature, focus groups allow researchers to look beyond the facts and numbers that might be obtained via survey methodology—researchers can learn or confirm the meaning behind the facts (Sign and Masuku, 2014) .

3.4.2.0 **DISADVANTAGES OF FOCUS GROUPS**

Focus group methodology has its limitations. The focus group relies heavily on assisted discussion to produce results; consequently, the facilitation of the discussion is critical (Sign and Masuku, 2014). The quality of the discussion depends on the skill of the moderator, who should be well trained and preferably from the target population, yet not affiliated with the researchers (to ensure impartiality). Focus group discussions should be audiotaped or videotaped in addition to the recording of field notes (Cresswell, 2014). All data should be transcribed verbatim. However, these large volumes of qualitative data might be difficult to analyze. While a focus group format prevents the dangers of a nominal group process, outspoken individuals can "hijack" and dominate a discussion (Dillon, 2008).

3.3.0.0 **DATA COLLECTION PROCEDURES**

The researcher collected data by giving questionnaires to respondents. The data was collected after being granted the permission from the university and ministry, thus, the district education offices. The questionnaires were taken to respondents by the researcher and each respondent has been issued with a stamped introductory letter.

3.3.0.1 **DATA PRESENTATION AND ANALYSIS**

Data Analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data (Cresswell, 2014). Data presentation and analysis refers to how the data collected from findings is presented, as meaningful information for analysis and derivation of some conclusions and implication. The researcher used bar graphs, pie-charts and tables to illustrate data gathered from the field. The use of pie charts helped the researcher in showing proper proportional variations in the data presented while bar graphs were

used for simplicity and accuracy in presenting the information for analysis and interpretation. For the purpose of the research, the presentation of data serves to accurately give an analogy of the results gathered in the field. The methods used protected respondents' confidentiality and ethical considerations. Thematic analysis was used to analyse data collected from teachers, students, and, data was analysed and interpreted by themes related to each sub-question and related supportive literature review. Data from teachers' survey questionnaires were analysed using descriptive statistical methods including percentages, tables and graphs where appropriate. Qualitative data gathered during interviews and observations were used to substantiate findings from the survey data. Detailed descriptions of classroom observations/practices were also recorded as a reference for indicating what actually occurred. A cross-case analysis approach (Yin, 2009), also called comparative analysis (Schwandt, 2001) was adopted for this purpose. A detailed report of the individual case studies was presented, and using comparative analysis, the similarities and differences between the cases were discussed. As indicated previously, the embedded multiple-case study design (Yin, 2009) was chosen for the second stage of the study. The purpose of this was to determine whether similar or contrasting outcomes would be produced. Yin (2009) has stated that "analytic conclusions independently arising from two cases will be more powerful than those coming from a single case alone" (p. 61). The comparison was helpful to identify how different contexts and individual expertise affect policies and practices regarding physics teaching and learning in high schools.

3.3.1.0 **ETHICAL CONSIDERATIONS**

Ethics searches for reasons for acting for believing or denying something about virtuous conduct or good or evil rules (Pilot & Beck, 2014). The researcher sought permission from the responsible authorities to use the research sites, that is, the schools used, learners and students who participated in the research (Cresswell, 2014) and provided sufficient information and assurances about taking part to allow individuals to understand the implications of participation and to reach a fully informed, considered and freely given decision about whether or not to do so, without the exercise of any pressure or coercion. Privacy and anonymity or respondents were greatly considered. Participants were allowed to participate voluntarily. The researcher ensured that no names of both the schools and other respondents were taken down during the research process so that no one feels

offended when ever involved in the research process. The researcher also ensured that not face pictures were taken during the research process.

3.4.0 **SUMMARY OF THE CHAPTER**

This chapter focused on the research design used by the researcher in gathering. The research also looked at the instruments used by the researcher in gathering information and population and sampling procedures. The researcher looked at the presentation and analysis of the data gathered from the field. The next chapter will look into detail, quantitatively represent the data and analyse it for the purpose of the research.

CHAPTER 4: **DATA PRESENTATION, ANALYSIS AND DISCUSSION**

4.1.0.0 **INTRODUCTION**

In the previous chapter, the researcher discussed in depth the research design used in investigate the problem, the research instruments used, data collection procedures and how the data collected was to be presented and analysed. In this chapter the researcher focused on the presentation, interpretation and analysis of the data collected. The data will be presented on the bar graph, pie charts and tables.

Coding of themes: teachers

Table 4.1

School	Number of teachers	Code
A	1	SA
B	1	SB
C	1	SC
D	1	SD

Four teachers responded to the interview.

Coding of themes: students

Table 4.2

School	Number of STUDENTS	Code
A	8	SA1
B	11	SB2
C	6	SC3
D	5	SD4

There were twenty eight learners who responded to the questionnaires and focus groups. The distribution of learners who responded to the interview from each school is shown in the table above

4.1.1.0 **Which teaching methods are used in the teaching and learning of physics?**

All focused groups were in agreement that teachers need to demonstrate experiments in front of learners. Respondents argued that they gain experimental skills by looking at the teacher demonstrating. Form the focus conducted, the researcher realized that mainly teacher centered teaching methods are used during the teaching and learning of physics for example learners from the school coded SC and SD said, 'we are being denied the chance actively participate during our learning process, teachers simply come and lecture on us and this demotivates us as learners as learners as some of us fall asleep during lesson delivery.' The teaching methods used in these schools contradicts (Brass, Gunstone, & Fensham, 2013) who states that effective learning of physics (learning with understanding) is described as a type of learning in which learners take responsibility for their own learning through active construction and reconstruction of their own meanings for concepts, events, experiences and phenomena. Still on the same question, asking on

teaching methods being used in the school SB and SA, stated that mostly demonstrations and discussions were used while experimentation was rarely being used. When asked why the carrying of experiments was shunned in the learning and teaching of physics, the learners gave the following responses; lack of science laboratories, lack of adequate information on how to conduct practical work, shortages of lab materials required to carry out experiments and in availability of lab technicians. As a result the teaching methods employed were the lecture method, group discussions and demonstrations where the resources could not tally with the number of learners. The teacher moved around the four selected schools in the district to observe if the schools have enough facilities to carry out physics practical. The key areas the researcher was concentrating on were schemes of work used by physics teachers to figure out if they were considering carrying out experiments during lessons, availability of school science laboratories, lab technicians, and apparatus for experiments to be carried out and availability of apparatus the researcher checked inventories. The research realized that out of four schools visited only two of these have laboratories, one have a lab technician and all schools have limited apparatus and as a result it is very difficult for the physics teachers to carry out practical activities, hence resorting to the lecture method when conducting lessons. This means that learners were taken as mere absorbers of knowledge. The research realized that shortage of enough science apparatus, shortage of science laboratories and lab technicians seriously hindered the use of experiments when conducting physics lessons. The teachers also carry out the duties of the lab technicians, yet there is limited time allocated for the subject allocated on the time table. Most teachers conducted lessons without practical sessions. The teacher also observed some physics lessons at all the selected schools and mainly the lecture method and demonstrations were used. This was mainly because of the scarce lab materials and the teachers could not use locally available resources for improvisation. Table 4.3 shows the distribution of teaching methods

School	Teaching methods used in physics lessons
A	Lecture method, demonstration, experimentation, question and answer and discussion

B	Lecture method, demonstration, experimentation, question and answer and discussion
C	Lecture method, demonstration, question and answer and discussion
D	Lecture method, demonstration, question and answer and discussion

4.1.1.1 Why do teachers fail to use experiments?

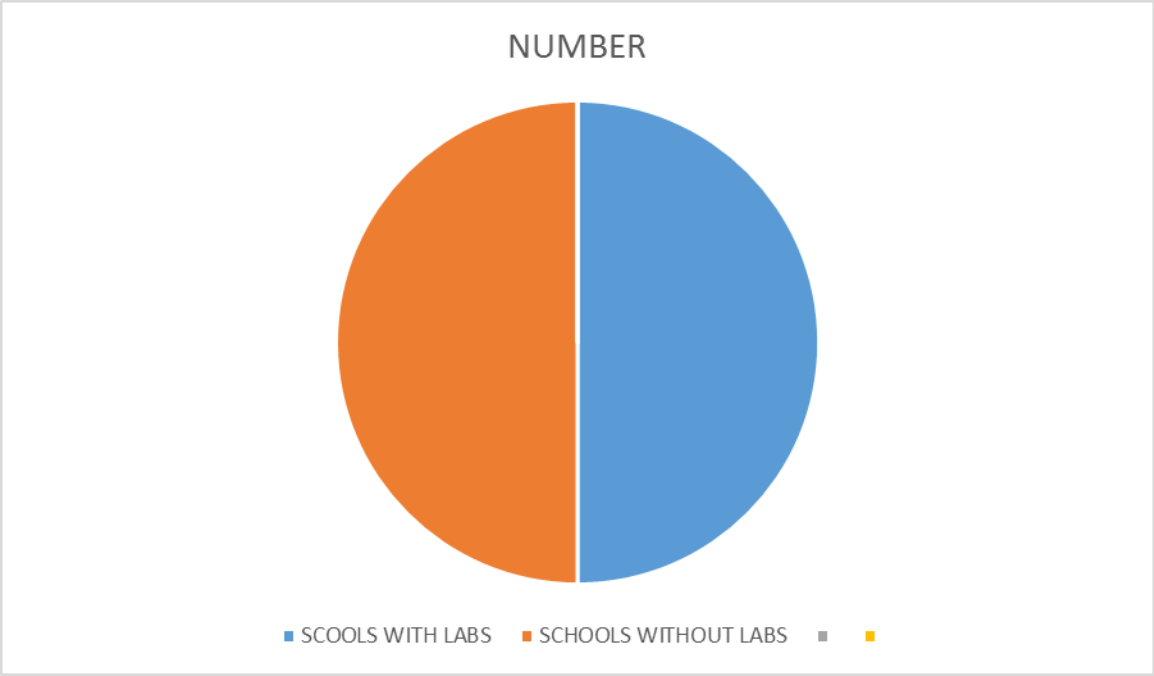
The teachers that were interviewed in this study have different ways of responding to the challenges despite not losing their interest to involve learners in high levels of practical work. One teacher believed in improvising some indicated time allocation as a factor need to improve practical work implementation as well as laboratory apparatus and laboratory technicians. The teacher who believed in improvising will always get a way to make sure the action is done despite those resources are not available at school (Watts, 2013). From the observation carried out, it was found that most teacher do not carry out physics practical sessions due to limited resources, absence of lab technicians and laboratories. Most teachers were working as both lab technicians and teachers which consumed much time for them. From the questionnaires for learners it was found that most learners do not carry out experiments but are only learn passively. Students from school C and D pointed out that they lack some of the essential scientific skills for practical work, which can be a challenge when you are faced with a large syllabus to teach and students who are uncertain of the equipment and method. They further indicated that teaching learners each skill one on one is difficult since there will be limited time. Students from school A and B responded by saying that learners face challenge of acquiring safety equipment for use during the practical lessons. The safety equipment mentioned were safety shoes, laboratory coats and goggles. The safety material is important in ensuring the safety of learners in case of laboratory accidents. One learner from school B responded by saying students don't know how to collect and properly use practical equipment. Some students meet the apparatus in the laboratory during external examination period for the first time, therefore they need more time to learn about the use of the apparatus before using it in the practical lesson (SCORE, 2008). From the interviews conducted,

SC and SD indicated that they neither have the school laboratories nor the laboratory resources. This concurs with Hattingh, Aldous & Rogan (2007) who stresses that availability of physical resources (e.g., laboratories, science apparatus or portable laboratory stations) is a challenge that teachers face whenever they want to teach Practical Work. From the information collected all teachers gave a common challenge of lack of materials in their respective schools, where by the schools did not have apparatus or instruments to be used during practical work. This can cause a teacher to be demotivated. SA felt that the 60-minute time frame was also said not to be enough for practical work. Furthermore, reduced security on setup apparatus/practical work is a challenge since there is no proper place to leave apparatus for activity that gives results after hours/day. SA encountered a challenge on time management as the time given does not accommodate every leaner to participate especially in situations where materials are limited. SA was heard from the interview saying that improvising is very difficult, she talked about topics like measurement whereby the veneir calipas cannot be improvised in any way. This made teacher to resort to the lecture method which does not require the use of resources. This contradicts with constructivists according to Woolfolk (2015) which states that one of the major principles of the constructivist view of learning is that the learner has to take an active role in building understanding and making sense of information. This question was asked to teachers to find out difficulties that learners face when doing practical work. SB and SC pointed out that some students lack some of the essential scientific skills for practical work, which can be a challenge when you are faced with a large syllabus to teach and students who are uncertain of the equipment and method as a result of lack of teacher development programs. They further indicated that teaching learners each skill one on one is difficult since there will be limited time. SA and SC responded by saying that learners face challenge of acquiring safety equipment for use during the practical lessons. The safety equipment mentioned were safety shoes, laboratory coats and goggles. The safety material is important in ensuring the safety of learners in case of laboratory accidents. SB responded by saying students don't know how to collect and properly use practical equipment. Some students meet the apparatus in the laboratory for the first time, therefore they need more time to learn about the use of the apparatus before using it in the practical lesson (SCORE, 2008). This was seconded by SA who said mainly the school administration usually purchase apparatus towards the examination period and this is when students meet practical. All focused groups identified similar challenges that were faced by teachers during the practical lessons. Focus groups identified lack of resources as a major

challenge. “Resources are not adequate we end up sharing apparatus and this takes most of our time” said one respondent students from school A and school B also pointed out the issue of lack of adequate time to do the practical because the teacher looks busy most of the time. The teacher sometimes teaches practical lessons after lunch during the study time, at this time the students will have got tired and loose interest. One learner indicated that teachers found it difficult to prepare the apparatus and to store them for future use. Some of the learners indicated lack of laboratory as one of the challenges faced by teaches to conduct an experiment. One learner added that, they did not do any practical work with their teacher therefore no challenges had been seen by this responded. One student from school A also suggested that schools should organize educational seminars that will help learners to learn from other schools on how experiments are done. Educational tours will help learners to learn from their peers and have access to well-equipped laboratories. Most students were of the opinion that student must be given clear and simple instructions on the procedure on conducting practical work.

The pie chart below shows the distribution of the laboratories in schools

Figure 4.3



The table below shows the distribution of lab technicians in Binga district schools

School	Presence of the science laboratory technician
A	The technician is present
B	The lab technician is absent
C	The lab technician is absent
D	The lab technician is absent

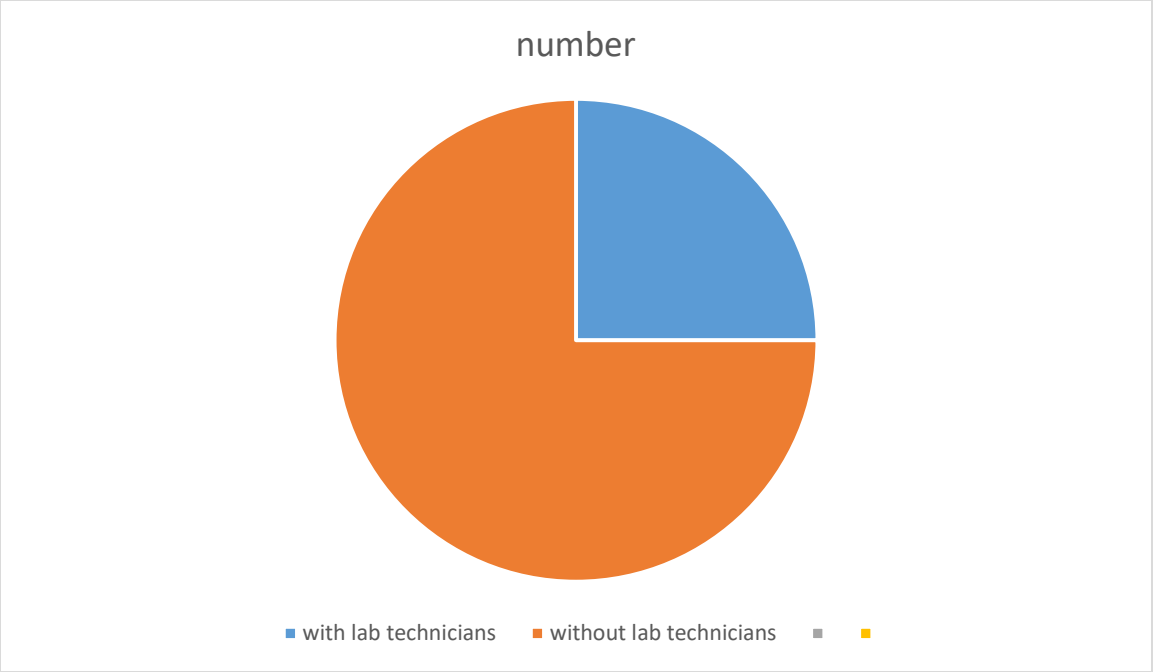
The following table show the observation made by the researcher during the visiting of schools

Table 4.4

School	Is the lab present	Do schemes show that teachers integrate experiments in physics lessons	Does the school have physics apparatus	Teaching method used in teaching physics
A	Yes	For few concepts	Only a few	Teacher centred for example demonstration and lecture, and a few learner centred teaching methods eg question and answer

B	**Yes**	**For few concepts**	**Only a few**	**Teacher centred for example demonstration and lecture as well as question and answer**
C	**No**	**None at all**	**None at all**	**Lecture method, question and answer and discussion**
D	**No**	**None at all**	**None at all**	**Lecture method, question and answer and discussion**

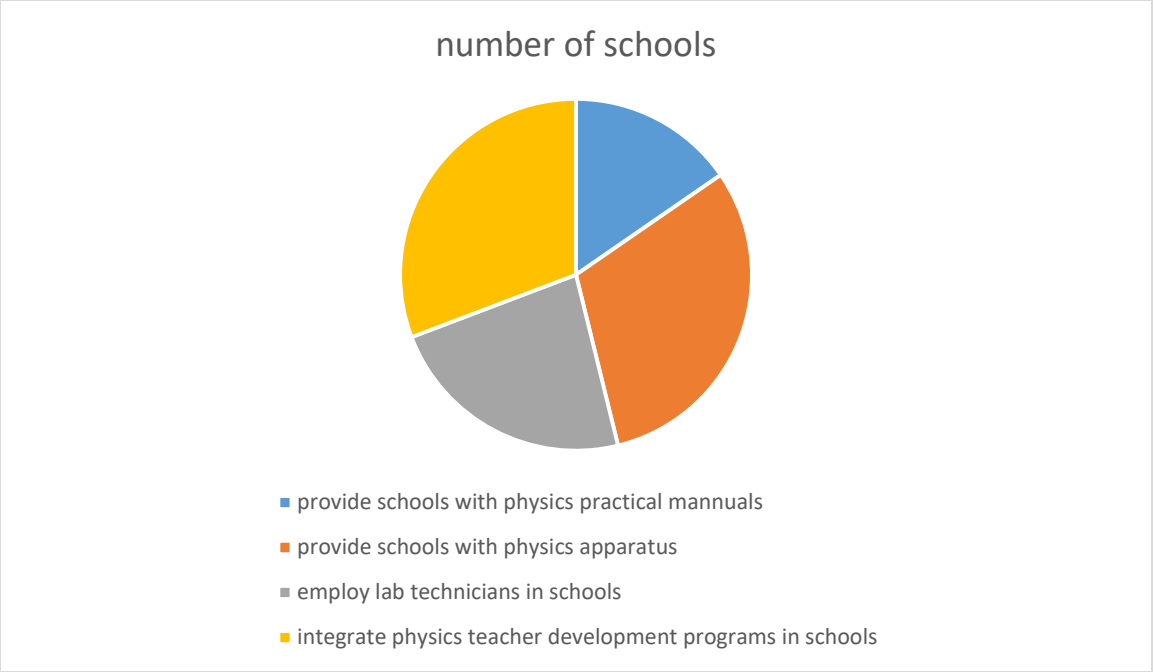
Figure 4.3 show the distribution of lab technicians in the district



4.2.0.0 What strategies can be employed to ensure that experiments are used in the teaching and learning of physics?

The pie chart below shows strategies to be employed so that experiments are integrated in the teaching and learning of physics

Figure 4.5 shows the strategies to integrate physics practicals in schools



When SD was asked this question, he responded by saying "I believe in trying my best despite the challenges that come my way. A teacher must borrow from other schools where possible. Where not, I always improvise to come up with something which can fit what is required for a practical work to take place but improvising is only possible for a selected number of topics." All teachers interviewed indicated that provision of more time on the time table is important in teaching practical work. Since teachers must check progress of each learner during a practical work, more time allocation is needed for the teacher to work more efficiently. SA, SB, SC and SD concurred that a science laboratory technician should be employed in their schools so as to help on preparation of chemicals prior to the practical lesson. Respondents added that, teachers have a lot of work to do, preparation of practical material will consume more time. Therefore, a laboratory technician will help teachers to save time. Laboratory technicians are essential in saving time as well as providing the essential skills in helping teachers to execute their work easily, for example preparing solutions prior to a practical work (Dillon, 2008) SB and SC pointed out that administrations should build laboratories and furnish laboratories with apparatus needed for practical work. Respondents added on that, some chemicals cannot be improvised and it will be difficult for to carryout practical work. They added on that practical work need to be done in the laboratory for the safety of learners and the teacher. Watts, A. (2013) pointed out that "it is the

duty of the administration to ensure that all necessary apparatus and solutions are available for effective learning of practical work." SB and SA felt that teachers need to do some staff development on practical work. Teachers need to be oriented and do some workshops which will help teachers gain experience in practical work.

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Table below shows strategies that could be taken to improve conducting of practical in physics

Table 4.5

	School	Number of learners who attended the focus group	Coding
	School A	8	SA
	School B	11	SB
	School C	6	SC
	School D	5	SD
Total	4	28	4

4.2.2.0 **Discussions of findings**

The finding shows that both teachers and learners face some challenges during conduction of practical work. Lack of laboratory, lack of resources such as laboratory technicians, chemicals and equipment and laboratory manuals are chief among challenges stated by respondents. From the observation conducted by the researcher it was found that the district physics pass rate is very low due to the fact that learners were not having hands on activities. This has been seconded by (Adunola, 2011) who stated that regular quit, regular poor academic performance by the majority

of students in physics is fundamentally linked to application of ineffective teaching methods by teachers to impact knowledge to learners. Use of experiment as a teaching methodology for Physics in secondary school is crucial for successful concept delivery by the subject teachers and concept mastery by the learners as this was witnessed in schools A and B where experiments were carried and the pass rate was even higher than in the two schools where learners attended to lessons passively. According to Woolfolk (2015) one of the major principles of the constructivist view of learning is that the learner has to take an active role in building understanding and making sense of information and this contradicts what was happening in the four selected schools where mainly teacher centered teaching methods were implemented for example the lecture method and demonstration in which the teacher is the center of everything. In the constructivist perspective, learning takes place when students use their prior learning to interpret and make sense of their surroundings (Tobin, 2002). Practical work in science education is designed to promote science learning and isdetermined by the particular goals and aims of the science education program. The dual purpose of practical work to support scientific literacy and to induct students into professional science is problematic. As they interact with their teachers, peers, and instructional materials, students in primary and high school construct knowledge. The methods of teaching are dictated by the medium of instruction for example, where English is used, the method of instruction has to be more interactive than passive (Ibrahim, Hamza, Bello & Adamu, 2018). This is because the method adopted by the teacher may promote or hinder learning as it may sharpen mental activities which are the basis of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult. As stated by Chala (2019) who asserted that working in science laboratory can only be possible if there are sufficient pieces of equipment for experiment. Laboratory equipment are the key to any practical work, which promotes long term memory in students, enhances pupil's development of the ethical dimension of science, inspires the spirit of collaboration and active participation among learners, exposes learners to scientific experiences that could ultimately help them in developing scientific attitudes and skills and inculcate in the students the spirit of inquiry and scientific mode of thinking. As illustrated in the four instruments used in data collection, it was realized that mainly schools buy science apparatus only for the examination session and this is when can do experiments. The situation in schools contradicts views by certain authors who looked into the same topic under study, for example, Oyoo (2013) stated that "creative use of equipment in teaching science increases the probability that students

will learn and improve their performance that they are to develop" and Watts (2013) showed that instructional or laboratory materials when appropriately used, enhance learning, improve the competence of teachers and make learning more meaningful to learners. This implies that learners in the district as the selected schools were taken as a true representation of the entire district, only know the theory which can be easily forgotten. Maslow motivational theorist, created a "hierarchy of needs" in his theory of worker motivation. Teacher performance and attitude, which directly aligns with student learning and achievement, is closely connected to job satisfaction (Tenaw, 2015). Teacher motivation comes through salary and that is the initial need for them. Hence, teachers who are dissatisfied within the profession are not likely to produce quality lessons and deliver engaging instruction in the classroom (Baker & Smith, 2011). Teacher dissatisfaction was witnessed by the manner in which the teachers were planning their work for example they could not carry out practical even in cases where the apparatus were there. Teachers that are satisfied with their jobs tend to produce more in the classroom and yield better instructional results with their students. Hence, job satisfaction of science teachers can have direct relationship with teaching science and also can affect the implementation of practical work in different secondary schools. But they are a number of determinants for job satisfaction. One teacher from school stated that they have limited time to prepare for the physics practical and also this gives them too much work while they are highly demotivated by poor remunerations and as a result resort to the lecture method which offload them from much labour. Soares & Lock (2007), states that the service provided by technicians is to support the work of teachers and improve their efficiency. Teachers need to plan for the experiments with the help of technicians so that less time is consumed during planning and teaching. As the lack of technicians in schools, teachers are forced to assume the role of technicians, as such laboratory practice and instruction is compromised due to time constraints in balancing between teaching and being a technician (Kapting'ei and Kimeli, 2014)

4.2.2.2 **SUMMARY**

This chapter focused on the presentation of data and discussions of findings. The interviews from teacher, questionnaires for learners, focus groups and observation schedule were analyzed and discussed. The next chapter will focus on the summary and recommendations of the study.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0.0.0 **INTRODUCTION**

This chapter concentrate on summary, recommendations and conclusion for the research carried out. The purpose of the study was to find out challenges faced by teachers and learners which hinders them from doing physics practical lessons. Focus groups, questionnaires, observation schedule and interviews were conducted by the researcher on the four selected schools which were named as school A, B, C and D. The aim of this chapter is to analyze the results, make conclusions, summarizes the findings and come up recommendations based on the analysis and outcomes of the challenges faced by teachers and learners on implementing practical work.

5.0.0.1 SUMMARY

Chapter one focused on the background of the study, statement of the study, research questions, limitations of the study, and delimitations of the study, importance of the study and definitions of key terms while chapter two looked at literature review that is, the views of various authors pertaining the topic under study. The chapter also reviewed theoretical and conceptual frameworks underpinning the study. Chapter three concentrated on methodology, that is the chapter focused on the research design used by the researcher in gathering information. The research also looked at the instruments such as focus groups, questionnaire for the learners, interviews for the teachers and observation schedules used by the researcher in gathering information and population and sampling procedures. The researcher looked at the presentation and analysis of the data gathered from the field. The interviews from teacher, questionnaires for learners, focus groups and observation schedule were analyzed and discussed in chapter four.

5.0.0.**2 Main conclusions**

The following were the major findings put according to themes revealed that

Firstly, the findings it was established that at the time of the study some schools had no laboratories at all.

Secondly, the study revealed that, some school had no laboratory technicians. In such situations teachers are forced to assume the role of technicians, as such laboratory practice and instruction is compromised due to time constraints in balancing between teaching and being a technician.

Moreover, the study established that there is a shortage of physics practical guides manual.

Furthermore, the study established that the sampled schools had insufficient laboratory equipment, apparatus and chemicals.

In addition, most respondents indicated that the syllabus for O' level physics is very wide therefore to save time, practical is avoided for syllabus coverage.

Furthermore, experienced teachers should be deployed to schools where physics is being offered to help learners on conducting Practical work

Moreover, the study revealed that experienced teachers have better understanding of practical work and teach practical better that inexperienced teacher.

Lastly, the findings revealed that no time is allocated in school timetables for practical.

5.2.1.1 **Recommendations**

From above findings, it is recommended that:

In-service courses in doing effective practical work should be conducted by subject advisors and experienced physics teachers, as the curriculum is updating. Yet it is clear that an inspiring teacher engaged with and motivated by their subject, is the springboard for many pupils' future choices. There should be a teacher training for physics graduates.

Practical works must be allocated time on school time table with improved minutes to allow teachers work at their own pace.

The school management must see to it that they include necessary science equipment and resources when drafting the school budget to ensure effective learning takes place in their respective schools.

The researcher also recommends that science laboratories be built in all Secondary Schools in Binga to ensure a strong foundation in physics

Seminar on how to conduct practical of all physics students should be done in order to acquire skills and broaden knowledge from colleagues and different teachers.

To ensure effective teaching and learning, only the teachers with higher education in physics should teach practical classes of physics. For this purpose, a number of subject based teachers could be appointed in schools according to the number of physics students.

Posts for laboratory assistants could be created in order to reduce teachers‟ work load and also for the proper maintenance of laboratory equipment. .

Awareness of the value of practical work in teaching and learning of physics and in developing students' clear conceptual knowledge of physics must be developed in administration staff as well as among the physics teachers.

Lastly, further research could be carried out on high number of schools to have more views from a large number of teachers and students; hence a similar study could be done but with a larger sample in order to obtain a clearer idea of the challenges faced by teachers and learners when conducting practical work.

5.4. **Summary**

The study established that teachers have desire to conduct practical work more effectively, however, many challenges affect teachers which are beyond their control which led to less effectiveness in teaching practical work. Firstly, challenges such as limited time, limited resources, and lack of equipment which cannot be improvised affect teacher's implementation of practical work. In addition, lack of science laboratory technicians makes it difficult to conduct experiments effectively as extra time is needed for teachers to prepare the work. Moreover, a laboratory is important in schools because that is where physics practical is done, lack of it make it difficult for teachers to conduct practical work. Physics is a powerful tool for dealing with the present. It drives economic growth. It creates our options for the future. It is the key to our global competitiveness. Therefore, physics practical in schools will help learners prepare for jobs which will drive the economy of the nation and world at large

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List of appendices

Appendix 1 : Questionnaire for learners

I am Nyathi Oncemore, from Bindura University of science education carrying out a research on the effectiveness of experimentation in the teaching and learning of physics, a case study of Binga district. You have been chosen to participate in this research. Your names will be treated with confidentiality. You are kindly requested to be honest when completing the questionnaire.

Section A

Tick where appropriate

1. How often do you use experiments in the learning of physics?

Duration in days	
None at all	
Once a week	
Twice a week	
In every lesson	

2. Does the school have enough apparatus for physics practical?

For selected topics	
For all topics	
None at all for all topics	

3. What do you think must be done to ensure that experiments are carried out during physics lessons?

……
……
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……
……

What challenges hinders the use of experiments when teaching physics?

……
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……..

Do you use experiments in teaching physics YES ☐ NO ☐

Why do you shun the use of experiments in teaching physics?

……
……
……
…….

Do you use computers as virtual labs YES ☐ NO? ☐

If your answer above is no give reasons for your suggestions

……
……
……
……
……
……

Appendix 2: TEACHERS' INTERVIEWS

Morning sir or madam, thank you for affording me the chance to talk to you. Feel free to answer the following questions to the best of your knowledge. No name is not going to be recorded, hence no one should feel betrayed in this interview session.

Does the school have laboratories and lab tools for physics experiments?

If the answer above is no what teaching and learning methods are often used in teaching and learning of physics?

What challenges are experienced in physics practical lesson?

What can be done to improve the conduction of physics experiments?

Appendix 3: OBSERVATIONS SCHEDULE

The following observation schedule was used to figure out if the school environment in the district promoted the use of experiments in physics lessons and the results got are summarized in the schedule. The schedule concentrated on students' engagement, classroom management and curriculum implementation.

STUDENT ENGAGEMENT

This scale is intended to capture the degree to which the teacher make all students in the class focus on and participate in the learning activity presented or facilitated by the teacher through the teaching method used. The difference between passive engagement and active engagement is of note in this rating. This was carried out during lesson observations in schools visited

	Low	Mid	High
Promoting learners active engagement	The majority of students appeared distracted or disengaged.	The majority of students were passively engaged, listening to, or watching the teacher	Most students frequently volunteered information or insights, responded to teacher prompts, and/or actively manipulated materials.
Sustaining students'	Low engagement levels	Some students were engaged	High engagement were sustained

engagement	were sustained over activities and lessons.	but others were engaged for only parts of the activity or lesson	through the planned lessons

CURRICULUM IMPLEMENTATION

This scale is intended to measure the degree of teachers' practices in implementing the Zimbabwean educational curriculum in the classroom as well as the preparedness of the school environment for the conduction of experiments

	Low	Mid	High
Preparation of the lessons in terms experiments as per syllabus requirement	Teacher was not prepared for the lessons and tasks.	Teacher was mostly prepared for lessons and tasks, but occasionally lost time from instruction in last minute and ended up not conducting the intended practicals	Teacher was fully prepared for lessons and tasks—included high degree of familiarity with content and procedures to carry out experiments
Presence of the lab technician	There was totally no lab technician and the teacher did not even bother to prepare for the practical activities	The lab technician is present but not an expert in the area as she/he is not trained for the job	The lab technician is present and does his work as expected

Presence of the school laboratory and the apparatus	There is no science laboratory nor science apparatus	There are insufficient science apparatus but the laboratory is there	The science laboratory is there and is fully equipped with apparatus and chemical for experiments

Appendix 4: Focus groups

The researcher used focus groups whereby he gave learners the following questions to discuss in groups per selected school and groups were coded as shown in the table below. The researcher then went on gather information from the focus groups comparing the responses. The questions were as follows:

Which teaching methods are used in the teaching and learning of physics?

Why do teachers fail to use experiments?

What strategies can be employed to ensure that experiments are used in the teaching and learning of physics?