BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

FACTORS AFFECTING TEACHING AND LEARNING OF ORDINARY LEVEL PHYSICS: A CASE STUDY OF 3SCHOOLS IN MASVINGO DISTRICT.

BY

CHAMAUYA TAFADZWA TICHAONA

B211487B

SUPERVISOR: DR E MUDZAMIRI

DR N ZEZEKWA

RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF PHYSICS IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR BACHELOR OF SCIENCE EDUCATION HONOURS DEGREEIN PHYSICS

YEAR: 2022

BINDURA UNIVERSITY OF SCIENCE EDUCATION

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF PHYSICS EDUCATION

RELEASE FORM

NAME OF AUTHOR: CHAMAUYA TAFADZWA TICHAONA

TITLE: FACTORS AFFECTING TEACHING AND LEARNING AT ORDINARY LEVEL PHYSICS: A CASE STUDY OF 3 SCHOOLS IN MASVINGO DISTRICT.

DEGREE FOR WHICH THESIS WAS PRESENTED: BACHELOR OF SCIENCE EDUCATIONHONOURS DEGREE IN PHYSICS

YEAR DEGREE GRANTED: 2022

ADDRESS

Nyabata High School, P. Bag 3020

Renco Mine, Masvingo

PHONE NUMBERS: 0783423730/0716165284

E-MAIL ADDRESS: sirchams03@gmail.com

BINDURA UNIVERSITY OF SCIENCE EDUCATION

APPROVAL FORM

The undersigned certify that they read and recommended to Bindura University of Science Education for acceptance of a project entitled , " Factors affecting teaching and learning at ordinary level physics: A case study of three selected High Schools in Masvingo District" submitted by TafadzwaTichaona Chamauya in partial fulfilment of the requirements of Bachelor of Science Education Honours Degree.

……………………………………………. **.3.11.22**

SUPERVISOR **DATE**

………………………………………….. **……………………………**

CHAIRMAN **DATE**

DECLARATION

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

………………………………………. **……………………….**

Signature **Date**

DEDICATION

I dedicate this study to my wife and my son Newton Chamauya for their being a shoulder to lean on during this painstaking process. Relatives and friends were also social support renders through encouragement and guidance.

Your support is highly cherished and applaud able. You are my source of vision and strength. Without you I could not have made it. I love you all!

ACKNOWLEDGEMENTS

I am so thankful to God Almighty, by whose grace, mercies and wisdom I have sailed through the storm to witness success in this piece of work.

It would be a great academic offence not to express my profound gratitude to my supervisor, Doctor Zezekwa and Doctor Mudzamiri for their resolute attention, encouragement and constructive criticism during the research process. This piece of work would not have been a success it has become, had it not been his heartfelt and intellectual guidance.

My heartfelt appreciation goes to my beloved wife for her unwavering spiritual, emotional and encouragement throughout my entire study period.

To various authors whose work I consulted in the course of writing this research study and all the respondents who devoted their time to respond to my questionnaires and interviews, I really appreciate their support.

I would also want to extend my tender gratitude to my friend …. For her ideas, encouragement, support and grounding he provides towards this work. To all those that I have omitted, all your efforts and support have not gone unnoticed I thank them very much.

May the lord richly bless you

ABSTRACT

The main aim of this study was to gain insight on challenges faced in teaching and learning of physics in Masvingo District education system. The study was underpinned by the constructivist theory and cognitive apprenticeship model. The sample size for the study comprised 5 high school physics teachers and 75 learners from three selected schools within Masvingo District. Data from teachers and learners' survey questionnaires and interviews were analysed using descriptive statistical methods (including tables, pie-charts and graphs where appropriate) and inferential statistics independent samples test and multivariate analysis of variance. Detailed descriptions of classroom observations were also recorded as a reference for indicating what actually occurred. The cases were compared for similarities and differences.

The research findings indicate that all schools are still using old laboratories and inadequate materials. Learner-centred instructional approaches were not common in many physics classes as most teachers use teacher-centred as teaching method. The use of more traditional teaching approaches for physics contributed to learners thinking that physics is a difficult subject and not something they want to participate especially girls. Some learners in this study took physics because it is a requirement for future qualifications such as for engineering or medicine. The findings of the study also indicated that there was a lack of alignment between the aspirations of the curriculum which promotes inquiry based approaches to teaching and learning, and how physics is actually being taught. Also lack of adequate equipment hinders the uptake of physics subject in most schools within the District. The teachers who participated in the research however, believed that several factors hindered the quality teaching and learning of physics in Masvingo District. The teachers believed that physics teaching in Masvingo District is driven by assessment, not by learner interests, and that schools place too much emphasis on performance and grades. Findings from the study also provided insight about physics teachers' preparation and indicated that the physics education programmes for would be physics teachers generally do not cover content knowledge for the subject at junior level. That is, they should be physics teacher education programmes at primary for pedagogical content knowledge. The teachers perceived that their initial teacher qualification did not adequately prepare them to teach some of the content areas now in the curriculum.

Among other things, the findings from the research lead to a conclusion that limited time to work with learners had worsened the problem of finding time to prepare interesting physics lessons. Based on the findings, the study recommended that more financial support is needed from government and stakeholders so that schools will be able to upgrade their physics laboratories. Schools are also encouraged to include physics subject on their budgets so that they will be able to buy all the required equipment. There is a need for future studies investigating more carefully about gender differences in learners' attitudes towards physics.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

CHAPTER ONE: INTRODUCTION

1.0 Introduction to study

Physics is the study of matter and interaction between the fundamental constituents of the observable universe (Gregersen, 2021). The implementation of Nziramasanga revised curriculum of 1999 sees the pressing need to increase the number of learners studying science subjects. As a result, the country is scrambling to meet the anticipated demand for more scientists, engineers, and doctors in order to overcome under-representation and foster equality. In rising of qualified physicians, the country will be able to compete on global scale and keep up with peer instruction advances in science and technology. However, this research will outline Factors affecting teaching and learning at ordinary level physics; a case study of three High Schools in Masvingo District. Finally, chapter one covered the background to the study, objectives of the study, research questions, significant of the study, delimitation and limitations of the study. The researcher concluded by defining the key terms and the summary of the chapter was provided.

1.1 Background of the study

Despite the importance of physics for the development of the country, physics education is facing some challenges including: low learners' performance caused by negative attitudes towards the subject, the classes is too numerous sometimes 30 learners, school labs are old fashioned, insufficient equipment in the lab and old textbooks (Vannier, 2012).

The main purpose of this study was to find out the challenges faced by teachers and learners in the teaching and learning of physics in the secondary in Masvingo District. The study explored problems in the teaching and learning of physics from the following perspectives: problems related to school facilities, teachers, learners, plasma instruction and the extent to which the school is conducive for practical activities. The research methodology employed in the study was a descriptive survey. Purposive, stratified and simple random sampling techniques were used to select the data sources of the study.

Research has reported a low number of learners decide to pursue physics as non-compulsory subject in high school and university respectively (Augustyn, 2022). According to this research, some teachers pointed out that some learners fail physics because of their pessimistic attitude and lack of interest in the subject. Rodriguez (2022) highlighted that learners' negative attitudes towards physics are attributed to the fact that learners consider the subject as a difficult, unattractive, boring, and abstract subject. According to (Jain, 2012) female learners believe that that physics is difficult for them because it is a male dominated subjects. With the selected schools in Masvingo District, the researcher also found out that learners' poor enrolment in physics compared to other science subjects and their low performance in the subject matter were caused by their negative attitude towards the subject.

Therefore, it is important to investigate learners' attitudes towards physics at an early stage in order to facilitate the provision of solutions to improve their attitudes towards the subject matter. The educational problem of faint interest in physics lies not only on the side of learners but also on the teachers (Kagwesage, 2012). Teaching is frequently done in a boring manner, mainly textbook reading during lesson, instead of real experiments or multimedia teaching methods. Lessons are schematic, with no innovation scenarios, like role-play, reporting, competitions. A negative perception of Physics creates a kind of a negative feedback. Physics lessons are reduced to the very minimum time. Ahmed (2018) sighted other problems which are poorly equipped laboratories, usually possessing only old experiments, with no explanation or teaching scenario. Innovative textbooks would be required and new experimental set-up. The tradition teaching only kinematics, with numerous mathematical formulas, essentially to be remembered is too boring (Macaro, 2012). To overcome this problem there is need to prepare new experiments, from electromagnetism to computer guided laboratories. There is also a problem that young teachers have difficulties because studies do not prepare them to work in schools with old set. Schools are not able to buy new ones because in their budgets always are some important expenditures. There is also a possibility that an experiment set is available in schools but the teacher does not use it because may not have the facilities to make experiments because might have lesson in a classroom not in a laboratory and will have too little time. School do not have laboratories which are computerised. Another problem is fact that some of experiments which are supposed to be done by learners are impossible because school laboratory has only one or two sets but in class there are about 30 to 40 learners (McKinnon,2017).

1.2 Purpose of study

The study focused on factors affect teaching and learning of Physics at Ordinary level; a case study of three High Schools in Masvingo District. Also the research sought insight into policies and practices that might promote excellence in physics teaching and also improve the number of learners, and possibly teachers, involved. It also investigated how approaches to teaching high school physics in the District influence learners' perceptions of physics and their consequent desire to continue with the subject. The study also sought insight into the course structure, course components and programme requirements for physics education in Masvingo District. More importantly, it investigated whether the tertiary study adequately prepared and allowed pre-service teachers to become effective in their teaching fraternity.

1.3 Statement of problem

As discussed in background, physics is one of the subjects offered in the secondary schools. It is true that, knowledge obtained from the physics is applicable in any technological and engineering work, and also its benefit for the District of Masvingo and the nation at large. However, the teaching and learning of physics in the secondary schools of Masvingo District have been encountered by many problems. The researcher also observed that, the majority of learners in the secondary schools had no interest to learn physics. Majority of learners choose natural science because they assume that they cannot cope up physics dominated fields like engineering and technology. So, it is necessary to study the problems that affected the teaching and learning of physics in the District of Masvingo. Hence, these problems need special attention to get reliable solutions. Thus, the researchers extremely interested to identify problems in teaching and learning physics in Masvingo District secondary schools and to suggest possible solutions.

1.4 Main research questions

- What are the challenges faced by teachers and leaners in physics.
- How can these challenges be addressed

1.5 Research objective

The research was driven by the following objectives:

- To find out challenges faced by teachers and learners in teaching and learning of physics in Masvingo District.

- To try and found out ways of addressing the challenges faced in teaching and learning physics and how to solve these challenge.
- Investigating factors constraining the teaching and learning of physics and the dwindling number of learners involved in Masvingo District.
- Exploring ways to improve teaching and learning of high school physics in Masvingo District.

1.6 Hypothesis

The researcher used both research questions and research hypotheses. The use of mixed method research as well as hypotheses helps to explore the problem at hand to the fullest (Creswell, 2014).

Research hypothesis: if you know physics then it's not difficult to teach the subject.

Null hypothesis: Learners who become physics teachers do not have the ability to make it as successful physicists.

1.7 Significant of study

This study was an attempt to explore the practices that might enhance excellence in physics teaching and learning in Masvingo District and also including challenges and recommendations for future policies. The study attempted to survey the actual classroom teaching and learning practices in order to have first-hand information about how teaching and learning of physics takes place. Research of this type, will examines high school physics teachers' initial teacher education training, instructional pedagogies or methods, professional learning and the activities which go on in physics classrooms has rarely been undertaken (Bull et al., 2010). Therefore, as far as Masvingo District is concerned, this is a ground-breaking study. The findings from this study contribute to a better understanding of the content knowledge, pedagogical content knowledge and strategies physics teachers have and might benefit from teaching physics.

The findings of this study have highlighted constrains in physics classrooms and how high school learners perceive the subject in Masvingo District. The findings may serve as a catalyst for innovations in physics teaching, which may in turn enhance physics learning and the number of learners involved. The findings also serve as a basis for offering useful suggestions to all stakeholders in science education. They could also be useful in discussions about professional development of high school physics teachers. Furthermore, the study makes an important contribution to enhance greater participation in the teaching and learning of physics.

Another significance of the study is that the findings can be used to compare current methods and procedures of teaching and learning of physics with international standards. The findings open doors for improvement in teaching of physics and take physics learning to a higher level. The findings also inform future policies and practices and identify significant areas for further studies. Additionally, the study serves as resource material for learners or researchers who may make a related study in the future.

1.8 Delimitations

The study was conducted in line with the stated objectives. The researcher used three high schools in Masvingo District. The research involved school heads, physics teachers and physics learners from the selected schools.

1.9 Limitations

The survey and case study approaches, for this study, presented above have the advantage of describing thoroughly the challenges faced in teaching and learning physics in high schools. However, there is no method that is free of problems (Sarantakos, 2015).First of all, the focus on only three high schools in Masvingo District placed a limitation on the study. Again, survey questionnaires are difficult to construct and 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, 2010). 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, 2014; Creswell, 2017). 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.

It is possible that other teachers from different schools may have offered important information which would have been relevant to the study. However, the findings serve as indicators of what may be happening in other schools within the District and District of Masvingo at large.

The teachers' accounts of what they did were triangulated through classroom observations. However, the observations themselves could lead to the "Hawthorne effect". Although the respondents consented before observations were carried out, it is natural that when people are aware that they are being observed, they tend to perform better and this can affect the findings of the study. However, since respondents were observed teaching multiple times and any differences between the teacher's and researcher's scores were reconciled, it is possible that true behaviors were exhibited.

In this study, the limitations were whether the teachers were able to accurately assess themselves in terms of their teaching abilities and whether they accurately reported that. There was no guarantee that the respondents in the survey accurately assessed themselves regarding the teaching and accurately reported it.

Again, the opinions of learners in the study about their teacher's teaching ability were used to establish trustworthiness of the teachers' accounts. However, the learners' interviews may affect the findings of the study since learners' responses may be influenced by fear, hatred, love and other emotional concerns about their teachers.

1.10 Definition of terms

Physics- is the study of matter and interaction between the fundamental constituents of the observable universe (Gregersen, 2021).

Quality teaching and learning - the kind of teaching that promotes learner intellectual engagement and learning (Njagi, 2016).

Contextual constraints - school parameters and/or conditions that have negative influence on teaching and learning (Wenning, 2010).

Effective pedagogy - teaching strategies that support intellectual engagement, connectedness to the wider world, supportive classroom environments, and recognition of individual differences (Wenning, 2010).

1.11 Organization of study

The remaining chapters of the study are organized as follows:

Chapter 2-discusses the literature related to the study. The review involves theoretical and studies related to the problem under study.

Chapter 3- describes the methodology used in the study. Specifically, the research design, the research instrument, sample and sampling technique, the procedures for data collection and the data analysis.

Chapter 4- The analysis and presentation of the quantitative and qualitative data are presented in different formats which include: tables, charts and graphs.

Chapter 5-Finally, the summary, conclusions, implications, recommendations and areas for further research are presented.

1.12 Chapter summary

The main aim of this chapter was to introduce the reader to the major concepts of the study that include background of the study, statement of the problem, purpose of the study, research questions, significance of the study, assumptions to the study , delimitation of the study, limitation of the study , definition of key terms and finally chapter summery.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

The research sought to gain insight into challenges faced in teaching and learning of physics in Masvingo District. The study explored physics teachers' initial teacher education and practices that might promote excellence in physics teaching and also improve the number of learner and possibly teachers, involved. It also investigated how approaches to teaching physics in Masvingo District influenced learner' perceptions of physics and their consequent desire to continue with the subject. The researcher found out that it is with great heart that investigation into the teaching and learning of physics is 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 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 secondary schools; initial teacher education effectiveness; professional development for teachers; and purposes and practices of assessment in teaching and learning.

2.1 Challenges faced in teaching and learning physics

2.1.0 Negative Attitude towards Physics by learners

Learners' negative attitude towards Physics subject was also cited as a challenge teachers experienced in their implementation of physics in Masvingo District. Form one of the selected schools in the District one teacher said, "Learner belief that physics is a very complicated subject reduces learner' motivation for leaning the subject."

Ryan and Guido (2013.p. 2087) also stated that "Learner perceived physics as a difficult subject during high school days and it becomes more evasive when they reach in the colleges." In addition, they confirmed that the beliefs of learner that physics is tough, leads to lack of learner' motivation to learn the subject.

2.1.1Insufficiency Materials and laboratories in schools

The respondents from school heads and physics teachers in Masvingo District shows that lack of teaching and learning materials and laboratories is a challenge they faced in physics teaching. One of the participant in the District, for example reported that "lack of appropriate textbooks and infrastructures such as laboratory, classrooms and smart classrooms are challenges which affect my physics teaching especially with the new-curriculum which encourage learners to do practical subjects." These findings were in harmony with previous research findings. A study conducted by Rwanda Education Board (REB) in Nyagatare District located in Eastern District of Rwanda, for instance, identified insufficiency of learning and teaching materials for CBC in schools as one of the hindrances to the implementation of IBTL" (REB, 2018, p.6).

Similarly, a study conducted by Nsengimana (2021) regarding opportunities and challenges of CBC implementation in Rwanda reported the absence of laboratory apparatus and lack of teaching and learning materials as the main challenge faced by CBC implementation**.** Most interviewees commented on the lack of laboratory, inadequate physics equipment, large class size and lack of enough teachers in schools as the major barriers to the use of practical work in teaching and learning physics. Some participants also mentioned that practical physics is hindered by the lack of practical physics manual. Some of the participants' comments are as follows: "The major barrier is insufficient of laboratory equipment and lack of laboratory" (teacher from school C).

2.1.2Shortage of Time allocated to physics lessons

The shortage   of time assigned to do practical work on the school time table were mentioned by most physics' teachers and learner in the survey and those issues were also confirmed during interviews in one of the selected schools as follows: "There is no practical physics curriculum existing and there is no specific time allocated for doing practical work. Practical work does not exist on the school timetable. Teachers themselves have to make time for practical activities" (Physics teacher from school A).Other physics teacher offered similar comment. "Even if practical lessons are allocated on the timetable, the theory will continue to dominate due to lack of materials and laboratory" (Physics teacher from school B).Learner's comments on these issues include the following: "Another barrier is that there is no specific time allocated for doing practical work on the school timetable and also some physics teachers who are responsible for teaching physics have many responsibilities in school such as being physics teacher, class teacher, laboratory attendant and senior teachers' duties" (learner, from school A)."There is shortage time for learning physics because if a teacher is going to teach a new lesson having only one period of 40 minutes, you understand that time is not enough" (learner, from school C).A study conducted by Gutulo and Tekello (2015) for the purpose of assessing the challenges associated in teaching and learning of physics in the schools of Wolaita and Dwuro Zones, including secondary and post-secondary schools, reported limited time for making discussions as one of main challenges faced by physics teachers in their physics teaching. Furthermore, they reported that due to the shortage of time allocated for each unit, some physics teachers' preferred to use teacher-centred method of teaching instead of using learner centred as encouraged by new-curriculum.

2.1.3 Lack of Teachers' Skills and Knowledge

Lack of regular training for physics teachers on the use of practical work was confirmed by most teachers and school heads of studies during interviews. Some of their declarations are presented as follows: "One of the major barriers is the lack of regular training on the use of practical work in teaching and learning of physics to enhance lifelong learning" (teacher from school A). "The barrier here is that some teachers do not have those skills to use equipment available and to integrate practical work in teaching and learning" (teacher from school C).

Participants stated that they had not had enough knowledge and skills to prepare the practical lesson due to lack of training. One respondent held that **"**preparation of practical lesson at work place is a challenge due to lack of skills on how practical lesson is prepared." This challenge was also reported by Nsengimana, Habimana and Mutarutinya (2017) in a study conducted in three districts of Rwanda. They reported that teachers' knowledge and skills in using learner-cantered approaches including IBTL during implementation of science CBC were limited. Furthermore, they recommended policymakers and institutions in charge of pre-service teachers to organize training related to learner-cantered approaches for a better implementation of competence -based curriculum (CBC).

2.1.4 Teacher- learner ratio

Information on the school facilities, the number of teacher- learner ratio, class room -learner ratio, was also another challenge that was highlighted by most physics teachers.

All of above identified barriers are in line with several study findings (Babalola, 2017; Daba&Anbesaw, 2016; Harcourt, 2018; Mogofe&Kibirige, n.d.; Motlhabane, 2013;Ndihokubwayo, 2017; Olajide et al., 2017;Vilaythong, 2011), their findings also support the findings of this study. They asserted that physics is mostly affected by lack of practical textbook, inadequate practical physics equipment, lack of separate well equipped laboratory for physics, large class size, lack of laboratory at all, less attention of school administrators to practical work, lack of laboratory manual, less motivation of science teachers to use local materials, lack of proper supervision, lack of proper trainings on practical work and time limitation.

The findings of this study are also consistent with obstacles to practical work in science indicated by (Score, 2010), in which most frequent responses from teachers and technicians in rank order were presented respectively from 1 to 10: Curriculum content, Resources and facilities, Time, Exams and assessment, behaviour, Teachers 'inexperience, Technical support, Health and safety, Class size, and Lesson lengths.

2.2 Theoretical framework

This research was undertaken by two theories that are constructivism and cognitive apprenticeship model.

- **Constructivism**

Constructivism is characterized by the view that knowledge is not transmitted directly from one person to another, but is actively built up by the learner (Hoy, 2010). Kauchak (2013) argues that constructivism is an avenue of research that directs attention to the role of culture in the learning process. He believes that a constructivist classroom is one in which people are working together to learn according to him, such a classroom will be a place where inquiry is conducted. Discourse will be the mode by which participants engage in negotiations of meaning. Cognitive, social and cultural differences among learners will be honoured and alternative world-views respected (Kauchak, 2013).

Conner (2014) also accentuates that a constructivist classroom is a learner-centred environment which acknowledges and brings to the fore the past experience of learners. She articulates that in constructivist classrooms, learning is "reflective, interactive, inductive and collaborative, and questions are valued as a source for curiosity and focus for finding out information".

Constructivism as a theory, has evolved from not only learning about declarative knowledge that is understanding what but also knowing “how and when” to learn in different ways (Conner, 2014). In such classrooms, the teacher acts as a facilitator or mediator of learning rather than someone who only takes on the role of imparting knowledge.

Theories of cognitive development. Over the past decades, many learning theories, including the cognitive development theories of Peer instruction, Vygotsky and Bruner, have been implemented in different instructional models in learning environments. Peer instruction indicated that social interactions create disequilibrium to encourage growth in knowledge. He emphasized that the individual learners construct their knowledge through the process of adaptation – which can be accomplished in two ways:

(i) Accommodation, where existing schemes are modified so that new information can fit in.
(ii) Assimilation, where new information is modified to fit in the existing schemes.

According to Peer instruction, social interactions can reinforce this mechanism but it is the learners themselves who play the major role in peer instruction their knowledge. Vygotsky, on the other hand, promoted the dominant influence of social interactions. In his sociocultural learning theory Vygotsky suggested that social interaction leads to continuous step-by-step changes in learners’ thought and behaviour that can vary greatly from culture to culture (Hoy, 2010). This learning process involves three key elements – culture, language and “zone of proximal development”.

Vygotsky believed that when learners interact with peers they can actively participate in dialogues, discover how others think about their experiences and then incorporate the ways others interpret the world into their own ways of thinking. By this way, learners are able to develop their knowledge towards more complex and sophisticated structure (Eggen & Kauchak, 2013; Hoy, 2010).

Bruner also suggested that instruction follows a sequence of three stages. The basic stage is called enactive stage where learners manipulate objects to learn about the world around them. The next stage is iconic stage where learners represent experiences and objects as concrete images. In the last stage, the symbolic stage, learners are able to think in abstract terms with symbols (Cahyadi, 2013). The principle of progressing towards a higher level of thinking process has a lot of applications.

Two prominent ones are the curriculum (were concepts are developed from simple forms involving concrete objects and experiences to a high level of abstraction) and discovery learning (where learners work from examples to find general principles on their own (Cahyadi, 2013).

The ideas in these cognitive learning theories are in line with constructivism in the sense that learners construct their knowledge and/understanding on their own, rather than knowledge being transmitted by someone else. Though these theories have been used in different instructional models in learning environments, constructivist theory has been found to be more related to instructional methods, and can be used to improve teaching of physics. It encourages learners to use active techniques (e.g. experiments, real-world, problem solving) to create knowledge, reflect on, talk about what they doing and how their understanding is changing (Conner 2014; Keser et al., 2010). The constructivist theory of learning also applies to teachers' learning when learning to teach.

- **Cognitive Apprenticeship Model**

The cognitive apprenticeship model also presumes that learners should be exposed to the teaching methods that give them the chance to observe, engage, invent, or discover expert strategies in context (Chandra & Watters, 2012). According to Conner (2014) the teaching methods should "systematically encourage learner exploration and independence" (p. 5). Conner stresses that teachers only coach – "offering hints, feedbacks, and reminders; provide 'scaffolding' (support for learners as they learn to carry out tasks); and 'fade' – gradually handing over control of the learning process to the learner" (p. 5). More so, the learning environment should reproduce the technological, social, time, and motivational characteristics of real world situations with varying levels of difficulty to enable learners to work with their peers in finding solutions to problems as experienced in the real world (Chandra& Watters, 2012).

This studies show that the cognitive apprenticeship model or constructivist theory is an accurate description of how learning occurs and the instructional strategies can be designed into formal learning contexts with positive effect (Chandra & Watters, 2012; Conner, 2014; Keser et al., 2010). With these two theories (constructivist and cognitive apprenticeship) teachers acknowledge they cannot mandate what learners learn. They design learning activities that are informed by what learners already know and believe, and actively encourage learners to reflect on and manage their own learning.

2.2.0 Beliefs and Conceptions of Physics Teachers about Physics

According to New Oxford Dictionary of English belief is an acceptance that a statement is true or that something exists; something one accepts as true or real; a firmly held or conviction. An inspection of other dictionaries and entries also brings out the meaning of belief as:…. a state or habit of mind in which trust or confidence is placed in some person or thing; conviction of the truth of some statement or the reality of some being or phenomenon especially when based on examination of evidence (Woolf, 2010);… the feeling of being certain that something exists or is true (Sinclair, 2011) … a strong feeling that something is right or good; an idea that you are certain is true (Rundell& Fox, 2010);… the feeling of certainty that something is true (Cambridge University Press, 2012).

In short, belief can be understood as the psychological state in which an individual holds a proposition or premise to be true (Cahyadi, 2011).The Oxford dictionary and Merriam-Webster dictionary also define conception as: a complex product of abstract or reflective thinking; the sum of a person's ideas and beliefs concerning something; and the originating of something in the mind. In science education research, conceptions of teaching can be defined as: The set of ideas, understandings, and interpretations of experience concerning the teacher and teaching, the nature and content of science, and the learners and learning that the teachers used in making decisions about teaching, both in planning and execution (Hewson&Kerby, 2014, p. 7).

Drawing from Pajares (2012) general research into teachers' beliefs, Mulhall and Gunstone (2010, p. 439) noted that "beliefs travel in disguise and often under alias attitudes, values, perceptions, conceptions, implicit theories, explicit theories, and perspectives." Various labels have also been used to refer to teachers' conceptions, such as, views, beliefs practical personal theory, orientation, and cognitive structures. In this study, conceptions, beliefs and views are used interchangeably in the report to describe participant teachers' understanding and experiences about teaching and how these inform their teaching.

Generally, what people know and believe influences their actions and informs the choices they make in their everyday lives. Beliefs also inform how teachers engage in and go about their classroom practices (Loucks-Horsley et al., 2010).

Teachers' conceptions about how science is developed may be potentially related to their beliefs about how to teach science and how learners learn science, including physics. Gallagher (2014) described the views of the nature of science held by 25 experienced secondary science teachers in Michigan State, USA, as "unsettling" (p. 124). Classroom observations showed that all the teachers emphasized science as a body of knowledge, spent more time in peer instruction terminology than on building relationships across concepts and rarely engaged learners in laboratory work.

Tsai (2015) investigated science teachers' conceptions about teaching, learning science and the nature of science. Research data were gathered through interviews with 37 secondary school science (physics and chemistry) teachers. Results from the study showed that most science teachers had 'traditional' beliefs about the teaching and learning of science – science is best taught by transferring knowledge from teacher to learners (e.g. transferring of knowledge, giving firm answers, providing clear definition, giving accurate explanations, presenting the scientific truths or facts.

Using the Maryland Physics Expectations (MPEX) Survey and Reformed Teaching Observation Protocol (RTOP), Mistades (2015) also investigated beliefs about physics teaching held by three physics teachers (faculty members) of the De La Salle University in the peer instruction, and sought to determine how many of these beliefs translated into classroom strategies and practices. Findings from the study showed that teacher's beliefs influence their actions and practices in the classroom. The physics teachers who participated in the study viewed learning physics as primarily understanding underlying ideas and concepts rather than simply focusing on memorizing equations and formulae. The classroom observation data, obtained using the RTOP, supported this view as they (teachers) scored highest (83.3%) in the propositional content knowledge.

Mistades indicated that the teachers' lessons highlighted fundamental concepts by giving specific examples, showing relationship between concepts, and moving from simple to complex problems. As part of the research on teachers' knowledge and thought patterns (conceptions, beliefs and views) about teaching, some studies often make conclusions about teachers' practice but do not support these conclusions with observational data (Hashweh, 2012; Tsai, 2015). However, recent studies about teachers' conceptions and beliefs that included classroom observations found a relationship between their conceptions about teaching and learning science, their beliefs and their teaching practice (Ladachart, 2011; Mulhall & Gunstone, 2012). Mulhall and Gunstone (2012), for example, found that the approaches used by physics teachers to teach physics were generally linked to their views about learning physics.

Mulhall and Gunstone used qualitative methodology to explore views about physics held by a group of physics teachers whose teaching practice was traditional, and compared them with the views held by physics teachers who used conceptual change approaches. Semi-structured interviews and observations were employed for this purpose. The authors discovered that the perception that particular physics teaching approaches may be linked to particular views about physics "seemed to apply to the traditional group but not to the conceptual group" (Mulhall & Gunstone, 2014).

Findings from the study suggest that the two groups of teachers had distinct views about learning physics: The Traditional teachers thought of physics learning as the outcome of doing certain activities, and in terms of acquisition of information about physics ideas. For the traditional teachers, physics was seen as hard because it is mathematical and abstract, and many learners do not have the special attributes necessary to learn it. The conceptual teachers thought that learning involves cognitive activity by the learner, and that individuals construct their own understanding in terms of their personal frameworks. For the conceptual teachers, the ideas of physics were considered to be counter-intuitive and troublesome in terms of learning. They saw discussion as being important for learners as it helps tease out and develop understandings of physics ideas (Mulhall & Gunstone, 2012, p. 444).

In discussing the implications of the data collected, the researcher indicated that traditional approaches to teaching physics, which often fail to promote adequate learners understanding of physics ideas, still persist. The challenge then, reported by the authors, is to find ways of promoting teacher change, of peer instruction physics teachers understand and implement ways of teaching that lead to better learner learning.

Research on teachers' conceptions about teaching is framed within the constructivist perspective on teachers learning (Ladachart, 2011). According to this perspective, it is believed that teachers process information and build cognitive structures about teaching based upon their prior experience which they have gained since their days as a learner and such cognitive structures can act as a point of reference for their current teaching practice (Koballa et al., 2015). Hewson and Kerby (2015) noted that teachers are likely to choose instructional approaches which are align with their conceptions about teaching so that they can achieve their teaching goals.

Thus, teachers' conceptions about teaching have a direct relationship with their teaching practice. Koballa et al. (2015) therefore contended that understanding of teachers' conceptions about teaching can be used as point of reference to understand their teaching practice. Even though such conceptions about teaching are often resistant to change and Ladachart (2011) observed that, teachers are most often, likely to compromise their ideal and as peer instruction conceptions about teaching due to contextual constraints causing them to "hold working or back-up conceptions about teaching" (Ladachart, 2011, p. 177).

Given that teachers have their personal conceptions about teaching and these beliefs are likely to influence their instructional decision-making, this study, in part, explored the conceptions held by some physics teachers and examined them in the context of a constructivist peer instruction.

2.2.1 Nature of Physics Classroom Practices

For learners to have an expert understanding of scientific concepts, Vosniadou (2017) argues that learners must undergo profound conceptual change. She recommends that instruction must address both the "need for individuals to construct their own understanding and the socio-cultural factors that are present in school settings" (p. 34). Even though many peer instruction studies have demonstrated that carefully planned, interactive instruction can be effective in promoting conceptual change and enhance performance (Vosniadou, 2017)

For instance, in the late 1980's in Perth Australia, Tobin and Gallagher (2010) found that the most common instructional mode in high school science classes was whole class interactive when the teacher dealt with the class as a whole, and interacted with one learner at a time while the others listened; and whole class non-interactive comprised of lecture presentations followed by individual seatwork and small group activities. More than a decade later, Hackling et al. (2016) found that the teacher-centred instructional approach was still prevalent in many of the secondary schools in Australia:

For many secondary learners, the teaching-learning process is teacher directed and lessons are of two main types: practical activities where learners follow the directions of the teacher to complete an experiment, and the chalk and talk lesson in which learning is centred on teacher explanation, copying notes and working from an expository text. The extent of teacher-centeredness was revealed by 61% of secondary learners who indicated that they copy notes from the teacher nearly every lesson and 59% also indicated that the teacher never allows learners to choose their own peer instruction to investigate.

A similar situation was described in high schools in Norway. Angell et al. (2013) administered questionnaires to 2192 learners taking physics and 342 physics teachers in high schools in Norway and followed up with focus group interviews. They found that in relation to physics, proportionally a greater part of classroom time (about 60%), was spent with the teacher presenting new material on the blackboard/whiteboard. Physics classrooms were found to be dominated by "chalk and talk instruction" (p. 701). Though learners in the study perceived physics as interesting and describing the world and everyday phenomena, they also perceived the subject as demanding, formalistic in nature and more mathematical as it uses the language of mathematics to express physical processes and phenomena. The majority of the learners wanted a stronger emphasis on context and connectedness as well as conceptual approaches that are learner-centred. Based on the findings, the authors suggested that: secondary physics education preparing learners for tomorrow's society should be characterized by variety, both within and among courses, integration of mathematics in the physics courses, more peer instruction-centred instruction, and a stronger emphasis on knowledge in context.

In Germany, learners at secondary level described physics lessons as "chalk-loaded demonstrations" (Tesch, Euler, &Duit, 2013, p. 1). Tesch et al. (2013) used a video study to identify patterns of instructional phases and interactions as well as to detect key indicators for conditions, processes, and beliefs that characterise the quality of physics instruction. They found that:

- Limited and rigid questioning-develop peer instruction strategy predominates in whole class discussions. Learners have little voice in these phases;
- Though experiments play a substantial role in instruction, learners have little opportunity for planning, carrying out and interpreting the results of the experiments by themselves;
- Opportunities for learning by cognitive activation are not often provided. Most teachers' thinking about physics instruction is rather oriented on contents. Moreover, most teachers also do not hold a constructivist view about teaching and learning (Tesch et al., 2013, pp. 3-4).

It has also been shown that teacher interactions affect learners' attitude towards learning and their participation in class activities (Masika, 2011).

Masika indicated that teacher interaction behaviours were an important aspect of the learning environment and are strongly related to high school learner outcomes. Masika found that, in

Kenya, physics teachers were autocratic and dominated their classrooms by talking only and sometimes talking with illustrations. The study recommended that an initiative involving teachers of physics in action research in the area of classroom interaction would go a long way in peer instruction the teachers improve their teaching behaviour. Recently, using a mixed method approach, physics instruction in Alabama State was reported generally as teacher-oriented with lectures forming a significant part of the lesson (Sunalet al., 2015). The authors indicated that the classroom observation data did not support teachers' references, during interviews, to their common use of hands on instruction.

One can infer from the above studies that teacher-centred instruction continues to be a widely used instructional strategy in secondary school physics classrooms. Moreover, learners have expressed a desire for more interactive environments. In a teacher-centred approach, there is little opportunity, if any, for learners to articulate their thinking, hear what others are thinking and examine those ideas (Crowe, 2017). At best, questions posed by instructors to individual learners may be the limit of interaction in most physics classrooms.

Remaining members of the class are not required to subject their own ideas to the type of scrutiny that might reveal any incoherence in their minds. The practical challenge consists of finding instructional methods that would help learners to understand, accept and use current scientific views. Some of these methods have been reviewed below.

Teaching and Learning of Physics – Conceptual Change and Problem Solving

2.2.2 Dealing with Conceptual Change and Problem Solving

Research into learners' understanding and learning of physics is prominent in the literature. Interest and motivation have been reported as essential factors for learner learning and academic achievement (Nolen, 2012). Science classrooms that focused on understanding and qualitative thinking were found to positively predict learners' satisfaction with learning (Nolen, 2003). In physics education in particular, the motivation, active knowledge and participation of the learners is of paramount importance. Passive, unmotivated learners and minimal creativity in learning have a limited future in contemporary education (Ülen & Gerlič, 2012).

At the heart of physics education research is a shift in physics instruction from "What are we teaching and how can we deliver it?" to "What are the learners learning and how do we make sense of what they do?" (Redish & Steinberg, 2014, p. 2). Over the years, physics education researchers have used a variety of tools in trying to find out what learners' real difficulties are and how to improve their achievement in the subject. The connection between physics and mathematics for instance, has been found as a major weakness to physics understanding. In order to make this shift achievable, Redish and Steinberg stress that teachers of physics need to listen to the learners and find ways to learn what learners are thinking. By doing this, teachers then begin to make sense of how learners learn physics in a way that helps them improve their courses to be more meaningful to learners.

Adding to this, McDermott (2012) extols that the focus of physics teaching must be on the learners as learners. She underscores that close contact with learners provides the opportunity to observe the intellectual struggles of learners as they try to understand important concepts and principles. "Day-to-day interaction in the classroom has enabled us to explore in detail the nature of specific difficulties, to experiment with different instructional strategies, and to monitor their effect on learner learning" (McDermott, 2012, p. 1128), reported by McDermott and her research team (Physics Education Group).

Research findings have indicated that the conceptual learning of physics often uses models, animations and simulations for problem solving approaches. For example, in teaching electric circuits, one model that has been proven effective is Physics by inquiry, developed by McDermoth and her physics education group (see McGinnis, 2012; Campbell, Danhui, & Neilson, 2011). Physics by inquiry is a module with carefully structured experiments, exercises, and questions that are intended to engage learners actively in the construction of important concepts and in their application to the physical world.

As the learners work through the module, they are guided in constructing a qualitative model for a simple circuit. In the process, specific difficulties identified through research are addressed (McDermott, 2012).

Learners work with partners and in larger groups. Guided by the questions and exercises, they conduct open-ended explorations, perform simple experiments, discuss their findings, compare their interpretations, and collaborate in constructing qualitative models that can help them account for observations and make predictions. Great stress is placed on explanations of reasoning, both orally and in writing.

The instructor does not lecture but poses questions that motivate learners to think critically about the material. The appropriate response to most questions by learners is not a direct answer but a question to help them arrive at their own answers. (McDermott, 2012, p. 1129)

The Project for Enhancing Effective Learning (PEEL) in Melbourne, Australia is another example of a movement in education that directly responded to teachers' concerns about learners learning, especially in the sciences. Though, it was developed as partly a consequence of traditional teaching, PEEL teachers view teaching as problematic and have become experts in develop peer instruction procedures that are the direct opposite of trans missive teaching (Loughran et al., 2012). One experienced PEEL teacher, Rosemary Dusting of Wesley College – Glen Waverley in Melbourne, Australia, offered an extensive report of her efforts to move from teaching as telling to teaching for understanding.

She indicated: my teaching had shifted from me doing all the work for the learners to the learners now working out part of the content for themselves. They had been provided with meaningful opportunities to think and I had not taught by telling. My understanding of what it meant to teach learners to be active learners was being developed and I valued what was happening. (Dusting, 2012, pp. 177-180)

PEEL is a project which focuses on the teaching and learning practices in secondary school classrooms (Mitchell, 2015). This project supports the "creation of classroom learning environments, which are more productive and enjoyable places for learners and teachers alike in comparison to more conventional classrooms" (Erickson et al., 2015). As stated by Lumb and Mitchell (2011), PEEL operates as a network of autonomous and voluntary groups of teachers who take on a role of interdependent innovators. The teachers agree to meet regularly to reflect on their practice, and to provide mutual support and stimulation for the processes of teacher and learner change. Thus, coherence is provided by the shared concerns about passive, dependent learning and by the dissemination of information about the project and by structures that allow teachers to learn from and share new wisdom with teachers in other schools as well as a few academic friends.

PEEL's achievements include the development of a repertoire of teaching procedures designed to promote effective learning; findings about the nature of learner change, and teacher change; and findings about the nature of collaborative professional development in schools and between the school and tertiary sectors (Lumb& Mitchell, 2011). Having been founded in one secondary school in 1985, PEEL has since then spread to schools throughout Australia and many other countries including the U.K., Canada, Sweden and Iceland (Erickson et al., 2015). PEEL's large collection of ideas, strategies, procedures, support and resources, developed over a long period of time, for science teachers have helped to improve upon their classroom practices, such as group work and assessment (Lumb & Mitchell, 2011). These collections are available online (http://www.peelweb.org/index.cfm?resource=peer instruction) and both physics teachers and teacher educators can access them to inform better physics teaching practices and learning.

2.2.3 Interactive Teaching Approaches in Physics

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 learners are motivated to construct knowledge by themselves, rather than the knowledge being transmitted to them by their instructor as in the traditional approach (Hake, 2011). 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. The term interactive teaching approach is used in this thesis to refer to those "methods designed at least in part to promote conceptual understanding through interactive engagement of learners in heads-on (always) and hands on (usually) activities which yield immediate feedback through discussion with peers or instructors" (Hake, 2011).

This section discusses four of these interactive approaches: peer instruction interactive lecture demonstration photonics explorer (Prasad et al., 2012), and visual interactive computer software programs (Horner, & Bentall, 2012; Ülen & Gerlič, 2012; Wieman et al., 2018). Physics teaching should include more learner interactive approaches than the way it is now, and when physics is taught in this way, the subject would be made more accessible to all learners (Wieman et al., 2018), especially those at secondary schools, thereby improving upon the number of learners involved and possibly teachers as well.

2.2.3 Peer instruction

Peer instruction is a widely used pedagogy in which lectures are interspersed with short conceptual questions, usually multiple-choice questions, called Concep Tests (Fagen, Crouch, & Mazur, 2012; Lasry, Mazur, & Watkins, 2018). The peer instruction engages learners during class through activities that require each learner to apply the core concepts being presented, and then to explain those concepts to their fellow learners.

Unlike the common practice of asking informal questions during a lecture, which type instructionally engages only a few highly motivated learners; the more structured questioning process of peer instruction involves every learner in the class. It modifies the traditional lecture format to include questions designed to engage learners and uncover difficulties with the material (Crouch & Mazur, 2011).

Results from ten years of teaching with peer instruction, through true experimental-based research – where subjects are assigned randomly to intervention and control groups, (Crouch & Mazur, 2011) indicate an increased mastery of both conceptual reasoning and quantitative problem solving. Fagen et al. (2012) focused on assessing the effectiveness of peer instruction via a web survey. The researchers polled peer instruction users (teachers) to learn about their implementation of and experience with peer instruction.

The survey collected data about how instructors learned about peer instruction, courses in which peer instruction was used, implementation details, course assessment, effectiveness, and instructor evaluation. Out of the 50 participants that completed the survey, 40 were identified as using the peer instruction. The peer instruction survey results indicated that most of the assessed peer instruction courses produced-learning gains matched with interactive engagement pedagogies, and "more than 40 instructors (greater than 80%) consider their implementation of peer instruction to be successful" (p. 208). also, the majority (over 90%) of those using the method plan to continue or expand their use of peer instruction.

Lasry et al. (2008) measured learners' conceptual understanding of Newtonian mechanics using the force concept inventory in both peer instruction and traditional courses at John Abbott College (a two-year college) and Harvard University. The results showed that peer instruction-taught learners demonstrated better conceptual learning and similar problem-solving abilities than traditionally taught learners. They also found that, by engaging learners on the course, peer instruction reduces the number of learners who drop the course. The researchers concluded that peer instruction is an effective instructional approach not only at a top-tier university, but also at a two-year college. In both settings, peer instruction increases conceptual learning and traditional problem solving skills.

2.2.4 Interactive lecture demonstration

The interactive lecture demonstration is designed to engage learners in the learning process by converting the usually passive-learner lecture and recipe lab environment to a more active one (Sokoloff et al, 2017).

With the interactive lecture demonstration, the researcher initially describes a demonstration to the class. Learners record their individual predictions on a prediction sheet and engage in small-group discussions. Afterwards, they record their final predictions and hand in the prediction sheets to the instructor. The instructor elicits common learners' predictions from the whole class. The instructor then carries out the demonstration, with measurement tools suitably displayed. A few learners may be asked to describe and discuss the results in the context of the demonstration. The instructor may proceed with presenting analogous physical situation(s) with different "surface" features based on the same concepts (Sokoloff, 2017).

Through a pre-test and post-test experimental study, supplemented with questionnaires, Cahyadi (2017) conducted two case studies to investigate the effectiveness of the peer instruction, and ILD approaches on learners understanding of Newtonian concepts. The first case study took place at the University of Surobaya, Indonesia and the second study was conducted at the University of Canterbury, New Zealand. In the areas that she assessed (conceptual change and problem solving); the results showed that the experimental classes achieved significantly greater improvement in conceptual change compared to the control classes. Learners in the experimental classes also performed significantly better in problem solving than those in the control classes.

Results from the second case study also produced a marked improvement in learners' comprehension of learning materials as all the learners welcomed the application of "new elements of the instruction" (Cahyadi, 2017). Even though the sample sizes for Cahyadi's studies were large (341 for the first study and 198 for the second study) for an experimental study, the results were obtained with non-randomization of the subjects to the treatment conditions, indicating that the gains might have resulted from pre-existing differences between the groups. Galvan (2013) emphasized that in the school settings learners are not normally assigned to the classes hence there may be "important pre-existing differences between the two groups, which may confound the interpretation of the results of such an experiment" (p. 45).

2.2.5 Photonics explorer

In order to solve the declining interest of learners in science subjects, particularly physics, in Europe the European Union has initiated various projects to foster science education at European high school level. One of these projects is the Photonics Explorer Kit (PEK) which focuses on the development of an educational kit for light, optics and photonics (Cords, Fischer, Euler, & Prasad, 2012; Fischer, 2011; Prasad et al., 2012). The PEK is specifically designed to cover the peer instructions that are in the curriculum in order to help the teacher and learners to achieve educational targets – yet with the use of hands-on experiments in an inquiry-based learning context (Cords et al., 2012).

The photonics explorer project offers well prepared resources that can be integrated into the existing European curricula and which can also be easily integrated into other curricula. It does not take away teaching time but rather helps the teacher to make the best use of the time already designated for light and optics in their curriculum to ensure that educational targets are easily achieved (Cords et al., 2012). The experimental equipment in the kit has been specifically designed to support inquiry-based teaching and learning. The kit equips teachers with class sets of experimental materials related to optics and photonics within a supporting didactic framework consisting of worksheets, factsheets, teacher guides and multimedia material (videos, photos etc.). The kit consists of eight modules, four for lower secondary (12-14 years) and four for upper secondary (16-18 years). Each kit includes a class-set of experimental materials such that a class of about 25 to 30 learners can work together in small groups of three and four.

It contains not only the components, worksheets and factsheets for conducting hands-on experiments but also a guide for the teacher with a suggested outline for the use of each module, and these save the teacher valuable lesson preparation time (Prasad et al., 2012).

From a peer instruction lot study in six school classes in Germany and five school classes in Belgium, the authors report that the approach has been very well received by both teachers and learners. Many learners are reported to have said that they appreciate the "additional freedom due to the 'simplicity' of the components to develop their own experimental setups far away from the regular step-by-step programme" (Cords et al., 2012, p. 72). The photonics explorer program aims at teachers in European secondary schools free-of-charge with up-to-date educational resources to really engage, excite and educate learners about the fascination of working with light (Fischer, 2011). A teacher receives the kit free of charge once he/she attends a teacher training course on how to implement it in their classrooms. This is mainly to introduce teachers to the concepts of guided inquiry based learning and the importance of learners doing the hands on experiments themselves (Prasad et al., 2012).

2.2.6 Visual interactive computer software programs

The advances in computer hardware and software programs have provided new platforms for physics teaching and learning. One such program is applets, which have been running on the World Wide Web for the past decade. When an applet is oriented on a small, specific domain of physics, we talk about physlets (Ülen&Gerlič, 2012). Physlets are interactive materials, where processes happen at certain intervals and there is an interaction between the model and the learner. Learners have the opportunity of changing the conditions and immediately observing the impact. In addition, when dealing with new physical phenomena, learners can change relevant parameters and immediately see the consequences of their actions. This can help learners to understand the main concepts of the phenomenon. Ülen and Gerlič stress that due to the phases of physics (illustration, exploration and problems), "they can be used as an element of almost any curriculum with almost any teaching approach, so they could also play an important role in the conceptual learning of physics" (p141).

A similar model, which has been developed, tried and tested, to help develop learners' conceptual understanding of complex ideas with problem solving is Physics Education Technology (Wieman et al., 2016). Physics Education Technology is a collection of web based interactive simulations for teaching and learning physics and other sciences as well. It was developed with three primary goals: "increased learner engagement, improved learning", thereby improving performance and "improved beliefs about and approach toward learning" (p. 394). These goals have been the critical areas for physics education research over the years (McDermott, 2011). The majority of the PhET simulations are physics-related and cover a range of peer instructions from introductory material in mechanics and electricity and magnetism to advanced peer instructions such as quantum mechanics, lasers, and magnetic resonance imaging (Wieman et al., 2014). The key features of PhET simulations, that is, visualization, interactivity, context, and effective use of computations are particularly effective for learners understand the abstract concepts in physics.

Another form of technology development for increasing learner interaction has been augmented reality. The argument reality technology has emerged as one of the interactive engagement approaches which provide visual and interactive experiences that allow in-depth understanding of abstract phenomena (Dünser et al., 2012).

It provides physics educators with an exciting interactive environment to engage learners and enhances understanding of key concepts. What is different with regards to argument reality is that it provides the platform for both teachers and learners to think about how to use technology to represent complex concepts. Thus, the learning materials (AR books) are developed by teachers and learners themselves which in turn enhances greater understanding of the content (Dünser et al., 2012). Using the software application BuildAR (HIT Lab NZ) as an educational tool for constructing AR scenes, Buabeng, Conner, Winter, and Walker (2013) interacted with a small group of pre-service secondary school physics teachers with constructed AR sequences. The peer instruction physics teachers visualising the magnetic field about an inductor were able to fully immerse themselves in the three-dimensional projection of the field, thereby actively interacting with the physical phenomena in virtual space. The peer instruction physics teachers were convinced that using argument reality as a teaching tool would facilitate an improved conceptual understanding of the underlying physics concepts.

All the interactive approaches mentioned above aim to encourage learner interaction in physics classrooms and to focus learners' attention on fundamental concepts. Involving learners actively in the lesson, through these interactive teaching methods is likely to improve their conceptual understanding of physics concepts (Cahyadi, 2011; Lasry et al., 2017; McKagan et al., 2013). As observed by Brekke (2015), high school physics can be a great experience for learners if some changes are made in the way the subject is taught. Brekke advises physics teachers to remember that most learners gain knowledge when subject matter is tangible or real, therefore physics instruction should generally proceed from the concrete to the abstract, rather than other way around which is prevalent in many physics classrooms.

2.2.9 The Role of Content Knowledge

Initial teacher education plays a key role in supporting the development of effective teachers. Lederman and Gess Newsome (2011) found that, peer instruction is the fairly high level of confidence pre-service teachers have in their subject matter knowledge and the attainment of a bachelor's degree in the academic area, most do not understand the content that they are to teach in a conceptually rich or accurate manner. In discussing how the nature of science content affects learning and teaching, Fensham, Gunstone, and White (2014) indicated that content, learning and teaching are interrelated.

To them, the extent to which teachers will go about a particular task in the classroom is greatly influenced by the subject matter content they know. Advancing on this, Gunstone (2014) suggested that content knowledge is important for "metacognition purposes" (p. 145). He argued that, understanding the science subject matter content, for physics in particular, is most important for pre-service teachers, in the sense that it promotes self-reflection amongst them about their learning and how and what others have learned.

Conner and Gunstone (2014) noted that learning outcomes are maximised when content knowledge is promoted together with strategic learning approaches. All these have implications for ITE in that ITE programmes need to model how to identify and learn content knowledge for pre-service teachers so they will gain confidence to teach the fundamental aspects of physics. ITE providers are responsible for the training and development of effective teachers. Commenting on the role that science teachers can play in facilitating high school learners' learning, Wellington and Osborne (2011) indicated that "as teachers of science … our primary skills lie not in our ability to do science, but in our ability to interpret and convey a complex and fascinating subject". This statement indicates the importance of subject matter content knowledge (Fensham, 2013) and how beginning teachers might be enabled to interpret and connect ideas and make these explicit in their teaching.

McDermott (2010) found that in the USA, a science degree programme majoring in physics does not provide adequate preparation for teaching in high schools. McDermott emphasized that the scope of peer instruction and the laboratory courses offered by most physics departments rarely address the needs of learner teachers. Likewise, MohdZaki (2018) found that in Malaysia pre-service teachers had a weak conceptual understanding of Newtonian concepts, and had difficulty understanding kinematics graphs. Similar observations have been made by other researchers (Russell, 2016).

This has led to various attempts to reorganise teacher education programs. Korthagen et al. (2016) for example, after analysing effective features of teacher education programs in Australia, Canada and Netherlands, outlined how to guide the development of teacher education programs that are responsive to the expectations, needs and practices of learner teachers. Also, Fensham (2014) argued that in develop peer instruction appropriate pedagogies, the problematic nature of the content itself should not be ignored. This means that when educating physics teachers, we need approaches that are specific to the content domain of physics (MohdZaki, 2018).

2.2.10 The Shortfalls (What Works and what does not Work)

McDermott and Shaffer (2010) argued that a well-prepared teacher of physics or physical science should have, in addition to a strong command of the subject matter, knowledge of the difficulties it presents to learners. The authors, through a series of classroom observations and interviews with pre-service and in-service teachers, found that traditional courses in physics do not provide the kind of preparation that teachers need to teach physics at secondary school level. They indicated that teachers tend to teach as they were taught – "if they were taught through lectures, they are likely to lecture, even if this type of instruction is inappropriate for their learners" (p. 72). They (McDermott & Shaffer, 2010) argued further that, although the content of the high school physics curriculum is closely matched to the introductory university course, the latter does not provide adequate preparation for teaching the same material in high schools.

The authors emphasize that the breadth of peer instruction covered and the laboratory courses offered by most physics departments also do not address the needs of learners, in that most of the time the equipment used in universities is/are not available in high schools, and no provision is made for showing teachers how to plan laboratory experiences that utilize simple apparatus. In discussing the implications of the study, the authors noted that separation of instruction in science (which takes place in science courses) from instruction in methodology (which takes place in education courses) decreases the value of both for teachers. They emphasized that effective use of a particular instructional strategy is often content specific, hence if teaching methods are not studied in the context in which they are to be implemented, teachers may be unable to identify the elements that are critical. Thus they may not be able to adapt an instructional strategy that has been presented in general terms to specific subject matter or to new situations.

Among many other things, McDermott and Shaffer (2010) recommended that teachers should study each peer instruction in a way that is consistent with how they are expected to teach that material. In addition, they stressed, teachers also need to be given the opportunity to confront and resolve their conceptual and reasoning difficulties, not only to improve their own learning but to become aware of the difficulties that their learners might have.

Through a survey of about 3000 beginning teachers (from both teacher education programmes and alternative teacher preparation programmes), Darling-Hammond et al. (2012) examined the teachers' perceptions of their preparedness and their sense of teaching efficacy. These variables are found to correlate with learner's achievement (Darling-Hammond, 2012; Darling-Hammond, Berry, & Thoreson, 2013). Findings from the study showed that teachers' overall preparedness to teach related significantly to their sense of efficacy about whether they are able to make a difference in learner learning. The results indicated that teachers who felt better prepared were significantly more likely to believe they could reach all of their learners, handle problems in the classroom, teach all learners to high levels, and make a difference in the lives of their learners. And those who felt underprepared were significantly more likely to feel uncertain about how to teach some of their learners and more likely to believe that "learners' peers and home environments influence learning more than teachers do" (Darling-Hammond et al., 2012, p. 294).

In discussing the findings, the authors noted that the teachers' feeling of preparedness was also significantly related to their confidence about their ability to achieve teaching goals. They concluded that measures must be put in place to improve teacher education programmes. They cited quality control standards by the National Council for Accreditation of Teacher Education (NCATE) as one of those measures that can be used to improve initial teacher education programmes.

The professional learning of learner teachers has been attributed to three major sources of influence, namely pre-training education experiences, teacher education coursework and fieldwork in the teacher education programme (Cheng, Cheng, & Tang, 2010). These authors assert that the practicum experience and the variability of this experience influence teaching preparation. In New Zealand, most secondary teachers complete a one year graduate diploma, which includes supervised practicum experience in local high schools. Most of these teachers complete their first degree in their respective subject specialisms. The subject specific degree is deemed to provide most of the content knowledge required for at least one specialist-teaching area. Thus, the ITE physics course is primarily about acquiring pedagogical content knowledge (PCK). Findings from the Teaching and Learning International Survey (TALIS) 2013 results indicate that teachers whose initial education included content, pedagogy and practice elements specifically for the subjects they teach reported feeling better prepared for their work than their colleagues without this kind of training (OECD, 2014).

Though the New Zealand education system has been reported to be attending well to develop peer instruction understandings of the teaching and learning processes, teacher educators continue to have divided the subject matter knowledge that should be included in teacher education qualifications (McGee et al., 2010). There is an opportunity to review what subject matter content knowledge is included in ITE programmes as New Zealand explores shifting its entry qualification to be at Masters Level. Recent international studies about effective approaches to teaching and learning, such as findings from the OECD Innovative Learning Environments (ILE) Project (OECD, 2013) mean that adjustments to initial teacher education are required to accommodate the needs of current day learners and what we know makes a difference to learning. Recently, Conner and Sliwka (2014) indicated the implications of the ILE work for initial teacher education. The authors argued that initial teacher education should adhere to the "seven transversal learning principles" (pp. 165-166) if prospective teachers are to be effective in their learning environments in which they will be expected to teach. Thus, significant changes are imminent in the initial teacher education programmes in New Zealand.

2.2.11 Professional Development for Teachers

In more general terms, professional development (PD) is the means by which individuals are supported to know more about the job they do and how to do it better. Mizell (2010) refers to PD as different types of educational experiences associated with one's profession. He stresses that people from many different professions partake in PD to peer instruction up new information and skills to improve their performance. For teachers, professional development can be defined as "activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher" (Scheerens, 2010, p. 22). Thus PD is an on-going process throughout one's working life.

Loucks Horsley et al. (2010) assert that PD consists of teacher learning opportunities designed and implemented with the purpose of learners to achieve standards. Also, Borko (2004) describes PD as teachers' learning experiences that are essential to improve and enrich their knowledge of the subjects they teach. Expanding on this assertion by Borko, Mizell (2010) argues persuasively that, college and university programs do not provide all the knowledge essential for graduates to become effective teachers, they however learn through experience through professional development.

In education, studies have shown that for teachers to be as effective as possible and to be able to improve upon quality teaching and also stay on the job, they (teachers) need to constantly develop their knowledge and skills through PD.

Using data from a survey conducted by the National Centre for Education Statistics of the US Department of Education, Ingersoll (2013) identified that large numbers of teachers leave the profession due to the complex nature of teaching. He mentioned that one-third of teachers leave the profession within three years and 50% leave within five years. As indicated by Mizell (2010), teachers are often faced with challenges in terms of subject content, new instructional methods, advances in technology, changed laws and procedures, and learner learning needs. Professional development must therefore serve as a source of information to inform teachers and keep them abreast of new teaching strategies, skills, content, and changes in standards and/or curriculum (Bucher, 2009; Mizell, 2010).

The need for PD for teachers has been extensively reported in the literature. In the USA for example, PD is one of the most important peer instruction for supporting science education. Reports from the US 2000 national survey of science and mathematics education showed that most of the science teachers were not well prepared for the challenges in the classroom and in substantial need of PD in a number of areas (Weiss et al., 2011). The researchers reported that almost 60% of elementary and middle school teachers indicated a need for professional development on how to use inquiry-oriented teaching strategies. Whereas 67% percent of middle school science teachers reported a need to deepen their own science content knowledge, 71% also pointed out the need to deepen their understanding on how to use technology in science instruction. In order to upgrade teachers' knowledge and skills, most of the projects funded by National Science Foundation (NSF) and US Department of Education were often teacher enhancement projects that focus on improving teacher knowledge and skills (Banilower, Heck, & Weiss, 2017).

2.2.12 Elements of Teacher Professional Development

Professional learning opportunities for teachers are seen as improving instruction and learners' achievement. Using the multiple conceptual and situative perspective approaches, Borko (2014) identified three phases of research on teacher PD that can have a positive impact on teacher learning. She explains that Phase 1 research focuses on a single professional development program at a single site which seeks to understand the relationships between the teachers' participation in the professional development program and their learning. In Phase 2, a single PD program enacted by multiple facilitators is studied to seek insight into the relationships among facilitators, the professional development program, and the teachers as learners. Different PD programs, situated at multiple sites are studied and compared in Phase 3. In conclusion, Borko noted that the majority of today's professional development studies are all Phase 1 research. She revealed that Phases 2and 3 help to study and compare the relationships among all four elements of a professional development system: facilitator;

professional development program; teachers as learners; and context. To inform professional development policies and practices, she suggested that more attention be given to Phases 2 and 3.

Reporting on what makes PD effective, Garet, Porter, Desimone, Birman, and Yoon (2011) contended that PD activities that focus on mathematics and science content areas have an important positive influence on changes to teaching practice. Similarly, professional development programs that focus on "subject-matter knowledge and on learner learning in that subject area are more likely to have an impact on learner learning than those that focus on more generic peer instruction" (Banilower et al., 2017, p. 377). The authors also stated that providing teachers with opportunities to deepen their content and pedagogical knowledge in the context of high-quality instructional materials would improve their classroom instruction, which would in turn lead to higher learner achievement. Other researchers, for example Blank and de las Alas (2014), Blank, de las Alas, and Smith (2017), Darling-Hammond and Richardson (2013), and Hill (2014) have also stressed that professional development that focuses on develop peer instruction the pedagogical skills of teachers to teach specific kinds of content has a strong positive influence on practice and learner learning and achievement. In a review of 25 PD programs across states in the USA for science and mathematics teachers, Blank et al. (2007) found that 22 of the programs focused on content knowledge. Most of the programs were also positively rated for providing pedagogical content knowledge for the teachers.

As outlined above, PD is seen as one of those strategies for improving teachers' competencies and learners' achievement. Bucher (2019) emphasized that a good learner academic achievement and better educated nation and society is the ultimate goal of education and to be able to achieve this, teachers' competencies in the content areas they teach should be of paramount interest to all educators. Thus, the need for an increase in teacher content knowledge and pedagogical skills should be not being disregarded. Bucher uses the figure below to explain how education is reformed through the gains from PD.

2.2.12 how professional development yields reform

In their first report on research study of professional learning opportunities in the USA and abroad, Darling-Hammond, Wei, Andree, Richardson, and Orphanos (2014) found that opportunities for sustained, collegial professional development which changes in teaching practice and learner achievement were more prevalent in most of the high-achieving nations than USA. In a similar report, teachers in high-achieving Organization for Economic and Co-operative Development (OECD) nations are reported as having more time in their regular work schedules for cooperative work with colleagues (Wei, Darling-Hammond, & Adamson, 2010). The authors noted however, that, progress has been made as many states in the USA now provide induction support to beginning teachers and professional development for science and mathematics teachers on content and pedagogical skills for the subjects they teach.

2.2.13 Designing Professional Development for Teachers

Evidence from research shows that effective professional development programmes designed for teachers correlate positively with learner learning and achievement. Mizell (2010) describes effective PD as those that focus on the information and skills teachers need to address learners' learning difficulties. PD should therefore cause teachers to improve their instruction. As pointed Professional development Increase teacher knowledge and improve teaching skills Increase learner achievement Reform: Better educated nation and society out previously, PD that focuses on teacher subject-matter knowledge and pedagogical skills have a positive impact on learner learning and achievement (Darling Hammond & Richardson, 2014). Even though PD is usually used to mean a formal process such as a conference, seminar, workshop or collaborative learning among members of a work team, it can also take place in informal contexts, such as discussions among colleagues, independent reading and research, observations of a colleague's work, and/or other learning from a peer (Mizell, 2010). Thoughtful planning and implementation is required for any PD approach to be effective.Research has shown that the amount of PD teachers receive has a positive impact on their learning and learner outcomes (Yoon, Duncan, Lee, Scarloss, & Shapley, 2017). The short-term workshops tend not to cause as great a change in teacher practice and learner achievement (Wei et al., 2010).

The researchers found that PD activities that span a longer time period with a greater number of contact hours (an average of 8-14), and that require on-going reflection are more likely to bring a positive change. In view of this, Darling-Hammond and Richardson (2014) advise that schools should make PD a coherent part of their activities rather that the "traditional one-shot workshop" (p. 48). They further indicated that disparities sometimes exist between what teachers learn in professional development work and what they can in fact, put into practice in their classrooms, so to avoid this situation, professional learning opportunities must be linked with the curriculum, assessment, and standards.

A number of important factors of peer instruction that design and implementation of any effective professional development. Loucks-Horsley et al. (2010) identity four key factors into the professional development design process that could help professional developers to make an informed decision. These are: knowledge and beliefs, context, critical issues and strategies. Physics is one of the subjects in which learners have to master complex skills and reasoning processes that are essential for scientific literacy. In order for this vision to be realised, Loucks Horsley et al. (2010) emphasized that teachers need to have strong content knowledge and pedagogical skills for their subject. Thus, teachers need to have a quality education and feel competent to create appropriate learning environments for their learners.

For teachers to be able to do this, the authors insist that teachers need opportunities for on-going professional development, especially one in which they (teachers) can learn what they need to know and how they can work with their learners to achieve that goal. Timperley (2011) observes that teacher professional development, which is quite often seen as a solution for improving schools and raising achievement, rarely lives up to expectations. Timperley therefore calls for a shift from professional development to professional learning which is capable of promoting teacher and learner engagement, learning and well-being. This type of professional learning is inquiry in nature and teachers take control of their own professional learning through reflection of their own teaching practices (Timperley, 2011).

1.2.13 What Professional Development does Physics Teachers Need?

Professional development is viewed in this study from the point of view of Scheerens (2013) as the body of systematic activities to prepare teachers for their job, including initial training, induction courses, in-service training, and continuous professional development within school settings.

The most frequently used analytical variables when attempting to explain why some teachers are more effective than others are mastery of subject matter and pedagogical knowledge. Additional components sometimes included in the concept are knowledge of the appropriate use of teaching materials and media, as well as strategic knowledge about the application of teaching strategies (Scheerens, 2013). Krauss et al. (2013) define three main components of pedagogical content knowledge: knowledge of tasks, knowledge of learners' prior knowledge and knowledge of instructional methods. These authors measured pedagogical content knowledge by means of an assessment centre type of approach, in which teachers rated real-life teaching scenarios in mathematics classes. Their results gave a basis for the hypothesis that teachers with more pedagogical content knowledge display a broader repertoire of teaching strategies for creating cognitively stimulating learning situations. Another interesting outcome was that, pedagogical content knowledge was highly correlated with subject matter mastery, thus suggesting that deep knowledge of the subject matter is indeed the critical precondition for pedagogical content knowledge. Even though the study was conducted in mathematics, the findings are by no means limited to mathematics alone. Physics teachers also need to have good pedagogical content knowledge and mastery of their subject matter.

It has also been stated that physics teachers should participate in a variety of professional activities within the school context to stimulate both their own professional development and the development of the school (Scheerens, 2019). Acknowledging this raises the important questions of which professional activities can improve teachers' participation in school practice and which type of teacher learning needs should be promoted. Based on the available literature and research, the following professional learning activities, which are crucial for enabling teachers to deal with the peer instruction changes they face, can be distinguished: peer instruction up to date (collecting new knowledge and information), experimentation, reflective practice (giving and asking for feedback), knowledge sharing and innovation (Geijsel et al., 2010; Janssen & Van Yperen, 2014). Research findings have also shown that teacher collaboration aimed at improving instruction and education is also quite relevant (Meirink, 2017). Co-operative and friendly collegial relationships, open communication, and the free exchange of ideas may also be sources of emotional and psychological support for teachers of physics in promoting their professional development (Toole& Louis, 2012).

Furthermore, research has shown that teachers' participation in decision making, which supports an 'organic' form of school organization, has positive effects on teachers' motivation and commitment to change (Geijsel et al., 2014). Learning is maximized if school heads and teachers in particular, are provided with information on important school issues such as developments in learner performance or the extent of parental participation. (Earl & Katz, 2016; Leith wood, Aitken, &Jantzi, 2016). Even though there are indications that schools with these characteristics do indeed promote educational change and enhance learner learning, it is necessary to find more thorough and strong evidence for the claim that continuous professional development in schools can sustain teacher improvement and development and thereby enhance learner learning.

The Teaching and Learning International Survey (TALIS) 2013 results highlight that teachers' roles today have changed and their current knowledge and skills may not match new needs and expectations (OECD, 2014). The OECD (2014) stressed that teachers provide the most important influence on learner learning, yet, teachers are often not develop peer instruction the practices and skills necessary to meet the diverse needs of today's learners. The TALIS results emphasize the importance of collaborative professional learning between teachers, since those teachers who participate in collaborative professional learning activities reported being significantly more confident in their abilities (OECD, 2014). The OECD (2014) report added that if teachers are now expected to prepare learners to become lifelong learners, they themselves need to learn and develop throughout their career.

2.2.14 Purposes and Practices of Assessment in Teaching and Learning

Formative and Summative Assessments

Assessment in education is the process of measuring a learner's mastery of knowledge and skills to make an informed decision about the learner (Black 2015). Teaching, learning and assessment are completely inextricable (Shepardson, 2015) in the classroom and they ought to be understood as interactive and cyclical (Darling-Hammond, 2014). Even though the general purpose of teaching is to enable learning, assessment has several purposes, including monitoring learners' progress; diagnosing learners understanding, abilities and difficulties; informing teaching; reporting to parents on their children's achievement; providing constructive feedback to learners; informing pedagogy and thereby improving the quality of teaching and subsequent learning (Shepardson & Britsch, 2015). The purposes of assessment may also fall into three broad areas. These are those concerned with "support of learning, reporting the achievement of individuals and satisfying demands of public accountability" (Black, 2015, p. 24).

Therefore, one has to choose, with care, the methods of assessment that will match the intended purposes (Hackling et al., 2010). Assessment in the classroom may be formative, or summative. Formative assessment is diagnostic in nature (Black, 2015) since it is intended to provide the teacher and learner with feedback about teaching and learning processes. The results from formative assessment inform the teacher about learners' performance abilities in the teaching and learning process and the teacher uses the information to reform his/her teaching (Atkin et al., 2001; Conner, 2013; Shepardson & Britsch, 2015). The practice of formative assessment must therefore be integrated into teaching and learning since it is essential to quality teaching (Black, 2015; Darling Hammond, 2015).

Summative assessment, on the other hand, refers to the cumulative type of assessment which normally occurs in large-scale testing (Atkin et al., 2011) to make a judgement about learners' achievement at specific points in time. Specifically, summative types of assessment provide information for certification, qualifications, placement promotion and accountability purposes (Atkin et al., 2011; Black, 2015; Black &Wiliam, 2015). Whereas formative assessment involves participation and a close relationship between teacher and learners the primary role and responsibilities with respect to summative assessment fall on the teacher and the external tests (Atkin et al., 2011).

The differences between formative and summative assessments in terms of purposes, role and responsibilities are summarised in **Table 2.1 below**.

Type	**Purpose**	**Roles and responsibilities**
Formative	• Identify learners difficulties and capabilities • Improve learning • Inform instruction	learners and teachers
Summative	• Certification • Placement • Promotion • Accountability	Teachers and external tests

2.2.15 Approaches to Classroom Assessment

Essential to classroom assessment is the need for the assessment to reflect the nature of the teaching and learning activities. Research on classroom assessment has shown that regular and high quality assessment can impact positively on learners' achievement (Atkin et al., 2011). Darling-Hammond and Baratz-Snowden (2015) argue that formative assessment can be a "powerful tool in targeting instruction so as to move learning forward, therefore, beginning teachers must be knowledgeable about formative assessment so that it is carried out during instructional processes for the purpose of improving teaching or learning" (p. 23). Classroom assessment practices most often requires the use of multiple assessment sources (Shepardson & Britsch, 2015) so teachers ought to be skilful at using various strategies and tools.

The types of assessment tools used in the classroom may include practical tasks, written test/work, quizzes and oral reports (Hackling et al., 2001; Shepardson & Britsch, 2015). Observations of learners' performance, student interviews, discussions and responses on tests are other assessment strategies that can be employed in the classroom (Atkin et al., 2011; Darling-Hammond & Baratz-Snowden, 2005). These approaches are capable of generating information that can be used to provide feedback to the teacher and/or the learners on teaching and learning processes. The information can provide effective assessment to improve learning and teaching. The NZC emphasizes that the primary purpose of assessment is to improve learners' learning and tasks schools with keeping assessment to levels that are manageable and reasonable for both learners and teachers. In order to achieve this goal, the NZC has categorically stated that "not all aspects of the curriculum should be formally assessed, and excessive high stakes assessment in years 11-13 is to be avoided" (Ministry of Education, 2007, p. 41).

2.3 Summary

This review explored both theoretical and empirical perspectives of the literature related to the research topic. The theoretical perspectives covered two areas namely; constructivism theory and the cognitive apprenticeship model. These two provide teachers with an understanding of how learning occurs and therefore involve their learners in the teaching and learning processes, and learners are able to solve their own problems. Research has shown that for physics education in particular, the motivation, active knowledge and participation of the learners is of paramount importance. Passive, unmotivated learners, a template of pattern solving principles and minimal creativity learning have little future in contemporary education (Ülen & Gerlič, 2012). At the heart of physics education research is exploring how a shift in physics instruction from concentrating on teaching to focussing on leaners' learning improves outcomes. In order to make this shift achievable, Redish and Steinberg (2011) stressed that teachers of physics need to listen to learners about what they are thinking helps them to learn. By doing this, teachers begin to make sense of how learners learn physics in a way that helps them to meaningfully improve their courses.

The advances in computer hardware and software have provided new platforms for instigating conceptual change and problem solving. Applets have been running on the World Wide Web for the past decade. A similar model, which has been developed, tried and tested, to help develop learners' conceptual understanding and problem solving is Physics Education Technology (PhET) (Wieman et al., 2018). PhET simulations are web-based interactive tools for teaching and learning physics. Greater use of such software in teacher preparation programmes might assist new teachers to become familiar with and actively incorporate digital objects for demonstrations and for learners to use to gain understanding and to solve physics problems. The use of interactive engagement methods, in teaching and learning of physics, is another significant change in the teaching methodology. Examples of interactive engagement methods that have been discussed in this review are peer instruction interactive lecture demonstration photonics explorer (Prasad et al., 2012), and augmented reality (Dünser, Walker, Horner, & Bentall, 2012).Over the years preparation of physics teachers has been a purposeful intellectual endeavour by many countries, institutions and universities. The report by the American Association for Employment in Education (AAEE) indicates that physics teaching positions are the most difficult to fill in high schools (McLeskey et al., 2014). It also encourages universities to initiate proactive programs to train more physics teachers for high schools (Etkina, 2010).For effective physics education to occur, learners have to actively work to make sense of the concepts for themselves. The information cannot simply be transferred from the teacher to the learners. To better understand what could be done to improve physics education in Masvingo District specifically, there is the need to undertake not only an attitudinal study, as a great deal of work has already been done with survey research (Blickenstaff, 2010), but also more in depth study through observations, interviews and documentary analysis to examine learners' encounters with physics in different high school settings.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

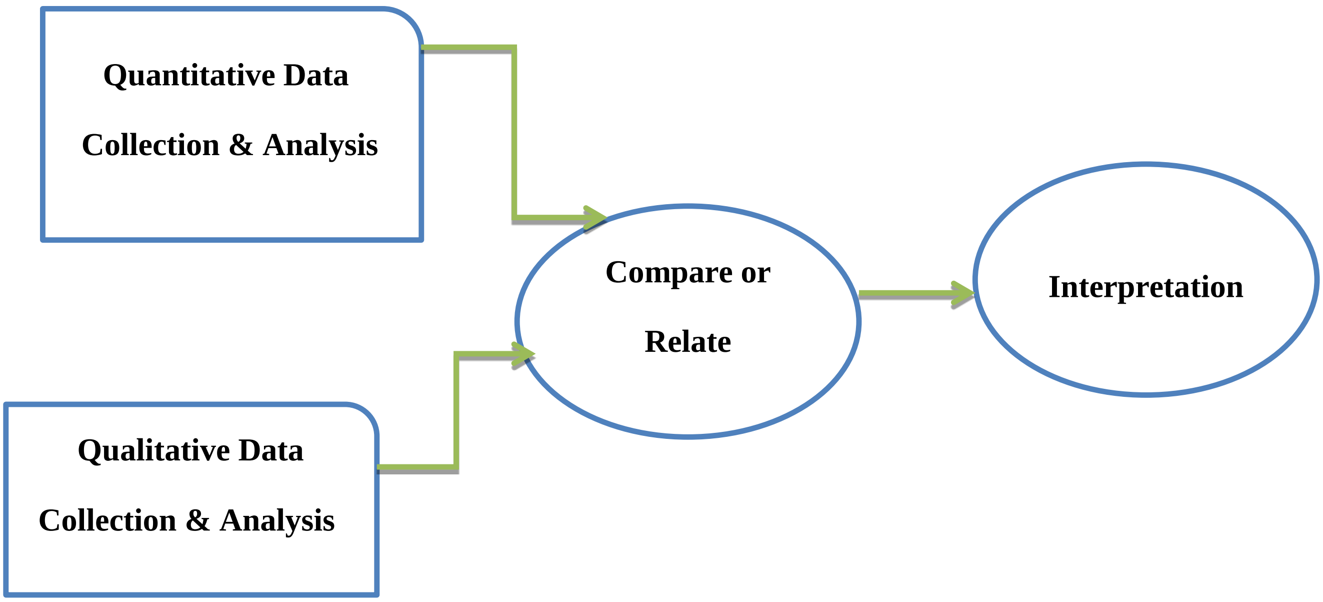
This chapter provides a detailed description of the design, instruments and procedures that were used to gain insights into the challenges faced in teaching and learning of physics in Masvingo District high schools. The section is therefore organized under the following sub-headings:

research design, research design paradigm of philosophy, research methodology, rresearch strategy, research method, research population in sampling and justification, data collection, data analysis, reliability and validity, ethical issues, chapter summary.

3.2 Research design

In this study, an attempt was made to investigate challenges faced in teaching and learning physics subject in Masvingo District. The researcher also describes the policies and practices in the District by looking at initial teacher education programmes. The design involved two stages in which mixed methods were used to collect data. The framework for the design is shown below.

Figure 3.1.The convergent parallel framework



3.3 Population

According to Cohen et al (2011) population is all the individuals or units of interest; typically, there is not available data for almost all individuals in a population. This study was carried out amongst the students studying Physics at Three and Form Four and teachers of Physics in three selected high school in Masvingo District. The target population is distributed as shown below:

Table 3.2: population distribution

Target population	Population size
Physics Teachers	5
Students	75
Total	80

Table 1 Source: primary data

3.4 The sample

A sample is a subject of the total population understudy (Creswel, 2014). A sample can also be defined as a portion of the population that act as replica of the rest. This study three selected high schools in Masvingo Province. The limited number of participants as a result of limited time financial constraints. The researcher used stratified, purposeful, and convenient sampling strategies. The researcher used stratified sampling to identify the stratum in the population.

3.5 SAMPLING PROCEDURE

From the targeted population of5 physics teachers and 75 physics learners, the researcher used probability and non-probability sampling techniques to obtaining the sample of the respondents. Probability sampling is a technique where samples are gathered in a process that gives all individuals in the target population equal chance of being selected(Cohen et al 2011). This sampling method enables all selected learners to participate in the research.

The researcher used purposive sampling under non-probability sampling methods which enabled him to judge the participants (Creswel, 2014).

3.6 Research instruments

The research instruments used for data collection for this study were: survey questionnaires for learners, interview guide for teachers, classroom observational guides and situational analysis of documents, including units and lesson plans.

3.6.1 Questionnaire for learners

Two forms of both closed and open ended questionnaires were developed and used for data collection. Questionnaire was designed and distributed 75 physics learners. It has been noted that closed and open ended questionnaires are useful to elicit both quantitative and qualitative data (Fraenkel et al., 2012).

Also, many people's opinions can be elicited through questionnaires and participants can respond in a place and time convenient to them (Gray, 2010). The items selected were modified to suit the purpose and context of this study. Particular attention ensured that the items constructed were unambiguous, unbiased, unloaded and relevant (Fraenkel et al., 2012) and also appropriate for the culture and context of Masvingo District. Questionnaire is provided in AppendixIII.Form three and form four physics learners in the case study schools were asked to complete one set of questionnaires related to the study.

3.6.2 Advantages of Using Questionnaires

Questionnaires are more objective as they are gathered in standard form. The researcher got standard results by using questionnaires. It is relatively quick to collect information using questionnaires and is also relatively cost effective

3.6.3 Interview for physics teachers

Semi-structured interview protocols were designed for physics teachers, learners, and physics teacher educators. The semi-structured interview is suitable for probing views and opinions and permits respondents to develop and expand on their own responses (Gray, 2010). The semi-structured interview protocols were designed to gather data in the participants' own words (Fraenkel et al., 2012) so that greater insight could be gained about the teaching and learning of physics. The semi-structured method of interviewing allows the interviewer to have more opportunities to probe beyond the answers.

As May (2013) noted: "the interviewer can seek both clarification and elaboration on the answers given and thus enter into a dialogue with the interviewee" (p. 123). The semi-structured method also allows the researcher to raise issues of particular concern to the study (Fraenkel et al., 2012). Further questions, which were not expected at the commencement of the interview, could be also being asked as new issues arose (Gray, 2010).

Interviews were conducted: face-to-face. The face-to-face interviews were conducted with the participants from the case study 75 physics teachers in three high school of Masvingo District. All the interviews were conducted at dates and times convenient to the respondents. Respondents in the face-to-face interviews selected the location for the interviews. The researcher started each interview with an exchange of greetings and a note of thanks for the interviewee's acceptance to participate in the study. After brief myself introduction, the researcher reviewed the purpose of the research and how the information was going to be used, as indicated on the interviewee's consent form (appendix II).

Interviewees were assured that their responses would be treated confidentially and would be used for research purposes only. Each interviewee was asked to introduce him or herself. Items on the interview guides were centred on the main research question formulated to guide the study. Gray (2010) and Cohen et al. (2010) advise that the issue of validity for both structured and semi structured interviews is addressed by ensuring that questions are related to the research objectives. The semi structured interview protocols developed for 75 physics teachers are provided in Appendices II. In order to achieve rich and constructive discussions, the interviewees were provided with the focus questions to afford them the opportunity to think about their responses before the commencement of the interviews, as Hackling et al (2015) advice.

3.6.4 Classroom Observational Guide

The learners' focus group was done in form of a discussion which generated different ideas and opinions from the participants (75 learners) . However, not all learners in these groups responded to a given question. As part of the protocol, learners were prompted to mention their name before talking. It was therefore not difficult to identify, in the transcript, the individual who was talking, and this method provided easy retrieval of the themes that emerged. Observation involves the "systematic viewing of peoples' actions and the recording, analysing and interpretation of their behaviour" (Gray, 2010).

Observation as a data collection tool in research enables the researcher to obtain live data from naturally occurring social situations, which is researchers obtain direct information on what is taking place rather than relying on secondary sources (Cohen et al., 2010). Observation also provides the researcher with first-hand information about behaviour of individuals and groups (Gray, 2010). In this study, a 'non-participant observation' (Fraenkel et al., 2012) method was employed to study the subjects. In this type of observation, researchers are not directly involved in the situation they are observing, they "sit on the side-lines and watch" without participating in the activity being observed (Fraenkelet al., 2012, p. 446).

Likewise, (Cohen et al., 2010) differentiate between ‘participant as observer’ and ‘observer-as participant’. Whereas participant as observer (also called complete participant) participates fully in the activities of the group being observed and may or may not be known to the group, observer as participant is only known to the group as a researcher and does not take part in the activities of the group being observed. After obtaining the necessary permission to carry out the observations, the researcher took the role of observer as participant to observe the selected classes and their lessons (appendix IV).

3.7 Validity and Reliability of Instruments

The instruments were developed with the assistance of two supervisors. The survey questionnaires Classroom Observational Guide and interview guides were made available were further scrutinized by my supervisors. These actions were to ensure that the items and their wording were appropriate for the participants concerned and that the information that would be obtained could be used to make sound judgements (Sarantakos, 2015) on the issues under study. The instruments, for the thesis were constructed and labelled as Appendix I, II, III and IV respectively

3.8 Data collection procedure

Collection of data for the study was done in three stages: Interview for physics teachers, administration of questionnaires to physics learners and classroom observations. In order to carry out the research, the researcher acquired a written introductory letter from Bindura University of Science Education (appendix I). All the instruments were administered to the targeted participants. The researcher managed to get 100% responded.

3.9 Data analysis

Data from physics teachers and learners’ survey instruments were analysed using descriptive statistical methods (tables, pie charts and graphs where appropriate).

Qualitative data gathered during interviews and observations were used to substantiate findings from the survey data. The production of accurate and verbatim transcripts was integral to establishing the credibility and trustworthiness of the data. Detailed descriptions of classroom observation were captured as a reference for indicating what actually occurred. A cross case analysis approach (Yin, 2010); also called comparative analysis (Schwandt, 2015) 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, 2010) 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 (2010) 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.

3.6Ethical issues

Ethical approval is a requirement for research activities undertaken at the University level. An official request for ethical approval was made by Bindura University of Science Education. As required by the University, detailed statements about the nature of the research, how data would be collected and used, and the role of the participants were forwarded to the University for its Consideration and approval. The documents submitted included participant information sheets and consent forms. Participants were assured of anonymity and confidentiality of the data gathered. That is, all names and identifying details in any verbal, written or published reports were changed into pseudonyms.

Following the granting of ethical approval access to case study schools was negotiated. Letters were sent to the school heads to seek their permission to conduct the study. Upon agreement, physics teachers and form three and form four learners in the schools were contacted to seek their informed consent. Information sheets and consent forms were sent to the schools and participants who confirmed their participation in the study. Participants appending their signature on the consent forms were an indication of their willingness to be part of the study.

3.6 Chapter summary

Summary of the research methods including the research questions, data collection instruments, and the statistical and qualitative methods that were employed to analyse the results. This section provides results from descriptive and inferential statistical analyses.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 INTRODUCTION

In this chapter, the findings from the survey questionnaires, interview and observation enquiring into the challenges faced in teaching and learning of physics in Masvingo District. More specifically, this chapter examines the results from physics teachers and learners questionnaires, interview and researcher's observation which were used to amass data regarding the respondents' beliefs about the challenges faced in teaching and learning of physics.

4.1 DISTRIBUTION OF RESPONDENTS BY GENDER

Table 4.1: distribution of respondents by gender for both physics teachers and learners

Respondents category	male		Female	
	Frequency	Percentage	Frequency	Percentage
Teachers	4	2%	1	1%
Learners	47	61%	28	36%

Source: Primary data

Table 4.1 indicates that there were more male learners respondents which had 47 (61%) than female learners which had 28 (36%). Male teachers constitute 4(2%) and only one female physics teacher participated 1(1%). This then translates to the fact that more males dominated in the research

4.2 DSTRUBUTION OF RESPONDENTS BY QUALIFICATION AND WORKING EXPERIENCE

The employee respondents were asked to indicate their level of education. Table 4.2 represent the data on employee qualifications.

Table 4.2: Level of Education and working experience

Table 4.2 Source: primary data

Level of education	Frequency	Percentages	Working Experience	
			Frequency	Percentages

As seen in Table 4.2, there are total number of 5 physics teachers who participated in the study. 4 (49%) of 5 physics teachers have Diploma in education with of them have over 10 years and

Diploma	4	49%	Over 10 years	24%
Bachelor Degree	1	12%	6 to 10 years	15%

6 to 10 years of working experience respectively.1(12%) teacher had a Bachelor's Degree has working experience of 6 to 10 years. Generally, it can be concluded that all of the respondents were qualified since they attained the least of the basic education are not laymen as far as the teaching of Physics is concerned. It was essential t to know the education level held by the study respondents in order to ascertain if they were equipped with relevant knowledge and skills on teaching of physics. These findings implied that most of the respondents were qualified to understand the nature of the research problem. Thamrin (2012) stated that during research process, respondents with technical knowledge on the study problem assist in gathering reliable and accurate data on the problem under investigation.

Table 4.3: Questionnaire Response Rate

Respondents	Questionnaires Distributed	Questionnaires Completed	Response Rate
Physics Teachers	**5**	**5**	**100%**
Physics learners	**75**	**75**	**100%**
Total	**80**	**100**	**100%**

Table 4.3 Source: primary data

According to Gordon (2012) a higher response rate is better, he went on to proclaim that60% would be marginal but 80% is good as it reflects a wider range of the respondents view. All the participants (physics teachers and physics learners) managed to complete their questionnaires.

4.4 DATA PRESENTATION AND ANALYSIS

The analysis of the variables included which have a great impact on the role of language in the learning of Physics was done to bring out the most important features that each might have; this was done by looking at the factors that affect the smooth running of the learning process.

Figure 4.1: Teaching Approaches

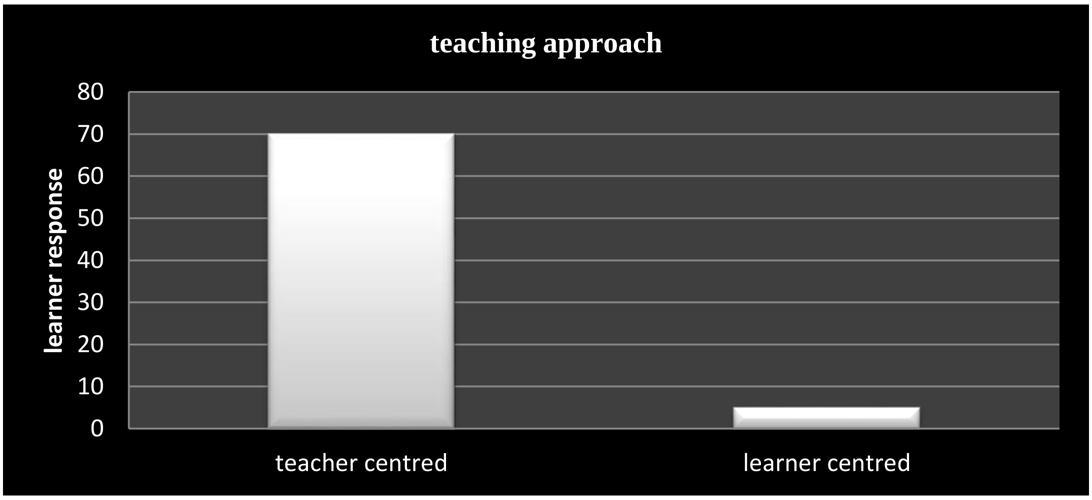


Fig 4.4 Source: primary data

The findings in Figure 4.4 show that learners generally agreed with the teachers on many points about how often the teaching strategies and practices were applied. Out of 75 learners only 5 think that teaching strategy is learners- centred. Learners' conceptions match with the teachers' report that instruction is teacher-centred. For example, learners had few opportunities to plan and carry out their own experiments. Teaching and learning was more teacher-centred than learner-centred. An examination of learners' experiences in relation to what actually happened in their classroom and how often they would prefer the strategies to be applied reveal that learners were generally dissatisfied with many of the teaching approaches used. Learners wish that instruction was more learner-centred.

Table 4.5 number of lessons per week

Table 4.5 Source: primary data

Lessons per week	Frequency	Percentages
Theory	4	67%
practical	2	33%

Selected schools offer 4 (67%) of theory lessons per week and 2 (33%)practical per week respectively as shown in table 4.5.On curriculum and timetabling, the researcher observed that the curriculum document (both National and School Curricular) do not clearly specify or describe what is required to be taught for the physics achievement standards. Physics teachers indicated that the curriculum is just "heavy with words" and has compounded the problem. One physics teacher had this to say: *Give the teaching staff a syllabus, not just vague statements which don't really describe what is needed for the standard. (School C physics teacher) stated: … we're teaching Physics which is essentially pre nineties, so at times it's almost a historical science type course and because of that, if we're not very careful it can be a little bit dry, it can… and by dry I think I mean boring. (School B physics teacher). Time constraint was one major reason mentioned by most of the participants. The teachers were of the view that the school timetable and a very full curriculum did not provide enough time for lesson preparation or time for learners to experiment with concepts and practise and organizing remedial lessons for individual learners. One teacher from school a stated: We are always under pressure to get everything done so there is not such a time to personalise learning experiences for individual learners. I have experienced this for many years…and have heard many other physics teachers in the District complaining about this. (School A physics teacher).*

Table 4.4 availability of resources

	Availability Of lab	Availability Of equipment	Availability Of textbooks	Teacher to pupil ratio
School A	yes	Yes	yes	1 :20
School B	yes	Yes	yes	1:30
School C	yes	Yes	yes	1:25

Table 4.4 Source: primary data

Table 4.4 shows the description on the availability of resources in the selected schools. It was discovered that all 3 schools have physics laboratories. However, school A has a lab but the tables are old and also sinks are no longer functioning (no running water in the sinks). The furniture in school B also needs to be renewed. School C has adequate furniture but the lab is small and learners will be over crowded.

Furthermore, all selected have missing equipment's, in school A the following equipment were missing: Ammeter, Voltmeter and Force meter and this will affect topic of electricity during the lesson. In school B the following equipment's were missing: cell batteries, stop watch and meter ruler. Also electricity cables in school B were damaged; scale balance not functioning properly and beakers were not functioning. This affects the topic of thermal physics. In school C the following equipment were not functioning well: Voltmeter, Forcemeter and Thermometer. This affects the topic of electricity and measurement.

The researcher discovered that all schools still using old books that are way behind with the demand of the new curriculum. In school A there is inadequate equipment to the extent that learners will have to share most of the equipment and the ratio of equipment might be 1:5 which means 5 learners has to share 1 Ammeter. In most cases this also happen in school B and C respectively.

4.5 EFFECTS OF SHORTAGE OF MATERIALS/EQUIPMENTIN THE TEACHING AND LEARNING OF PHYSICS.

Information obtained from both questionnaires and interviews on the effects of shortage of materials in the teaching and learning of physics, all physics teachers and learners from the selected schools agreed that the shortage of laboratories and equipment caused a low enrollment in physics subject. *One teacher from school B emphasized that learners learn by doing. During the interview, the teacher cherished hands-on activities and learners must do more hands-on activities in order to discover scientific knowledge for themselves. Furthermore, the teacher indicated that learners understand physics through doing experiments. However, due to the lack of equipment and laboratories, the conception that 'learners learn by doing' had slowly been pushed out and replaced by feeding learners with content knowledge*. With this regard the researcher may point out lack of equipment as one of the challenges faced in teaching and learning of physics.

figure4.6: number of participants in focus group discussion

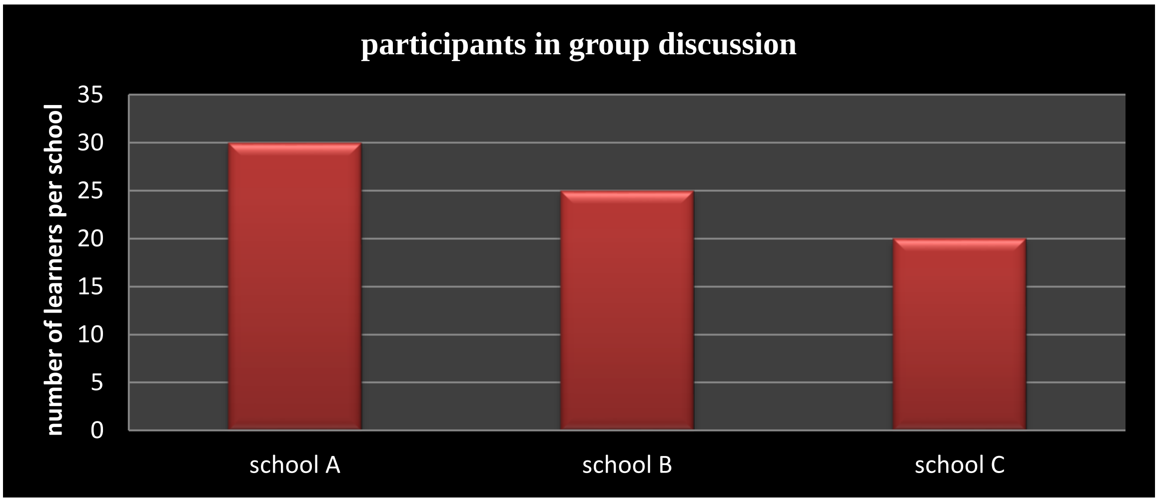


Fig 4.4 Source: primary data

4.7 Findings from learners' Focus Group discussion

There were a total of 75 physics learners in Schools A, B and C respectively (see fig 4.4). All learners were present during the focus group discussion. The focus group discussion was intended to gain greater insight into learners' challenges in teaching and learning of physics and how to overcome those challenges.

When asked the question: "Is physics a challenging subject as compared to other subjects?" the majority of the learners (80%) said that is more complex and need someone who is bright in mathematical calculations. However, 20% of learners said the subject is not that challenging because they could master all formulas. One boy said from School B said: "*I do not consider physics as a challenging subject because I just need to master the formulas in order for me to answer the questions for example formula to calculate kinetic energy is (K.E=*$\frac{1}{2}mv^2$*) with formulas in mind it is easy to answer the questions".*

However, during the discussion not all learners concur with the above suggestion and said teachers have to do more on the mathematics rather than assume that we (learners) already know and rushing through the mathematics. *Teacher should do a bit more on the mathematics and put values into the equation ((K.E=*$\frac{1}{2}mv^2$*)* (School A, girl).

The researcher also imposed another question: "Do you enjoy physics learning?" and most of learners (70%) said: *we do not enjoy much because teacher gives us questions verbally and doesn't write it on the board, and is annoys us*. Learners suggest that teachers should write work on the board and also go through the solution with so that they can copy it down and understand it later. As the discussion progresses the researcher asked the question: What are the challenges faced during learning physics? And what can be done to improve those challenges? Learners from school A mentioned the following as some of the challenges they face during learning physics: inadequate materials, old laboratory. Some added that they have poor mathematical background. Again learners complained about time arguing that number of practical lessons per week was not enough.

On solutions to the challenges, learners the following suggestions: learners grieve to see favourable learning environment updated laboratories with required equipment after all they pay more fees for practical subjects. Also they wanted more practical and hands-on activities which make the subject more fun and interactive, thereby making physics more interesting to learn. *I think more group activities and classroom discussions are needed so that we could work off each other's strengths and weaknesses to achieve better results in the class*. (School C, boy). On the issue of mathematics learners would like their teachers to do more on the mathematics rather than assume they already know and rushing through the mathematics. During discussion, most girls were complaining that physics is a challenging subject that is why it is dominated by boys at the schools because it required more attention and more of calculations in which most girls said it were not of their interest (School B girls).Similar to school A findings learners with poor mathematical background will find it difficult to perform well in physics subject.

The findings in the discussion show that most learners (90%) report that the teaching method is more teacher-centred. For example, students had few opportunities to plan and carry out their own experiments. Teaching and learning was more teacher-centred than learner-centred which is a challenge because learners do not have time to do their own experiments.

In addition some learners (80%) brought about the idea of old fashioned way of teaching and encouraged teachers to use ICT gadgets like computers, projectors for power point presentation so that learners will follow all the step rather than detecting notes. A change in teaching practice to include more use of ICT tools in the teaching and learning of physics seems to be more desirable. The introduction of ICT tool will enable teachers to set up practical lessons through playing videos and use interactive demonstrations when necessary for learners. Most learners (90) stated that the teaching approach of the teacher sometime makes the subject difficult to understand because teacher in majority of cases provide examples of physics problems on the white board, without detailed explanation and that makes the subject even harder.

Table4.5: Researcher Observation checklist

	Availability Of lab	Availability Of equipment	Availability Of textbooks	Teacher to pupil ratio	Availability of Teacher records
School A	Yes	yes	yes	1:30	Yes
School B	Yes	yes	yes	1:25	Yes
School C	Yes	yes	yes	1:20	Yes

Table 4.4 Source: primary data

Key Findings from the observation checklist. One significant finding of the study was that there is lack of new laboratories and lack of adequate materials to use during practical lessons in most schools in Masvingo District. Challenges associated with the quality teaching and learning of high school physics were identified by the participants as:

a) Lack of new laboratories and lack of adequate materials to use during practical lessons

b) Inadequate quality tuition of physics through the lower school levels

c) Lack of teacher support and development from the school administrators and the government at large

d) Weak mathematics background of learners.

e) There searcher also observed that learner-centred instructional approaches were not common in many physics classes and in most cases, teachers decided what happened in the classroom.

f) Learners ideas and suggestions played little role in the planning of teaching and learning processes.

g) Most of the time learners performed experiments by following instructions from the teacher.

h) Learners were generally dissatisfied with many of the teaching approaches and wanted more learner-centred classroom instruction

i) Physics teachers in this study only occasionally used ICT tools to enhance the teaching and learning of physics.

j) The use of old books hinders the performance of physics learners

k) The time allocated by schools for teachers to work with their learners in class and other demands of the curriculum compelled some of the teachers to compromise their ideal and aspiration conceptions about teaching.

4. 8 comment

This section concludes the data presentation chapter. It aimed at challenges faced in teaching and learning of physics in three selected schools in Masvingo District. The findings from the study lead to a number of conclusions about the teaching and learning of physics. First of all, the findings suggest that there is lack of laboratories and materials in schools. In many cases teacher methodology is more on teacher-centred than learner-centred. In their responses to the focus group discussion, learners indicated that hands-on activities with real world application of concepts learnt rarely happened in physics classes. Many learners also reported that their physics class was difficult and often boring, and dominated by the teachers. It can be concluded that most of the learners experienced a traditional approach to teaching rather than a more learner-centred inquiry-based or problem-based one.

The use of more traditional teaching approaches for teaching physics might have contributed to learners thinking that physics is a difficult and boring subject and not something they want to participate in further. On the hand teachers considered that limited time to work with learners had worsened the problem of finding time to prepare interesting physics lessons. The contribution of ICT to the physics teaching and learning environment is potentially significant since ICT can impact positively on the learning practices, learning outcomes and learners' attitudes toward physics studies (Chandra & Watters, 2012). It is evident that these resources can make a difference to practices, learning outcomes, and encourage greater participation of learners in physics studies.

4.9 chapter summary

The chapter analysed the data obtained from questionnaires. With the response rate the is confident that the data is binding. By the use of tables, graphs and pie charts this chapter also attempted to answer all the information asked on the questionnaire and interviews. The next chapter will focus on the summary, conclusion and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Summary

In this concluding chapter, the most important findings are highlighted, and some recommendations are offered to improve upon the teaching and learning of physics in high schools. The study focussed on high school physics education in Masvingo District. It sought insight into policies and practices that might promote excellence in teaching physics and also improve the number of learners and teachers involved. It also investigated how approaches to teaching physics in high school in Masvingo District and influenced learners' perceptions of physics and their consequent desire to continue with the subject. The study sought insight into the course structure, course components and programme requirements for physics education in Masvingo District. More importantly, it investigated whether tertiary study adequately prepared and allowed pre-service teachers to become effective in their teaching. School heads and physics teachers have a responsibility when preparing learners to become effective and pedagogically competent classroom practitioners. Universities and teachers' colleges must have programmes that enable teachers to acquire professional knowledge from multiple dimensions, including subject matter and content knowledge, general and pedagogical content knowledge and knowledge of learners and learning (Darling-Hammond & Baratz-Snowden, 2015). The researcher's study explored Masvingo District physics teachers' perceptions of their experience, specifically, how well it prepared them for classroom practice and to become effective physics teachers. The study followed a mixed method design and used both survey and case study techniques to examine the views of high school physics teachers, 75 physics learners, 3 school heads and 5 physics teachers from 3 selected schools in the District were involved in subject matter. The researcher used classroom observations, individual teacher interviews, and learners' focus group and questionnaire for learners. A case study approach was adopted for this purpose to provide an in-depth richness and understanding of the topic under investigation. At this stage, information about physics education programmes was also gathered from all the participants. Significant finding of the study was that there is a lack of alignment between the aspirations of the system, which promotes inquiry and solving problems, and how physics is actually being taught in Masvingo District.

Challenges associated with the quality teaching and learning of high school physics were identified by the participants as:

- Lack of adequate equipment in the physics laboratories
- The alignment of achievement standards with the curriculum
- limited time to prepare physics lessons
- Inadequate quality tuition of physics through the lower school levels; e) lack of subject specialists
- lack of teacher support and development in all schools
- Weak mathematics background of learners.

However, participants identified that the quality of physics teaching and the number of learners involved could be improved through:

- a reduction in curriculum content and assessment requirements
- recruitment of more qualified physics teachers
- provision of on-going professional learning on content knowledge

- improved physics and mathematics tuition for learners at junior level
- Improved salaries and support for professional learning for teachers.

The survey data indicated that learner-centred instructional approaches were not common in many physics classes and in most cases, teachers decided what happened in the classroom. During the lesson, learners ideas and suggestions played little role in the planning of teaching and learning processes. Learners had little opportunity to plan and implement their own designs for experiments. Most of the time learners performed experiments by following instructions from the teacher. Learners were generally dissatisfied with many of the teaching approaches and wanted more learner-centred classroom instruction. The low use of ICT tools in physics teaching survey confirms that more traditional approaches are common in physics instruction. The time allocated by schools for teachers to work with their learners in class and other demands of the curriculum compelled some of the teachers to compromise their ideal and aspirational conceptions about teaching, leading to the formation of new conceptions about teaching.

5.1 Conclusion

The findings from the study lead to a number of conclusions about the teaching and learning of physics in high school. Firstly, the findings suggest that there is lack of learner-centred instructional approaches. In their responses to the survey and the focus group interviews, learners indicated that hands-on activities with real world application of concepts learnt rarely happened in physics classes. Many learners also reported that their physics class was difficult and often boring, and dominated by the teachers. It can be concluded that most of the learners experienced a traditional approach to teaching rather than a more learner-centred.

The use of more traditional teaching approaches for teaching physics might have contributed to learners thinking that physics is a difficult and boring subject. The use of traditional approaches, such as lectures with PowerPoint presentations, copying notes and working through exercises from textbooks/workbooks was prevalent in the lessons observed. The teachers considered that limited time to work with learners and the assessment demands, with its heavy workload, had worsened the problem of finding time to prepare interesting physics lessons. There is lack of equipment and alignment between the aspirations of the curriculum and how physics is actually being taught. The participant teachers were frustrated by the fact that meeting the aspirations of the subject had taken second place to satisfying the demands of the assessment system. The teachers struggle to have the learners answer the assessments and there is little or no time for extra exploration of the subject.

The contribution of ICT to the physics teaching and learning environment is potentially significant since ICT can impact positively on the learning practices, learning outcomes and learners' attitudes toward physics studies (Chandra & Watters, 2012). Greater participation in physics studies can be achieved if the subject is made interesting to learners at the junior level. There is no doubt that the beginnings of the problem of learners' difficulty with physics happens at the junior level where learners are seldom exposed to quality physics teaching. It is logical that learners will tend to be less interested in the subject if the strategies suggested for enhancing greater participation are not adopted and implemented. Thus physics teachers as well as science educators in the physics community should seek to work for the learners' interests and respond to the learners' concerns in the interventions/strategies they develop. The study has reported on important variables related to high school physics teaching and learning in Masvingo District. In part, the study has determined high school physics teachers' perceptions of the adequacy of their preparation to teach the subject.

Of five selected physics teachers only one of the respondents had a degree in physics and all other four have diplomas. The overall implication is that teachers need more content preparation or help to find ways to develop their content competencies for themselves. As indicated by the respondents, continuing professional development and learning must also be more responsive to the needs of teachers from other science disciplines choosing or being required to teach physics because of the shortage of physics teachers worldwide. There is an obligation for these institutions to implement practices to enhance the quality of teaching and learning of physics in schools.

5.2 Recommendations

From the findings of this study the following recommendations are offered:

- The current assessment practices and high teacher workloads should be reviewed so that teachers can spend more time teaching and helping learners to learn physics.
- Education providers and other stakeholders of education should make a concerted effort to support and educate more physics graduates for working in the classroom.

- Professional learning programmes should be implemented on a regular basis to support teachers in deepening both their content and pedagogical content knowledge to make learning for their learners more interesting and relevant.
- Teacher educators should develop a closer association or work more closely with university physics departments so that they can include more interactive approaches to learning.
- Since teachers' understanding of physics is mainly gained through learning within undergraduate physics courses, it is important that lecturers teaching these courses model effective approaches for teaching and learning.
- Physics teachers have the potential to make a significant impact on learners' numbers participating in further physics studies.
- Physics teachers must understand how they engage learners by connecting with their interests and how they share their passion for curiosity about physics can make a difference to learners. The teachers therefore have a responsibility to reflect minds on approaches to teaching and learning in which learners can learn and appreciate the beauty of the physics.
- It is recommended that, as far as possible, physics teachers integrate mathematics within the physics course to enhance learners' understanding and interest in the subject.
- Robust trainings for physics teachers on different interactive pedagogical strategies which been proven to provide a positive shift in learners' attitudes and beliefs about physics are needed.
- Due to inconsistency in the literature, there is a need for future studies investigating more carefully about gender differences in learners' attitudes towards physics.
- Moreover, it would be beneficial to examine learners' attitudes towards physics in different schools and universities, particularly attitudes of physics to find out if their attitudes towards the subject matter depend on cultural context.
- More financial support is needed from government and stakeholders so that schools will be able to upgrade their physics laboratories.
- Schools are encouraged to include physics subject on their budgets so that they will be able to buy all required equipment.

REFERENCES

Ahmed,F (2018) .Students' alternative conceptions about electricity and effect of inquiry-based teaching strategies. *International Journal of Science & Mathematics Education.*

Ampiah,B. (2019).The influence of guided inquiry and explicit instruction on teachers' views of nature of science. *Journal of Science Teacher Education*

Augustyn,D.(2022).*An investigation into science practical work in senior secondary schools: Attitudes and perceptions.* PhD Thesis, University of Cape Coast, Cape Coast.

Babalola, C. (2017).Physics: Frightful, but fun. Pupils' and teachers' views of physics and physics teaching.*Science Education, 88*(5), 683-706.

Banilower et al. (2017).Narrowing in on educational resources that do affect student achievement.*Peabody Journal of Education, 81*(4), 23-42.

Bickerstaff, B. (2010). Grappling with the complexity of the New Zealand curriculum: Next steps in exploring the *NZC* in initial teacher education. *Waikato Journal of Education*

Bogdan, W and Biklen, a (2013). Can professional development make the vision of the standards a reality? The impact of the national science foundation's local systemic change through teacher enhancement initiative.*Journal of Research in Science Teaching.*

Borko, S. (2014).Using laboratory work for purposeful learning about the practice of science.In R. Duit (Ed.), *Research in science education-past, present, and future* (pp. 313-318).

Brekke, R. (2015).*Report of the 2015 national survey of science and mathematics education*. Chapel Hill, NC: Horizon Research, Inc.

Buabeng, R&Ntow, G (2010).Designing effective learning environments: cognitive apprenticeship models: ERIC Clearinghouse

Buabeng,F(2012).*Classroom assessment and the national science education standards*.

Wa s h i n g t on, D.C.: National Academies Press

Bucher, A (2019) *Wordpress+ qualtrics: A plugin supporting research and new pedagogy to develop personal sustainability via 360 evaluations.* Paper presented at the Seventeenth Americas Conference on Information Systems, Detroit, Michigan

Bull et al. (2010).*Research in education* (10th ed.). Boston: Pearson Education, Inc

Cahyadi, T(2013).Relationships between Fourth-Year Preservice Physics Teachers' Conceptions of Teaching and Learning Physics and their Classroom Practices during Student Teaching. *Songklanakarin Journal of Social Science and Humanities,*

Cambridge University Press, (2012).).Effects of teacher professional development on gains in student achievement.*Peabody Journal of Education*

Chandra, U&Watters,W(2012). Quality learning of physics: Conceptions held by high school and university teachers. *Research in Science Education*

Cheng,K(2010). *The theory and practice of assessment and testing*. London: Falmer Press.

Cohen, O (2010).). Assessment and classroom learning.*Assessment in education*

Conner, R (2014) *Analysis of the quality of professional development programs for mathematics and science teachers: Findings from a cross state study*.

Cooper,I (2010).*Qualitative research for education: An introduction to theory and practice* (5th ed.). New York: Pearson Education, Inc.

Cords,K (2012).A framework for understanding physics instruction in secondary and college courses. *Research Papers in Education,* Creswell,H (2017).Tips on maximizing high school physics teaching. *Teachers.Net Gazette*

Daba,J(2016). A comparison of exemplary biology, chemistry, earth science, and physics teachers' conceptions and enactment of inquiry.*Science Education*

Darling, S. (2012).Making physics appealing to female students: Perspectives of female students and physics lecturers. *Eurasian Journal of Physics and Chemistry Education*

Earl(2016).*Thai pre-service science teachers' conceptions of the nature of science.* Paper presented at the Asia-Pacific Forum on Science Learning and Teaching.

Eggen, G(2013).*A survey of instruments to assess teacher content knowledge in science.* Masters Thesis, Bowling Green State University, Bowling Green, Ohio.

Etkina, C(2010).*Teaching secondary school science: Strategies for developing scientific literacy* (9th ed.). Merril, New Jersey: Prentice Hall.

Fagen et al. (2012) *Improving teaching and learning in introductory physics.* Doctoral dissertation, University of Canterbury, Christchurch

Fensham, G. (2014).Model based inquiry in the high school physics classroom: An exploratory study of implementation and outcomes. *Journal of Science Education & Technology,*

Fischer, F(2011).Re-thinking physics teaching with web-based learning. *Computers & Education,*

Fraenkel et al. (2012).Closing the gap between the theory and practice of teaching: implications for teacher education programmes in Hong Kong. *Journal of Education for Teaching*

Gallagher.F. (2014).*Inspired issue brief: Inquiry-based teaching*. Retrieved May 21, 2013, from www.inspiredteaching.org

Geijsel et al.(2010)*Socio-cultural perspectives on science education: An international dialogue* (Vol. 4): Springer.

Geijsel et al., (2014).The new teacher education: For better or for worse? *Educational Researcher,*

Gray, G. (2010).*Research methods in education* (6th ed.). New York: Routledge.

Gregersen, H. (2021).The influence of educational context on science learning: A cross-national analysis of PISA. *Research in Science & Technological Education,*

Gunstone.T. (2014).Physics teachers' perceptions of the difficulty of teaching electricity.*Research in Science Education, 39*(4), 515-538.

Gutulo, T.(2015).The physics/maths problem again. *Physics Education,*

Harcourt,H. (2010).*A possible dream: Retaining California teachers so all students learn*. Sacramanto: California State University.

Heitzmann, R. (2012).Substantive-level theory of highly regarded secondary biology teachers' science teaching orientations. *Journal of Research in Science Teaching,*

Hill, F. (2014).Fixing teacher professional development.*Phi Delta Kappan, 90*(7), 470-476.

Hoy, G. (2010). Educational psychology (11th ed.). Upper Saddle River, New .Jersey: Merrill.

Ingersoll, T. (2013) the effect of teacher psychological and school organizational and leadership factors on teachers' professional learning in Dutch schools. *The elementary school journal,*

Jain, Y. (2012)What makes professional development effective? Results from a national sample of teachers.*American educational research journal*

Yperen, D.(2014).Educational reform, personal practical theories, and dissatisfaction: The anatomy of change in college science teaching. *American Educational Research Journal*

Kagwesage, G.(2012).Teacher preparation in science and mathematics education: A situational analysis. *Science education in the Philippines: Challenges for development*

Kauchak, J. (2013).A phenomenological research design illustrated.*International Journal of Qualitative Methods*

Keser et al., 2010).Motivating the academically unmotivated: A critical issue for the 21st century.*Review of educational research*

Korthagen et al. (2016).Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics, 66*(1), 64-74**.**

Krauss et al. (2013).Employees' goal orientations, the quality of leader-member exchange, and the outcomes of job performance and job satisfaction. *Academy of management journal*,

Ladachart, O (2011).*Doing research in the real world* (2nd ed.). Thousand Oaks, California: SAGE Publications Inc.

Lasry et al. (2008).The importance of specific science content in the enhancement of metacognition In P. J. Fensham, R. Gunstone& R. T. White (Eds.), *the content of science: a constructivistapproach to its teaching and learning*.

Lasry et al., (2017the state of science in Australian secondary schools.*Australian Science Teachers' Journal,*

Watkins, N. (2018).Effects of science teachers' epistemological beliefs in teaching.*Journal of Research in Science teaching.*

Lederman, H and Gess, N. (2011) Case Study Instruction in Teacher Education: Opportunity to Develop Students' Critical Thinking, School Smarts and Decision Making. *Education*

Jantzi, H(2016). *Learning environment and student attitudes in environmental science classrooms.Proceedings Western Australian Institute for Educational* Loucks-Horsley et al., Loughran et al., (2012).*Is there really a teacher shortage?* GSE Publications. Retrieved October 1, 2013, from http://repository.upenn.edu/gse_pubs/133 270

Macaro, (2012).*Teachers' professional development*. Europe in international comparison: An analysis of teachers' professional development based on the oecd's teaching and learning international survey (TALIS).

McDermott, K. (2010). *Conceptions of teaching science held by experienced high school science teachers.* Retrieved May 5, 2014, from http://files.eric.ed.gov/fulltext/ED364426.pdf

http://www.scribbr.com>dissertation

Appendix I: request for permission to carry out research

P Bag 1020
BINDURA
ZIMBABWE

SAMED

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

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: ------------------------------------

TO WHOM IT MAY CONCERN

NAME: CHAMAUYA TAFADZWA REGISTRATION NUMBER: B211487B

PROGRAMME: HBScEd PHYSICS PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the Bachelor of Science Ed Honours Degree programme. The research topic is:

Factors affecting teaching and learning at Ordinary Level Physics.

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

Your co-operation and assistance is greatly appreciated.

Thank you

Z Ndemo (Dr.)
CHAIRPERSON - SAMED

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
OCT 2022
P. BAG 1020
BINDURA

Appendix II questionnaire for physics teachers

DEAR PHYSICS TEACHER

This questionnaire seeks your opinions and concerns about factors affecting teaching and learning of ordinary level physics in Masvingo district. The questionnaire is part of Bachelor of Science Education (Honours) Degree in Physics research project being completed at Bindura University of Science Education. Your responses will be treated confidentially and will be used for research purposes only. No person or school will be identified in any respond. Thank you for completing the interview. Your cooperation is greatly appreciated.

Please make a tick in the box beside your selected response where are no options given write your response in the space below the question.

SECTION A: Biography data

Physics teacher [ ]

1. Gender : Male [ ]   Female [ ]
2. Your age range
   20 to 30 years [ ]   30 to 40 years [ ]
   40 to 50 years [ ]   50years and above [ ]
3. Educational qualification
   Diploma [ ]
   Bachelor Degree [ ]
   Masters Degree [ ]
4. Teaching experience
   1 to 4 years [ ]
   6 to 10 years [ ]
   10 years and above [ ]

Part B questionnaire for physics teachers

1. What motivated you to become a physics teacher?
2. What are the challenges faced during teaching and learning physics?
3. Do you write record keeping e.g. schemes of work, record of marks?
4. What was your physics pass rate results for the past three years?
5. How can we improve teaching and learning of physics?
6. In your opinion what can be done to improve teaching and learning of physics at Ordinary Level

SECTION C questionnaire for physics teachers

Have you completed the following courses at college /university

Courses	Completed	Not completed
Foundations of education (sociology, philosophy and psychology)		
Teaching Methodology		
Physics		
Communication skills		
Teaching practice		
ICT		

Answer the following items by putting a tick were appropriate

Item	Strongly Agree	Agree	Strongly Disagree	Disagree
During your teacher training at College/University you receive the knowledge on of teaching and learning physics				
Do you know how to assess learners during learning physics				
Use of language that learners understand				
During teaching physics use demonstrations, discussions and hands on practical's to illustrate physics concepts				
Constraining factors Inadequate teacher subject knowledge				
Lack of laboratory equipment				

APPENDIX III: LEARNERS INTERVIEW SURVEY

DEAR PHYSICS LEARNER

This interview seeks your opinions and concerns about factors affecting teaching and learning of ordinary level physics in Masvingo district. The interview is part of Bachelor of Science Education (Honours) Degree in Physics research project being completed at Bindura University of Science Education. Your responses will be treated confidentially and will be used for research purposes only. No person or school will be identified in any respond. Thank you for completing the interview. Your cooperation is greatly appreciated.

Please make a tick in the box beside your selected response where are no options given write your response in the space below the question.

SECTION A: Biography data

1. Gender : Male [ ]   Female [ ]
2. Age…………..years
3. Which level are you?

    Form 3 [ ]

    Form 4 [ ]
4. (a) Would you like to continue with physics at Advanced Level

    Yes [ ]   No [ ]

    (b) Give a reason

……………………………………………………………………………………………

……………………………………………………………………………………………

SECTION B

Item	Strongly Agree	Agree	Strongly Disagree	Disagree
Teacher giving you test to write and of term examinations				
We use internet for learning				
The teacher use the language that learners understand in physics lesson				
During classroom learning the teacher use demonstrations, discussions and hands on practical's to illustrate physics concepts				
Constraining factors Inadequate teacher subject knowledge				
Physics it's a challenging subject				
Lack of laboratory equipment				

5. What can be done to your physics class so that learning can be improved

……………………………………………………………………………………………………
……………………………………………………………………………………………………

APPENDIX IV: FOCUS GROUP DISCUSSION FOR PHYSICS LEARNERS

1. Is physics a challenging subject as compared to other subjects? Give reason for your answer.
2. Do you enjoy physics learning? Give reason.
3. Do you do practical in physics lessons? If yes how many times per week
4. Would you want to proceed with physics learning at Advance level? Give reason for your answer.
5. What are the challenges faced during learning physics?
6. What can be done to improve those challenges?

APPENDIX V: Researcher Observation checklist

	Availability Of lab	Availability Of equipment	Availability Of textbooks	Teacher to pupil ratio	Availability of Teacher records	Comment
School A						
School B						
School C						