AN ANALYSIS OF ZIMBABWEAN TEACHERS' INTERPRETATION OF THE ADVANCED LEVEL PHYSICS CURRICULUM: IMPLICATIONS FOR PRACTICE.

by

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DEDICATION

This work is dedicated to my late father Mr Isaac Munikwa and my mother Mrs Magreth Munikwain appreciation of all the sacrifices they made for me to receive education. Thank you Mum and Dad for your love, generosity, and support. Thank you too for the strong educational background that you laid for me to build on.

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DECLARATION

Student Number: **49917315**

I declare that **An Analysis of Zimbabwean Teachers' Interpretation of the Advanced Level physics Curriculum: Implications for Practice**is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNATURE **DATE 24/10/16**

(Mr)

LIST OF CONTENTS PAGES

CHAPTER 2

LITERATURE REVIEW

CHAPTER 3

THE ZIMBABWEAN EDUCATION SYSTEM

CHAPTER 4

RESEARCH METHODOLOGY

CHAPTER 5

DATA PRESENTATION, ANALYSIS AND DISCUSSION

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

FIGURES

Tables

LIST OF APPENDICES

ABSTRACT

The purpose of this study was to explore the Zimbabwean physics teachers' interpretation of the Advanced Level Physics curriculum. The study was motivated by the teachers' lacklustre approach to adopting new practices and the poor alignment of their understanding with the practice envisaged by developers (Fullan, 2007:39; Ndawi&Maravanyika, 2011:68). Zimbabwean Advanced Level physics teachers are in this predicament, as evidenced by the low numbers of undergraduate students and the misconceptions displayed by physics learners enrolling for first year university work in physics-related disciplines (Kazembe and Musarandega, 2012:4). Having an idea of physics teachers' perceptions, experiences and current practices with regard to the revised Advanced Level physics curriculum maybe fertile ground for intervention measures and policy decisions. To obtain a more holistic picture of the physics teachers' practices, a mixed methods research approach using the convergent parallel research design was adopted for the study. A closed survey questionnaire was used to solicit for information from 56 physics teachers in four educational provinces. Random sampling was used to select the survey respondents. From these participants, 10 were purposively selected for face-to-face in-depth structured interviews basing on their availability and accessibility. Ten schemes of work,one from each interviewed teacher, for one school term and six past examination practical paper 4 question papers were collected and analysed using a document analysis guide. Quantitative data was analysed using descriptive statistics and chi-square, whereas qualitative data was collated into themes for discussion purposes. The findings of the study reveal that the physics teachers have embraced the ideals of the physics curriculum and adapted it to their operating context through the reiterative interpretation process to construct personal meaning. The teachers are mainly utilising teacher-centred approaches to impart knowledge to the learners which is not consistent with the physics curriculum anticipations of using learner-centred approaches. The physics teachers are superficially interpreting the physics curriculum.The physics teachers need to embrace the learner centred teaching approach andbe empowered to enhance their curriculum interpretation and teaching practices through staff development.

Key words: analysis; curriculum; curriculum implementation; interpretation; Advanced Level Physics; practice; innovative; teacher-centred instruction; contextual constraint

CHAPTER 1
INTRODUCTION TO THE STUDY

1.1 ORIENTATION

It has become a common phenomenon and practice to benchmark a country's economic and social development with advancement in science, technology, engineering and mathematics (STEM). Science education reforms and improved access to science education have become ways to advance economic development and success. There is a deliberate effort in Zimbabwe to foster innovative teaching approaches, and to promote technological advancement and economic development. Consequently, it is necessary to assess and redefine the tenets of the process of education and its impact on national development and nation building. As such, people need to be aware of the challenges and critical issues in science teaching and learning. Such knowledge will lead to the provision of current and relevant practices that may foster global competitiveness, excellence and guarantee learners' success.

The Zimbabwean high school Physics curriculum revision has seen the inclusion of inquiry-based science teaching, innovative teaching approaches and integration of modern technologies in the classroom. The Advanced Level Physics curriculum is a body of knowledge that is designed to prepare learners for studies beyond Advanced Level in Physics, in Engineering or in physics-dependent vocational courses (Zimbabwe Schools ExaminationCouncil [ZIMSEC], 2013–2016:2). Through the restructuring of curriculum objectives by the Curriculum Development Unit (CDU) in Zimbabwe in 2002, it was anticipated that the implementation of the physics curriculum would usher in a new approach to teaching and learning of physics education in secondary schools. The main goal was to encourage teachers to offer learners more learner-centred and activity-based instruction. To this end, teaching was to be informed by the constructivists' philosophy. Constructivists stress the importance of learners' interests, problem-solving ability and concept formation.

Conner (2014a:3), Gray (2009:18) and Muijis and Reynolds (2011:77) hold that constructivism is based on the premise that learning is a product of mental construction, hence individuals construct their own perspective of the world and in turn their knowledge. Piaget (1967) cited in Creswell (2014:29) projects that learners learn via personal interactions with the physical environments in their daily routines. He points out that quality instruction needs to avail opportunities and practical experiences that challenge the child's previously held conceptions and foster learners to organise individual beliefs and principles. Mental construction is indeed facilitated by the engagement of prior conceptions with physical activities and objects in the learning scenario. Hence, teachers should take advantage of what learners are familiar with, and byemploying learner-centred instruction, facilitate exploration of ideas by the learners. Consequently, teachers become the focal point of the envisaged change in classroom practice as the possible source and solution with respect to learners' under-achievement in the sciences.

According to Bregman (2008:13), Hackling, Goodrum and Rennie (2001:8) and Kasembe (2011:316), progress and achievement of these objectives has been very slow and sporadic. Ajibola (2008:21) and Munikwa, Chinamasa and Mukava (2011:42) observe that teachers are not doing much to implement the prescribed teaching ideas and practices. Tesfaye and White (2012:4) concur,arguing that the mind and role play activities are limited, showing that learners are being given less time to participate during lessons. Teachers continue to devote a lot of their time and effort to transmission of content (Blignaut, 2008:117; Buabeng, Conner & Winter, 2015:9; Jetty, 2014:10; Tesfaye& White, 2012:5). The teacher-centred teaching approach is consistent with transmission views of learning and teaching, which is in contrast with facilitation as proposed by the new curriculum projects. Given the challenges experienced by the teachers in adopting innovative teaching approaches in the science classroom, there is need to understand what underpins the instructional practices of physics teachers and how they relate to the advocated effective teaching strategies.

The researcher had been an Advanced Level Physics teacher for ten years before taking up a university teaching post. As an educator, the researcher has a passion for physics teaching and learning, andstaysin touch with developments that take place in schools by maintaining contact with some colleagues in the schools. As a university teacher who has been heavily involved in teacher education for a further nine years,the researcherhas the necessary background experience to embark on this study. The researcher has been appointed a member of the National Curriculum Review Reference Group, which was initiated by the Ministry of Education, Sport and Culture of Zimbabwe in 2012. These experiences should serve as a vantage point for embarking on a study focusing on physics teachers' perceptions, experiences and practices.

A further motivation for conducting the study is that the Zimbabwean government has identified the learning and teaching of science and mathematics as a priority in the educational needs of the country (Chigwamba, 2012:9; Second, Science and Technology Innovation Policy of Zimbabwe, 2012:5; Mudhenge, 2008:3). The government is faced with an enormous task to build capacity in science, mathematics and technology education and this begins at school level before it can translate into the workplace. Learners need to be afforded opportunities to learn science and mathematics effectively. Currently harsh disparities are prevalent in the environment under which teaching and learning of science occurs in the country. Such glaring disparities can no longer be blamed on the colonial system of education. For example, it has been observed that urban schools are better resourced than rural schools (Dzinotyiwei, 2013:1). Against this background it is deemed worthwhile to study how learning opportunities afforded to physics learners at selected schools vary. The findings of this study may hopefully provide information that could contribute to good practices in physics teaching and learning. The knowledge gained may assist decision-makers particularly where teaching of physics is concerned.

1.2 CONTEXT OF THE STUDY

As alluded to earlier, the Advanced Level Physics curriculum is a body of subject matter that lays the foundation for the pursuit of higher studies in engineering or in physics-based vocational courses in tertiary institutions (ZIMSEC, 2013–2016:2). Implications are that physics is a very important subject as its knowledge is needed for the successful pursuit of many important professions. Learners need to pass Ordinary Level Physics or Physical Science with an A or B grade to be considered for Advanced Level Physics studies. Learners who study physics at thislevel do so in combination with two other subjects selected from Mathematics, Chemistry, Biology and Computing. Usually these learners are considered the "cream" of the OrdinaryLevel graduates and are expected to be the champions of the nation's scientific and technological advancement. The successful pursuit of scientific and technological advancement can be attained if the teachers provide effective teaching to the physics learners. Hence quality teaching is the cornerstone of any educational system for developing scientifically literate citizens. What learners learn is largely determined by how they are taught. Hence, teachers play a significant role in engaging learners with up-to-date and relevant activities that guarantee excellence and learner success.

In recent years several attempts at reforming science education in developing countries have focused on the needs of the respective countries. The quality of mathematics and science education is a source of concern for education authorities in both developed and developing countries (Elmas, Ozturk, Irmak &Cobern,2014:3; Jetty, 2014:42). Issues in the countries concerned evolve around concerns of relevance, quality, needs and aspirations of the local people and the challenges of the future (Ajibola, 2008:15; Chigwamba, 2012:8; Mudhenge, 2008:8). The issues raised have been taken on board from varied dimensions and perspectives, especially the relevance of learning experiences and their applicability to the local environment and needs of the learners. There has been a strong call for a more scientifically literate nation and workforce to be competitive in the regional and global market. The thrust is now on tapping learners' experiences before introducing new content (Chigwamba, 2012:6). The development of learners' experiences is guided by concepts such as constructivism, equity, science technology and society, educational technology, cooperative learning, hands-on activities and the nature of science (Dzinotyiwei, 2012:4;Elmas et al., 2014:27). The raised concepts underpinning science learning indicates that science education has become a critical matter of national concern.

A study into the teachers' interpretation of the Physics Advanced Level curriculum in Zimbabwe is plausible as there are questions on how new teaching innovations are implemented in schools. The motivation of teachers to adopt new practices and the match between their understanding and the practice envisaged by developers, do not always tally (Fullan, 2007:39; Ndawi&Maravanyika, 2011:68). As very few studies have been done on the analysis of teachers' interpretation of the new Advanced Level Physics curriculum in Zimbabwe, this investigation is deemed essential. A closer look at the implementation of Advanced Level Physics education curriculum in Zimbabwe is not only desirable for Zimbabweans, but for other science educators who may harbour plans to implement a similar physics syllabus at national level. It is anticipated that the findings will provide important implications for teaching, learning, resource mobilisation and support, and curriculum design.

Zimbabwe, being part of the developing world and having experienced an economic meltdown that impacted negatively on its education system, now has to cope with science and mathematics education provision that is highly compromised. This is evidenced by low enrolments in institutions of higher learning in science- and mathematics-related disciplines and low pass rates in science and mathematics in the schools (Adeyemo, 2010:111; Kazembe

&Musarandega, 2012:4; Awolabi, Akinyole&Adeyemo, 2011:4). Research findings in Zimbabwe are similar to those in Nigeria. Some Zimbabwean universities have started offering bridging courses in science and mathematics for a semester to facilitate students' entrance into university programmes (Nyoni, Chinyani&Nyoni, and 2013:170). This could be an indicator of the seriousness of the problem pertaining to the quality of the teaching and learning of sciences and mathematics in Zimbabwean high schools.

Research findings in Zimbabwe and elsewhere in the world have also recognised a lack of learner autonomy in science practical work, lamenting the fact that practical work is dominated by teacher demonstrations and a cookbook approach where learners merely followed the teacher's directions (Kazembe &Musarandega, 2012:8; Kim & Tan, 2010:484; Munikwa et al., 2011:43;Ramnarain, 2011:92). These research findings indicated serious shortcomings in the manner in which science practical work is being conducted in schools. The learners are not being given enough opportunities to take charge of their learning and explore their potential and capabilities. This study intends to extend previous research by undertaking interviews and documenting analyses of schemes of work to establish the extent to which the levels of inquiry and inquiry skills are being addressed. The study will also attempt to establish the quality and nature of teacher questioning during learners' practical work and the probable influential contextual factors. In undertaking this study, the physics teachers' perceptions of the physics curriculum inherently become the point of departure.

1.2.1 Teacher perceptions and the curriculum

Lim and Pyvis (2012:14) assert that teachers' positive perceptions are a critical component that facilitates their appreciation of curriculum reforms. The effective teaching by physics teachers in the classroom is critical and calls for teachers to adopt new roles. The taking up of new roles by teachers in classrooms is likely to materialise if they have positive perceptions ofthe new practices. The revised Advanced Level Physics curriculum was operationalised in 2002, ushering in new roles for physics teachers. At that stage the need was to become autonomous and to make the curriculum more relevant to the needs of the learners (Kanyongo, 2005:67). The issue of relevance implies that there was a need to cater for national interests and to ensure that material learnt had some relationship with the local environment. The need to use learner-centred strategies in teaching activities and relating physics learning to everyday life were deemed important (ZIMSEC, 2013:2). In addition some option topics such as Electronics and the Physics of Fluids have been added to the core sections, as well as a practical design component. It is partly for the inclusion of the Electronics and Physics of Fluids topics and the design practical component that teachers' perceptions are solicited, with respect to the level of preparedness and readiness to meet the needs of the physics syllabus. Kriek and Basson (2008:64) claim that teachers' level of preparedness and readiness to handle curriculum reforms are essential ingredients for effective teaching and learning. This is supported by Fullan (2007:129) who asserts that educational change hinges on what teachers do and realise. This implies that teacher practices are dependent on teacher perceptions. Thenextport of callmaybe to check on the teachers'preparednessto handle the envisaged curriculum reforms.

1.2.2 Teachers' sense of preparedness and teaching science

Kind (2009) in Venkat, Rollnick, Loughran and Askew(2014:23), asserts that teachers require precise, profound and extensive science knowledge to be effective in the classroom. For physics teachers to be effective they should be versatile and confident with their mastery of content knowledge (CK). According to Etkina (2010:2) and White and Tyler (2015:3), physics CK is concerned with sound knowledge of physics concepts, relationships between them and methods of knowledge acquisition. This implies that good mastery of subject matter of the discipline and how it would be accessed is a necessity for effective teaching. Teachers should have passed through good hands for them to be fully conversant with subject matter and should have been exposed to good teaching, to be effective in the classroom.

Zimbabwean physics teachers pass through different universities with different curricula and personnel and since they are unique individuals, their mastery of CK is bound to differ. Weak CK contributes to teachers' low confidence in executing science lessons, which is a recipe for poor quality lessons (Kind in Venkat et al., 2014:22). Zimbabwean physics teachers, like those of any other nation, are bound to have varied levels of CK. The first cohort of Zimbabwean physics teachers have a Bachelor of Education degree (B.Ed.) from the University of Zimbabwe and the Licentiate degree from Cuba. According to Chavunduka (2005:4) teachers who have these qualifications lack adequate teaching CK depth to effectively teach the subject at advanced level. However, the Bachelor of Education degree and Licentiate degree holders have the requisite pedagogical skills to impart that shallow knowledge. The second group of teachers have a Bachelor of Science degree without a certificate in Education. Chavhunduka (2005:4) claims that these teachers are well grounded in content knowledge, but lack basic training in pedagogies. These physics teachers are likely to interpret the physics curriculum in a deep or shallow sense depending on their CK levels.

Interpreting the curriculum from an examinations-focused perspective militates against the deep teaching which facilitates understanding of concepts by learners through interrogating these concepts by means of projects and discussions. It would be quite informative to establish physics teachers' levels of CK with a view to take advantage of their strengths and weaknesses to improve their confidence and effectiveness. This information would also go a long way in assisting university lecturers to adjust their curricula and teaching to meet the needs of their clients. Buabeng et al. (2015:4) and Kind(in Venkat et al., 2014:23) claim that CK is vital for good science teaching, but is grossly inadequate to ensure satisfactory classroom practice, since classroom practitioners must have pedagogical knowledge to impart content to the learners effectively.

Teachers with a Bachelor's degree only also need to be well-acquainted with and competent in pedagogical content (PC) to execute their teaching duties diligently. Etkina (2010:3) asserts that PC consists of knowledge of brain development, cognitive science, collaborative learning, classroom discourse, classroom management and school ethos. PC could be considered as the body of knowledge that embraces how learners develop mentally, how they accommodate new information, how learners interact with others and how teachers could create an environment conducive for learning. Kind, in Venkat et al. (2014:23), argues that teacher education has a critical role to play in redressing misconceptions relating to science concepts. Acquisition of PC by teachers is a critical factor that will enhance teachers' capabilities and skills in ensuring that learners access science knowledge easily. Of interest to this study would be to ascertain how much physics teachers' value collaborative learning, the investigative approach to practical work, restructuring existing topics, embracing effective classroom interactions, and how they facilitate the learning of physics in their schools. These issues are prioritised since they are deemed, to a large extent, to enhance physics teaching in the schools. From the foregoing, teachers' perspectives on the preceding issues would guide the learning experiences to which they expose learners.

Effective teachers need to be well-grounded in pedagogical content knowledge (PCK). Shulman (1987:8) argues that PCK represents the fusing of subject matter and pedagogy creating an awareness of how specific topics or issues are structured. He goes further to suggest that the fusion of CK and pedagogy is visualised by adjusting to the varied interests and capabilities of learners, and taking advantage of instruction. The stance on PCK is supported by Etkina (2010:3) who purports that PCK should embrace the knowledge of the physics curriculum, learners' problems, effective instruction strategies for a specific concept and appropriate assessment methods. PCK could be considered as the integration of what is to be taught and how it should be effectively taught and assessed. Botha (2012:1275) and Chinyere (2014:22) suggest that PCK is the nature of knowledge that is more credible in terms of separating the scientist from a science teacher. This indicates that PCK distinguishes a mere discipline expert from an individual who has the skills and capacity to facilitate learning and create an enabling environment. Etkina (2010:3) advances the notion that teachers tend to teach in the manner in which they were taught. Considering that the majority of Zimbabwean physics teachers are likely to have been subjected to traditional transmission teaching strategies, it would be interesting to determine the extent to which they have embraced learner-centred teaching strategies in their classrooms– and if not, why they have not adopted them. Zimbabwean physics teachers are a mixed group of subject experts and those who have gone through the rigours of teacher education. Hence, it becomes pertinent to bring to the fore how the differently positioned teachers value the demands of the revised Advanced Level Physics curriculum, challenges they face and strategies that they may use to overcome the challenges. One such strategy that teachers could be grappling with is inquiry-based science instruction.

1.2.3 Teachers and inquiry-based instruction

Recent curricula reforms in developing countries such as Botswana, Senegal and South Africa have called for classroom teachers to embrace more active forms of learning and shun teacher-dominated forms of teaching (Bregman, 2008:43; Kasembe, 2011:340). A good example is Curriculum 2005 of South Africa, Rogan and Grayson, (2003:1172). The new science curriculum focused on the nature, logical structure and the process of scientific inquiry, Aldous & Rogan, (2005:324). The thrust was to make science meaningful and relevant to the lives of the learners in their communities.This implies that curriculum reforms are calling upon teachers to facilitate learning and open more space for learners to participate in their own learning. However, it is an area of concern that many teachers still use the traditional lecture method (Mandina, 2012:158; Tesfaye& White, 2012:5). The teachers tend to remain with their familiar practices, despite the call for modernisation in teaching strategies. This means a lot of groundwork still needs to be done for a significant improvement in the teaching and learning of physics in schools. Some of the impediments are that teachers and learners are concerned about timely completion of the curriculum and getting credit for good examination results. Teachers preoccupied with timely completion of curricula were regarded as authorities of knowledge by learners and society and hence have an obligation to deliver (Bregman, 2008:43; Lim &Pyvis, 2012:142; Zhu, 2013:19). School authorities, teachers and learners who derive their credit from examination results would do all they can to maintain that credit. Such practices are contrary to inquiry-based science teaching and learning.

According to Dibiase and McDonald (2015:2), the National Research Council (NRC,2012:422) and Ramnarain(2016:3), inquiry science teaching is concerned with the different ways in which scientists and learners study natural phenomena through developing questions and suggesting explanations based on information obtained from their undertakings. In support of these ideas, Chabalengula and Mumba (2012:310) and Holloway (2015:1) project that inquiry is associated with the scientific approach, problem-solving, extracting conceptual meanings and hands-on exercises. This indicates that inquiry calls for learners to be actively engrossed in the learning scenario, which culminates in deep-rooted understanding of scientific concepts. Teachers are expected to provide guidance and encourage learners to take responsibility for their learning in appropriate contexts. However, one of the major challenges is that most teachers had not been exposed to the inquiry approach during their tenure as students. Consequently, inquiry-based instruction is a nightmare for most science teachers. With limited research available in Zimbabwe on inquiry-based science teaching, the researcher was prompted to undertake research in this area. Against the background of the few research studies conducted in inquiry-based science teaching, it appears to be a plausible approach to determine the development of inquiry and inquiry skills during physics lessons.

1.2.4 Teachers and contextualising science teaching

A further issue in the teaching of physics is that of relevance of the subject matter to a particular society. According to Chigwamba (2012:5) the relevance of a curriculum is based on the extent to which it addresses the needs of the individual learner, the national economy, society at large, and the future challenges of the country. Chigwamba (2012:5) goes further to proclaim that the focus should be on the individual's development of sound national values such as self-reliance, entrepreneurship and responsible citizenship, rather than on the interests of job-seekers. This author indicates that the curriculum should make an individual functional and productive contribution to society. To buttress the point, the Advanced Level Physics curriculum has as one of its aims to develop abilities and skills that are useful in everyday life (ZIMSEC, 2013–2016:3). In support, Gwekwerere, Mushayikwa and Manokore (2013:7),Liu (2009:307), Mistades (2011:446),Ng and Nguya (2006:40) and Yerdelen-Damar and Elby (2016:13) argue that teaching physics should be done in real-life situations in which phenomena familiar to learners' personal experiences are utilised as scenarios for learners. These authorities go further to suggest that these learning situations motivate and engage learners in active construction of knowledge. So, familiar contexts promote effective learning.

Awolabi et al. (2011:4) report that the physics school curriculum neither promotes entrepreneurship skills in content nor in teaching. In support of this idea, Belo, Van Driel, Van Veen and Verloop (2014: 95) posit that physics learners are not aware of job opportunities in the field and possible avenues of self-employment. The situation is a clear indication that physics teaching is not promoting entrepreneurship skills. With the Zimbabwean education system having committed itself to embrace ideals of entrepreneurship and self-reliance, this study intends to extend previous research by examining how the Zimbabwean high school physics curriculum embraces the ideals in both content and teaching. One such pertinent factor is the use of information communication technologies (ICTs) in the teaching and learning of science.

1.2.5 The use of Information Communication Technology in teaching and learning of science

The use of ICTs in teaching/learning is now a global necessity to facilitate personalised learning and instruction, sharing resources, collaborating, and promoting learning outside the classroom. Inline with this development, Zimbabwe has made efforts to avail schools of computers and internet facilities. The Second Science and Technology Innovation Policy of Zimbabwe (2012:5) has as one of its goals for education, the following: teachers and learners should frequently utilise the internet to search and interrogate scientific ideas taught and lucrative methods used in the global village.

One can deduce that technology should be used more frequently by both teachers and learners for teaching and learning. The use of these technologies needs to be evaluated, recognised and enlarged. According to Tesfaye and White (2012:5) the majority of schools that offer physics have only one physics teacher who has no colleague to turn to for assistance with regard to issues specifically dealing with physics. Hence, the physics teacher is isolated. Having technology such as the internet would be handy to alleviate the situation. However, Buabeng (2015:246), Kasembe (2011:336) and Ndibalema (2014:11) lament the lack of teacher initiatives in spearheading the integration of ICTs in the classrooms. This study also intends to extend previous research by establishing the extent to which technology is used in the teaching of high school Physics in Zimbabwe. Another important ingredient would be the school organisational culture and its impact on the teacher's effectiveness in the classroom.

1.2.6 School climate and science teaching and learning

According to Elmas et al. (2014:4), Ndawi and Maravanyika (2011:72) and Oyedele, Chapwanya and Fonnah(2015:41), the school leadership competencies, school climate and the availability of material resources, will determine what the teacher can achieve in reconstructing the syllabus into practice. The capacity of the school environment in terms of meeting the needs of the learner and the teacher are a recipe for effective learning and teaching delivery. The Zimbabwean government has admittedly failed to meet its obligation to provide schools with adequate resources and has enlisted the services of School Development Committees (SDCs) and other stakeholders to assist the schools in this endeavour. Tesfaye and White (2012:6), Onyeachu (2010:569) and Kasembe (2011:340) have shown that a lack of material resources and equipment seriously undermines the teaching and learning of science-related disciplines. Mudhenge (2008:6) projects that parents have been empowered through SDCs to spearhead development programmes in schools. Hence parents have a lot of say in what goes on in schools currently in terms of resource mobilisation. This research seeks to add to the findings by ascertaining the extent to which the involvement of SDCs and school administrators hasimproved or hindered the teaching and learning of high school physics.

The way teachers interpret the curriculum could also be influenced by the context in which they are operating. Fullan (2007:97),as well as Thijs and Van den Akker (2009:10) claim that new skills and beliefs, to a large extent, depend on whether teachers are working individually or sharing ideas and positive feelings about their work with colleagues. So the prevailing work environments to a large extent would shape the individual teacher's perspectives towards his/her work. With regard to Zimbabwean physics teachers, it would be of interest to find out how their school contexts, support from colleagues, school authorities and school ethos are shaping their perspectives and influencing their interpretation of the physics curriculum. Of significance are opportunities teachers have been afforded at the school to improve their understanding of the revised Advanced Level Physics curriculum. Such situations would make them more confident and comfortable in the classroom situation.

The Zimbabwean education system has been plagued by massive "brain drain", which has particularly affected science and mathematics teachers as a result of the economic meltdown. Those who remained behind have been accused of moonlighting as they struggle to make ends meet (Ndlela, 2009:10). Teachers have focused more on survival strategies at the expense of their daily core tasks. This has impacted negatively on the teachers' planning and execution of teaching and has grossly undermined learners under their guidance. These scenarios are likely to have a serious bearing on teachers' perceptions of the teaching profession in that it is perceived as less rewarding and a source of public ridicule. The high teacher turnover may have ushered in new recruits with little or no experience and who, in most cases, lack PCK. The few experienced teachers who remained have moved to private schools for better salaries. The implication is that new recruits have no mentors to lean on and have had to struggle to find their way. Another aspect worth considering is the support availed to teachers in their work stations to enhance the effective execution of their roles.

According to the Zimbabwean Education Act (2006:624), the SDCs are expected to promote the participation of the local community in the development of education at a local level. Depending on the nature of the local school community, some schools have fared well while others struggle financially and materially. Teachers interpret and implement the curriculum within the dictates of the school environment. Taking cognisance of the large gap that exists between Zimbabwean communities in terms of financial resources, it would be pertinent to unravel how different communities and school authorities are contributing to the learning of physics in their respective schools. The financial disparities with respect to potential to mobilise resources within the communities could be viewed in terms of material resource mobilisation and efforts in staff development to meet the new demands.

1.2.7 Quality of professional development and science teaching and learning

According to Bellibas and Gumus (2016:3), Gokmenoglu, Mark and Kiraz(2016:120) and Grayson and Kriek (2009:199), teachers need in-service programmes that articulate their needs and experiences. Qablan, Mansour, Alshmrani,Aldahmash and Sabbah (2015:629) as well as Zakaria and David (2009:230) further suggest that some of the areas that need to be addressed for effective teaching include CK, teaching strategies and professional attitudes. In the same spirit, Gulamhussein (2013:9) suggests that staff development initiatives should lead to changes in teacher practices that culminate in gains in learner learning. What is critical from these sentiments is the fact that the skills development programmes should be guided by teacher needs and experiences, and anticipated benefits for learners. Hence, the researchers capitalised on the Zimbabwean physics teachers' perceived needs and experiences and engage them to recommend an in-service professional development programme to cater for their needs. In-servicing teachers would in turn improve practice and make learners benefit more from the anticipated learning experiences.

1.3 THEORETICAL FRAMEWORK

This section focuses on justifying the chosen theoretical framework, developments in science education reform, problems bedevilling existing science curricula, teacher preparedness and implementation challenges. Teachers are considered important variables in this study and their articulation of curriculum implementation issues is a significant factor. The adopted framework for the study is Rogan and Grayson's 2003 Theory of Curriculum Implementation with particular reference to developing countries.The framework is selected based on its perceived relevance to curriculum implementation particularly in science education in developing countries (Rogan& Aldous, 2005:313; Rogan 2007:99). The framework is premised on three constructs and the idea of the Zone of Feasible Implementation (Rogan &Grayson, 2003). The constructs are the Profile of Implementation, the Capacity to Innovate and Outside Influences. Rogan and Grayson (2003:1202) project that the effectiveness of curriculum implementation can be determined through these constructs. Each of the three constructs can be employed to unravel the underlying features and determine the extent to which ideals of the curriculum are being realised in context. The framework will be discussed in detail in the next chapter.

1.4 PROBLEM CONTEXTUALISATION

The Zimbabwean Advanced Level Physics curriculum recommends that innovative teaching approaches should be enshrined as the main activity orchestrating the teaching of physics. However, in spite of the reforms initiated by curriculum designers, real innovative science teaching has been slow and sporadic (Mandina, 2012:158; Munikwa, Chinamasa&Mukava, 2011:43). Dibiase and McDonald (2015:5) and Tesfaye and White (2012:5) report that most teachers struggle to engage innovative teaching strategies. Few teachers maybe acquainted with the demands of innovative teaching and how it should be implemented, as per the dictates of learner-centred teaching. Teachers' limited skills on innovative teaching strategies suggest that much groundwork still needs to be done for a significant improvement in the teaching of physics in schools. Therefore, the question of employing appropriate curriculum implementation strategies to facilitate the effective implementation of the physics curriculum merits an investigation. The study is designed to explore teacher perceptions, experiences, practices and concerns in implementing the Advanced Level Physics curriculum, with aview to formulate strategies that may facilitate effective curriculum implementation.

Teacher-centred instructional practices dominate teacher activities within the Zimbabwean physics classrooms (Munikwa et al., 2011:43). The prevalence of teacher-centred approaches signals a narrow view of science teaching and learning, which maybe a reflection that teachers struggle to interpret and implement the curriculum. It is critical to understand why teachers are struggling to implement innovative teaching practices, and to suggest supportive structures that could empower teachers to utilise learner-centred teaching approaches in the science classrooms. Lastly, research in physics education is limited and lacks a comprehensive look at the overall field with respect to either curriculum interpretation or best instruction in physics. Hence, there is need to examine the nature of challenges which physics teachers may face when implementing innovative teaching strategies. In light of the preceding discourse, the following main research question and sub-questions are formulated.

1.5 RESEARCH QUESTIONS

The main research question guiding this study is as follows:

How do Zimbabwean physics teachers translate the Advanced Level Physics curriculum into practice?

The main research question is addressed through the following sub-questions:

- What are Zimbabwean physics teachers' perceptions of the Advanced Level Physics curriculum?
- What is the level of preparedness of teachers to implement innovative teaching strategies in the physics classroom?
- How do Zimbabwean teachers teach inquiry competences in Advanced Level Physics lessons?
- How is the teaching and learning of physics concepts being related to Zimbabwean everyday life?
- How are ICTs applied in the learning and teaching of the Advanced Level Physics curriculum?
- How does the school climate influence the implementation of the Advanced Level Physics curriculum?
- What is the nature of professional development opportunities availed to teachers in the schools?

1.6 AIM AND OBJECTIVES OF THE STUDY

The main aim of this study is to explore and describe how teachers interpret the Zimbabwean high school physics curriculum. To this effect the study is structured in such a way as to achieve the following objectives:

- To explore the perceptions of Zimbabwean physics teachers towards the new Advanced Level Physics curriculum.

- To determine the teachers' level of preparedness to implement innovative teaching strategies in the physics classroom.
- To investigate the inquiry inquiry competences addressed during physics lessons.
- To assess the extent to which the teaching and learning of Advanced Level Physics concepts is related to Zimbabwean everyday life.
- To determine the extent to which ICTs are used in the teaching and learning of Advanced Level Physics in the schools.
- To find out how the school climate influences the implementation of the physics curriculum.
- To determine the nature of professional development opportunities availed to physics teachers in the Zimbabwean high schools.

1.7 RESEARCH DESIGN AND METHODS OF INQUIRY

1.7.1 Research paradigm

The research is guided by the pragmatist paradigm. Creswell (2014:10) contends that pragmatism is preoccupied with issues that produce tangible results and provide solutions to problems. The approach demands that the researcher focuses on the problem and employs all applicable methods to unravel the problem (Creswell, 2014:10). This indicates that what is central is the research question under investigation and applying pluralistic strategies to gain information about the problem. The approach is realistic and practically orientated to solving real life situations, and is therefore more likely to result in change in practice. The pragmatist paradigm has been selected by the researcher on the basis that the problem under investigation emanates from a situation and calls for use of multiple methods to gain knowledge about the prevailing situation and possible solutions to enhance effective teaching practices.

1.7.2 Research approach

The study will adopt the mixed methods approach to provide a deeper understanding of the research problem, which may not be feasible using a single approach. According to Gray (2009:204), mixed methods research entails the process of collecting, analysing and mixing quantitative and qualitative data from single or multiple studies in order to understand a research problem more completely. The study intends to follow a descriptive survey design during data collection. A descriptive survey attempts to ascertain the characteristics of a specific population, either at a specified time or comparably over a period (Gray 2009:220). Perceptions, values and practices of Zimbabwean physics teachers will be examined and informed inferences drawn. Teachers' views on the implementation of the physics syllabus will be collected as quantitative data through a closed questionnaire, from which the researcher will draw inferences. This method is deemed appropriate as it involves the collection of extensive and cross-sectional data for the purpose of describing and interpreting an existing situation under study. The descriptive survey has the potential to identify, extract and describe people's perceptions using samples and different techniques of data collection and analysis.

Qualitative data to solicit deeper understanding of physics teachers' views, experience and interpretation of the physics curriculum will be sought through a structured interview and document analysis guide. Data triangulation is facilitated through the use of a closed questionnaire, interview guide and document analysis to collect the same information. The independent variables are gender, school type and school location and the dependent variable is mode of curriculum interpretation measured in terms of appropriateness of the Zimbabwe Advanced Level Physics syllabus, teaching strategies, and innovativeness, imparting inquiry skills, use of ICTs, organisational support and staff development opportunities.

1.7.3 Sample and its description

Random sampling will be used to select 56 physics teachers from56 schools in Zimbabwe. Random sampling is deemed convenient to afford participants equal opportunities of being included in the study and to understand the prevailing situation. Zimbabwe currently has 150 centres offering Advanced Level Physics (ZIMSEC, 2014:1). Cluster sampling was employed to group the high schools into rural and urban centres to ensure that all categories of high schools found in Zimbabwe located in socio-economically diverse communities are represented. Equal number of schools from rural areas and urban centres catering for both Day and Boarding schools would ensure equal representation of all schools from the socio-economically diverse communities. The representative sample will be selected from 28 urban public schools and 28 rural public schools. The schools were selected on the basis of accessibility, availability and that they had the variable - teaching and learning of Advanced Level Physics. Teachers participated on the basis that they are teaching Advanced Level Physics at their stations.

1.7.4 Methods of data collection

Permission was sought from the Ministry of Education, Sport and Culture, regional, district and the respective school heads authorities. Data was gathered through questionnaire administration, conducting interviews and document analysis. The survey, formal and non-formal interviews and document analysis were enlisted to solicit information that pertains to teachers' views, experiences, practices and circumstances underpinning the interpretation and implementation of the physics syllabus.

1.7.5 Data analysis

Quantitative data was analysed statistically using SPSS and qualitative data employing the Nvivo package. Inferential statistics was used where applicable to make informed conclusions. Qualitative data was organised into themes such as teachers' views on the curriculum, levels of preparedness to use innovative teaching strategies, application of inquiry-based teaching, linking physics concepts to everyday life, application of ICTs in the classroom, schools' climate, and professional development opportunities availed to teachers. Narrative descriptions were used to expound on emerging themes.

1.7.6 Reliability and trustworthiness

According to Gray (2009:193), reliability refers to the stability of findings. Reliability was guaranteed by data triangulation. This was achieved through the use of multiple data gathering tools such as the structured questionnaire, interview guide and document analysis. The methods were used to solicit the same information with respect to concepts under investigation and to the convergence of analysed data.

1.7.7 Validity

Gray (2009:155) advises that for validity, a research instrument must measure what it is intended to measure. To ensure validity, the research instruments were pilot-tested on six purposively selected physics teachers who complete the questionnaire and on another four teachers who were interviewed during the June,2015 examination-marking session. Feedback obtained was used to improve the data gathering instruments prior to use in the field.Two schemes of work were be scrutinised to determine if the document analysis guide was able to pick what was required from the schemes of work. The degree of alignment or non-alignment provided the basis for the adjustment of the document analysis guide.

1.7.8 Limitations

The study was conducted in a relatively volatile environment in terms of the history of the Zimbabwean education system, and the many changes that are anticipated. Itmay be possible that recommendations emanating from the study may be overtaken by events, since major changes in the practice of education are envisaged. To minimise these limitations, the researcher maintained a focus on exploring the major concept of the teachers' interpretation and implementation of the Advanced Level Physics syllabus. Through careful planning by the researcher and professional guidance by the supervisor, it was hoped these cited limitations would not curtail the study's future success.

It was anticipated that the participants could find the researcher's questioning and probing disrespectful of their professional credentials. To guard against this scenario, the researcher made an effort to create a free environment for the teachers by visiting the selected schools at least twice prior to the questionnaire and interview scheduleadministration. Due to the high financial implications of the study which affected extensive coverage of geographically dispersed schools, the researcher made an effort to source funding so that financial constraints didnot affect the study negatively.

1.7.9 Ethical considerations

In research there was a moral obligation to build trust between the researcher and the participants (Creswell, 2009:89). First, the issue of access to both the subjects and institutions was considered. Permission was sought from relevant authorities from the Ministry of Primary and Secondary Education, at provincial, district and school level where the study was undertaken. The issue of confidentiality was guaranteed through assurance of anonymity in the hope that respondents opened up and provided honest and reliable responses to questions in the questionnaire and interview guide, underpinned by confidentiality and anonymity. The importance of the participants' right to knowledge, privacy and participation was fully explained before their cooperation was sought. Hence the purpose of the study was explained to each participant as well as his/her right to refuse to participate or choose to withdraw at any stage of the study. This ensured informed consent of the participant. Clearance was obtained from the University of South Africa's College of Education Research and Ethical Clearance Committee prior to data collection.

1.8 SIGNIFICANCE OF THE STUDY

The study has potential to provide detailed information about Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum. It helped to understand how curriculum developers' decisions are interpreted and practised in the classrooms. The rich information gathered would unravel the forces at play during the interpretation and implementation of the physics curriculum. The discrepancies between the intended and implemented physics curriculum were identified. Valuable information gatheredmay assist decision-makers to develop better teaching and learning materials and make further progress in the curriculum design. Hence this study is a source of valuable feedback to curriculum planners and policy-makers. The study findings could make the curriculum more relevant and sensitive to the needs and demands of the teachers and learners and may assist the provincial teacher deployment policy.

The study helped to identify the practical challenges faced by the Zimbabwean teachers. These findings can be exploited to improve teacher performance and instructional practices. It identified potential and actual problems as early as possible and recommended possible solutions to improve school results. Thijs and Akker (2009:43) assert that it is critical to gain insight into the existing situation and the possibilities for improvement and innovation. Hence it was imperative to take a close look at how Zimbabwean teachers interpreted the Advanced Level Physics curriculum with due respect to the new approaches of teaching science.

The study has a potential to influence policy pertaining to pre-service and in-service teacher training. Reality definers and educators perceive learners' learning as a direct product of what and how teachers execute their daily responsibilities. The way teachers execute their daily chores hinges on their knowledge, skills, commitment to their work and availability of opportunities for in-service training at their work stations. It is critical to understand factors that have a bearing on effective science teaching (Nyamanhindi, 2014:1). With growing concerns about the state of science education and the anticipated role of teachers in enhancing the quality of science education provision, this study contributed further through unravelling how best to support teachers in the field to improve their effectiveness in teaching science.

Finally the study sought to come up with effective curriculum implementation strategies for the teaching and learning of physics. This was a culmination of teachers' experiences, expectations, suggestions and reviewed literature. The researcher anticipated that the proposed curriculum implementation strategies would go a long way to enhance effective curriculum implementation in Zimbabwe and elsewhere applicable in the region.

1.9 OUTLINE OF THE THESIS

This chapter is an introductory chapter, giving the background and context of the study, providing a context to the problem, the research question, sub-questions, aim and objectives of the study.

Chapter 2 presents Rogan and Grayson's theory of curriculum implementation as the framework which provides the structure for delineating the main issues to be examined. The chapter explains the anticipated relationships between the Profile of Implementation, Capacity to support Innovation and Outside Influences. The chapter also highlights the Zone of Feasible Innovation, and the shortcomings of the Rogan and Grayson's theory of curriculum implementation. Lastly it elaborates on the position of the teacher in the theoretical framework.

Chapter 3 gives a detailed description of the Zimbabwean education system and its development from pre-independence to the current situation with particular emphasis on the development of science education and the use of learner-centred approaches in science classrooms. The chapter sheds light on the challenges faced in accessing quality science education and efforts made in improving the teaching of science in Zimbabwe. The chapter also highlightedphysics as a course of study in high schools, the need to change the Advanced Level Physics curriculum and efforts directed towards innovative teaching approaches.

Chapter 4 is a methodology chapter that describes the setting of the study. It also indicates and justifies the parallel convergent research design and methods to be used to collect and analyse the data.

Chapter 5 provides the research findings and discussion.

Chapter 6 presents a summary of the study, conclusions and recommendations.

1.10 DEFINITION OFKEY TERMS

Analysis: detailed examination of the elements of physics teachers practices as the basis for interpretation

Advanced Level Physics: High school leavingphysics course of study that prepares learners for engineering-related courses in tertiary institutions

Curriculum: course or programme of study

Curriculum implementation: process of translating a course of study into practice

Innovative: practising new methods that are original and creative

Interpretation: process of unpacking a phenomenon

Practice: actual application or use of an idea, belief or method

Teacher-centred instruction: teacher approaches where most of the class time is spent with the lecturing and learners watching and listening

Contextual constraints: school conditions that have a negative effect on teaching and learning

1.11 SYNTHESIS

This chapter focused on the background, context of the study, conceptual framework, objectives and the research approach. The motivation for the study was spelt out and the importance of effective teaching and learning of science and mathematics in economic development and global competiveness was discussed. The limited of use of innovative teaching and learning strategies by science teachers is a major source of concern. The researcher pointed out that the findings from the study may lead to the formulation of strategies to guide curriculum implementation programmes for innovative teaching and learning in Zimbabwean high schools. The problem under investigation was put into context. The aims and objectives, research questions, significance of the study and rationale for the study were outlined. The research paradigm, design and methods employed in the study were briefly explained. The next chapter focuses on Rogan and Grayson's theory of curriculum implementation.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter focuses on the literature to establish a framework for the study.Rogan and Grayson's (2003) theory forms the bedrock of the study.This theory is hinged on three constructs, namely the Profile of Implementation, Capacity to Innovate and Outside Influences. The interplay of the three constructs shapes and determines the extent of the implementation of the innovation under consideration. According to Rogan and Grayson (2003:1181) the effectiveness of curriculum implementation can be determined via the sub-constructs and ascribed levels of operation.The respective sub-constructs will be explored and the subsequent levels of operation within the sub-constructs exposed in order to enhance comparisons with the Zimbabwean context of the revised physics curriculum implementation. The amalgamation of the three constructs as the basis for effective curriculum implementation will be analysed and adapted to the Zimbabwean context. Teachers' communities and environments in the schools will be discussed and related to how teachers implement the physics curriculum.

2.2 ROGAN AND GRAYSON'S THEORY OF CURRICULUM IMPLEMENTATION

The adoption of Rogan and Grayson's theory of curriculum implementation has been necessitated by its purported relevance and applicability in interpreting and analysing curriculum implementation innovations in developing countries. The theory focuses on developing nations' environments, which are usually characterised by a mix of poorly resourced and well-resourced schools, as is typical of Zimbabwean schools implementing the revised Advanced Level Physics syllabus. Of significant interest is the idea that the framework considers all aspects of the school context and education stakeholders equally important for effective implementation of any curriculum innovation. Regardless of the limitation that this frameworkhinges on the premise of national education systems with relatively good facilities and teacher networks – this study benefits from the experiencesof other researchers who have previously employed it. Rogan and Aldous (2005), Altinyelken (2010),Hattingh, Aldous and Rogan (2007), Rogan (2007) and Tawana (2009) have usedthe theory extensively in their studies in South Africa, Botswana and Uganda respectively and have comeup with enlightening insights. Based on their convictions and recommendations,the researcher found it pertinent to take advantage of the framework to analyse the implementation of the revised Advanced Level Physics curriculum in Zimbabwe. Taking cognisance of the fact that Zimbabwe is also a developing country grappling with a colonial legacy, the economic meltdown may have worsened the anticipated poor quality of physics education provision. It is also anticipated that applying the theoretical framework in a different context may provide fertile ground for testing the extent of usefulness of the theoretical framework and suggest possible modifications to the theoretical framework.

As alluded to earlier, the framework of Rogan and Grayson was decidedupon because of its perceived suitability and relevance to curriculum implementation concerns particularly in developing nations (Rogan,2007; Rogan & Aldous, 2005; Tawana, 2009). Rogan and Grayson (2003) argue that the effectiveness of curriculum implementation can be determined usingthree constructs. Each of the three constructs can be employed to unravel the underlying features and determine the extent to which the ideals of a curriculum are being realised in context, which in this case would refer tothe intentions of the Advanced Level Physics curriculum. The diagram in Figure 2.1 illustrates Rogan and Grayson’s theory of curriculum implementation.

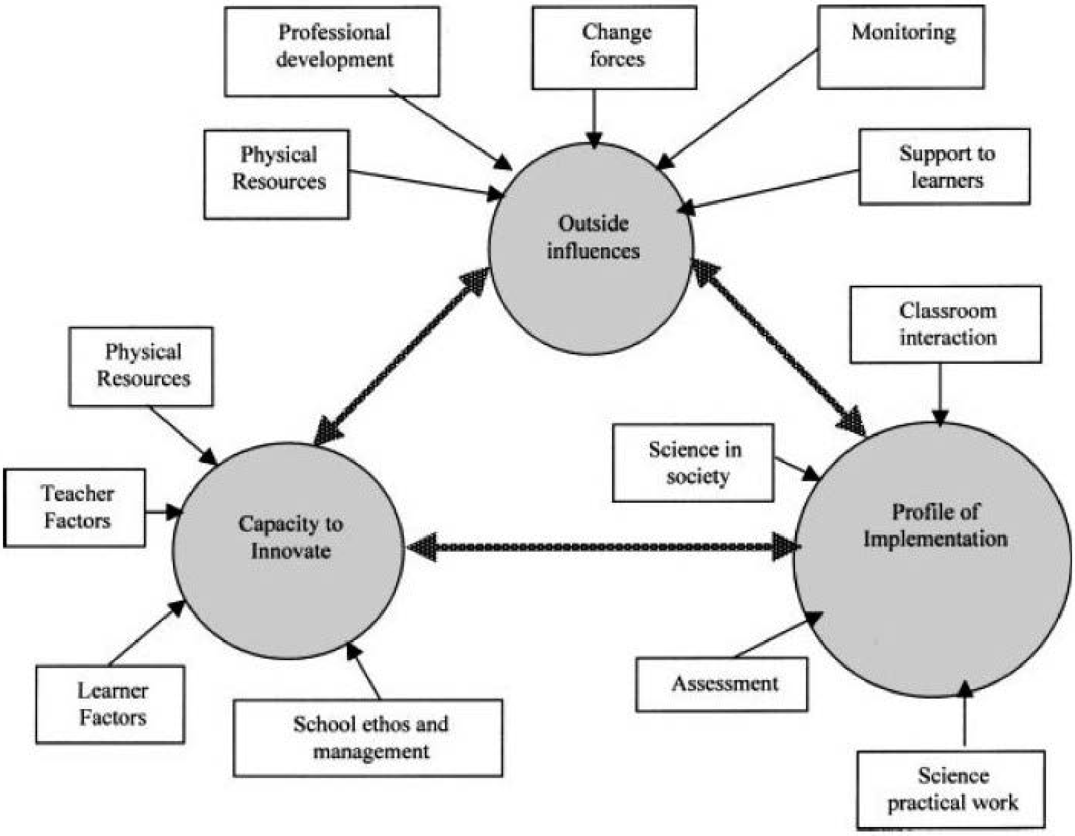

Figure 2.1: Framework of Curriculum Implementation (Rogan & Grayson, 2003)

2.2.1 Profile of Implementation

The construct Profile of Implementation (PoI) is in essence, an attempt to understand and express the extent to which the ideals of a set curriculum are put into practice (Rogan, 2007:99; Rogan & Grayson, 2003:1181). This implies an undertaking to ascertain the extent to which the prescribed curriculum is being transformed into reality. It acknowledges the fact that there are different degrees of implementation in any given curriculum. This is consistent with Fullan (2007:39) who argues that one critical feature of the feasibility of implementation is the provision of subsequent steps. Of significance is the acceptance that there should be a starting point and an expected end point. In this respect,PoI projects four sub-constructs at which implementation is presumed to take place, namely the nature of classroom interaction, use and nature of science practical work, assessment practices and incorporation of science in society (Altinyelken, 2010:66; Rogan & Grayson, 2003:1183). Each of these sub-constructs consists of four levels, where the highest level depicts the highest degree of learner-centred learning experiences (Altinyelken, 2010:66; Hattingh et al., 2007:77).These levels of operation can be considered as indicators of the extent of curriculum implementation, and will be discussed shortly as they help to unpack, analyse and figure out the extent to which the Zimbabwean Advanced Level Physics school curriculum is being implemented.

The PoI gives a measure of the extent to which curriculum intentions are being realised on the ground. In this study, these would bethe intentions of the physics curriculum with regard to physics in society, conducting physics practical work, classroom interactions and assessment processes. Examining the PoI is critical to this study as it unravels current practices in physics classrooms in the form of discourse, hands-on activities, and effective communication with respect to modern views of learning (Thijs & Van den Akker, 2009:36). Several points of view have been suggested to enhance effective learning of science. For instance, it is argued that allowing classroom interactions is a good recipe for learners to acquire scientific knowledge in an effective manner, to promote effective learning (Thijs & Van den Akker, 2009:34). Therefore there is a dire need to create opportunities for learner discussions, arguments and teamwork. The successful attainment of these purported skills is realised through what Rogan and Grayson (2003:1185) subscribe to as levels of operation referred to earlier. According to Rogan (2007:100) and Rogan and Grayson (2003:1182), Level 1 is the lowest level and Level 4 the highest level on the practice continuum. Indications are that Level 4 operations are more complicated, whereas Level 1 operations are good, but basic in nature.Table 2.1 shows the anticipated dimensions and sophistication levels of operation that could make up the PoI for the Advanced Level Physics curriculum.

Table 2.1: Profile of Implementation (Rogan &Aldous, 2005)

Level	Classroom Interaction	SciencePractical work	Science in Society	Assessment
1	Teacher presents content in a well sequenced manner, based on a well-designed lesson plan. Provides adequate notes. Uses textbook effectively. Engages learners with questions. Learners stay attentive and engaged. Respond to and initiate questions.	Teacher uses classroom demonstrators to help develop concepts. Teacher uses specimens found in the local environment to illustrate lessons.	Teacher uses examples and applications from everyday life to illustrate scientific concepts. Learners ask questions about science in the context of everyday life.	Written tests are given that cover the topic adequately. While most questions are of the recall type, some require higher order thinking. Tests are marked andreturned promptly.

2	**Teacher:** Textbooks are used along with other sources. Engages learners with questions that encourage in-depth thinking. **Learners:** Use additional (to text book) sources of information in compiling notes. Engage in meaningful group work. On own initiative offer a contribution to the lesson.	Teacher uses demonstrations to promote a limited form of inquiry. Some learners assist in planning and performing the demonstrations. Learners participate in closed (cookbook) practical work. Learners communicate data using graphs and tables.	Teacher bases a lesson (or lessons) on a specific problem or issue faced by the local community. Teacher assists learners to explore the explanations of scientific phenomena by different cultural groups.	Written work includes at least 50% of the questions that require comprehension, application and analysis. Some of the questions are based on practicalwork.
3	**Teacher:** Probes learners' prior knowledge. Structures learning activities along good practice lines (knowledge is constructed, is relevant, and is based on problem-solving techniques). Introduces learners to the evolving nature of scientific knowledge.	Teachers designs practical work in such a way as to encourage learner discovery of information. Learners perform "guided discovery" type practical work in small groups, engaging in hands-on activities. Learners can write a scientific report in which they justify their conclusions in terms of data collected.	Learners actively investigate the application of science and technology in their own environment, mainly by means of data-gathering methods such as surveys. Examples here include an audit of energy use or career opportunities that require a scientific background.	Written tests include questions based on see or unseen 'guided discovery' type activities. Assessment is based on more than written tests. Other forms of assessment might include reports on activities undertaken; creation of charts and improvised apparatus; reports on extra reading assignments.
4	**Learners**: Take major responsibility for their own learning; partake in planning and assessment of their own learning. Undertake long-term and community-based projects. **Teacher:** Facilitates learners as they design and undertake long term investigations and	Learners design and do their own "open" investigations. They reflect on the quality of the design and collected data, and make improvements. Learners can interpret data in	Learners actively undertake a project in their local community in which they apply science to tackle a specific problem or to meet a specific need. An example might be on growing a new type of crop to increase the income of the community.	Performance on open investigations and community-based projects is included in the final assessment. Learnerscreate portfolios to representtheir "best" work.

	projects. Assists learners to weigh up the merits of different theories that attempt to explain the same phenomena.	support of competing theories or explanations.	Learners explore the long-term effects of community projects. For example, a project may have a short-term detrimental effect.	

From the PoI's first sub-construct of classroom interaction, it is noted that Level 1 is associated with teacher domination of classroom activities,withlearners as passive recipients of information. Level 4 is associated with situations in which learners are responsible for their own learning and the teacher isa facilitator of the learning scenario (Rogan & Aldous,2005:316).For instance, a teacher may useopportunities for learners to discuss ideas in groups, while the teacher monitors and guides progress where necessary. The levels of operation in the PoI as visualised by Rogan and Grayson (2003) in their curriculum implementation matrix will act as standard pointers to the anticipated teacher practices and attainment criteria. The intentions of the Advanced Level Physics macro-curriculum will be considered as reference points against which current practices will be measured. The gaps identified, if any, would provide the basis for mapping the way forward with due respect to possible intervention measures. Teachers have been accused of ring-fencing their territories by sticking to traditional methods of teaching, despite the call to embrace more learner-centred teaching approaches (Kazembe &Musarandega, 2012:22; Tesfaye& White, 2012:4).It would be of interest to establish the levels of operation for the Zimbabwean physics teachers towards the envisaged learner-centred classroom discourse. This will also assist in giving the degree of mismatch between the macro-curriculum and the micro-curriculum.

The PoI seems to point out that teachers who are highly qualified and motivated are likely to display an array of sophisticated teaching strategies. However, Rogan and Aldous (2005:330) contradict this position by asserting that teacher qualification and motivation has no direct bearing on the quality of classroom interaction. This implies that the level of classroom interactions cannot be judged on the pretext of teacher qualification and degree of motivation. Worse still, some teachers in some developing countries typified by Zimbabwe are not highly qualified ormotivated to execute their duties diligently to attain such high levels as profiled (Altinyelken,2010:80; Mushayikwa, 2013:276; Ndawi&Maravanyika,2011:75).

Mushayikwa (2013:276) and Ndawi and Maravanyika (2011:75) go further to suggest that the teaching profession is looked down upon, characterised by poor remuneration and dissatisfied personnel. This prevailing environment may not be ideal for the adopted curriculum theory of implementation to be employed as the benchmark for the purported study. Hence, the merits or demerits of the situation on the ground will give guidance to the proceedings and findings.

The second sub-construct, namely practical work, entails practical learning experiences for the learners and is an essential component of what is regarded as good practice (Hattingh et al, 2007:82; Ramnarain, 2011:92). Practical work is a critical component of classroom interactions under focus as physics is a practically aligned discipline. Byconducting physics experiments, learners are expected to acquire skill in manipulation, designing and planning, interpretation and evaluation, and problem-solving. For instance, when considering conducting practical work at Level 1, the teacher would perform a demonstration experiment to drive home a concept, whereas at Level 4, the teacher facilitates while learners design and conduct their own experiments (Rogan & Aldous, 2005:316; Rogan & Grayson, 2003:1184).Consequently, a teacher operating on Level 4 is most likely to have mastered an array of teaching strategies at his/her disposal and is more inclined towards learner-centred teaching and learning approaches.

The PoI also takes cognisance of the incorporation of science in society – a third sub-constructwhichis an essential component of the Advanced Level Physics curriculum (ZIMSEC 2013–2016:2). Taking care of science in society is believed to enhance learners' creativity, good judgment, interest and positive attitude towards science. Rogan and Grayson (2003:1184) claim that learners should be afforded opportunities to actively interrogate the application of science and technology in their own backyard. They argue that learners should be made aware of the role of physics in their society and then be guided to actively embark on community sustaining projects. This emphasises the incorporation of societal issues and concerns in the learning of physics. For instance, to counter the problem of shortage of energy, learners could possibly come up with a project for lighting in their homes through exploiting solar power. If the project becomes successful the learners would have utilised their science knowledge to solve a societal problem, which is a critical component of learning physics. However, Rogan and Aldous (2005:331) maintainthat there is no relationship between incorporation of science in society issues and the professional development of teachers. This is attributed to the fact that the phenomenon of science in society is still a grey area in developing countries. It would be of interest to establish whether the concept of physics in society has taken root in the practices of Zimbabwean physics teachers.

The final sub-construct involvesassessment.Establishing the nature and level of sophistication of assessment practices employed by the physics teachers will give an indication of the value attached to assessment. Assessment should be holistic in nature by making efforts to go beyond written tests and incorporating oral presentations, written reports of research work by learners, and scientific projects undertaken by learners (Rogan & Aldous, 2005:316; Rogan & Grayson, 2003: 1185).Taking advantage of such initiatives would encourage learners to embark on individual research work and on scientific projects that could promote deep learning that is relevant to the society. The second construct of curriculum intervention, namely the Capacity to Innovate, is going to be discussed next.

2.2.2 Capacity to Innovate

The construct Capacity to Innovate (CtI) is an effort to understand and shed light on the factors that are able to support or hinder the implementation of new ideas and practices in a system such as a school (Rogan, 2007:99; Rogan & Grayson, 2003:1186). This construct concerns itself with the ability of the school environment to handle curriculum implementation. It should be appreciated that schools have different capacities to handle an innovation and hence differingdegrees of implementing an innovation. Rogan and Aldous (2005:318) and Rogan and Grayson (2003:1187) claim that the possible indicators of the CtI construct are physical resources, teacher factors, learner factors and the school ethos and management. Level 1 can be considered as depicting a school with poor resources, unqualified personnel and a dysfunctional administration. A move to higher levels depicts schools with better capacity to handle a new curriculum or an innovation. These indicators have been attributed dimensions and operation levels that serve as guidelines to determine the extent of the specific school’s Capacity to Innovate. Table 2.2 shows the operational levels and dynamics of thisconstruct.

Table 2.2: Capacity to Innovate (Rogan & Aldous, 2005)

Level	Physical resources	Teacher factors	Learnerfactors	School Ethos and management
1	Basic buildings – classrooms and one office, but in poor condition. Toiletsavailable. Sometextbooks – not enough for all.	Teacher is under-qualified for position, but does have a professional qualification.	Learners have some proficiency in language of instruction, but several grades below grade level.	**Management:** A timetable, class lists and other routines are in evidence. The presence of the principal is felt in the school at least half the time, and staff meetings are held at times. **Ethos:** School functions i.e. teaching and learning occur most of the time, albeit erratically. School is secure and access is denied to unauthorised personnel.
2	Adequate basic buildings in good condition. Electricity in at least one room. Textbooks for all. Some apparatus for science.	Teacher has minimum qualifications for position. Teacher is motivated and diligent. Enjoys his/her work. Teacher participates in professional development activities. Teacher has a good relationship with and treatment of learners.	Learners are reasonably proficient in language of instruction. Learners attend school on a regular basis. Learners are well nourished. Learners are given adequate time away from home responsibilities to do school work.	**Management:** Teacher attends school/class regularly. Principal is present at school most of the time and is in regular contact with staff. Timetable properly implemented. Extramural activities are organized in such a way that they rarely interfere with scheduled classes. Teachers/learners who shirk their duties or display deviant behaviour are held accountable. **Ethos**: Responsibility for making the school function is shared by management, teachers and learners to a limited extent. A school governing body is in existence. Schools function all the time i.e. teaching and learning always take place as scheduled.

3	Good buildings, with enough classrooms and a science room. Running water. Textbooks for all learners and teachers. Sufficient science apparatus. Secure premises. Well-kept grounds.	Teacher qualified for the position and has a sound understanding of subject matter. Teacher is an active participant in staff development activities. Conscientious attendance of class by teacher. Teacher makes an extra effort to improve teaching.	Learners are proficient in language of instruction. Learners have access to quiet, safe place to study. Learners come from a supportive home environment. Learners can afford textbooks and extra lessons. Parents show interest in their children's progress.	**Management: Principal** takes strong leadership role, is very visible during school hours. Teachers and learners play an active role in school management. **Ethos:** Everyone in the school is committed to making it work. Parents play active role in school governing bodies and in supporting the school in general.
4	Excellent buildings. One or more well-equipped science laboratories. Library or resource centre. Adequate curriculum material other than textbooks. Good teaching and learning resources (e.g. computers, models). Attractive grounds. Good copying facilities.	Teacher is over-qualified for the position and has an excellent knowledge of content matter. Teacher has an extraordinary commitment to teaching. Teacher shows willingness to change, improve and collaborate, and has a vision of innovation. Teacher shows local and national leadership in professional development activities.	Learners are fluent in the language of instruction. Learners take responsibility for their own learning. Learners are willing to try new kinds of learning.	**Ethos:** There is a shared vision. The school plans for, supports and monitors change. Collaboration of all stakeholders is encouraged and practised. **Management:**There is a visionary, but participatory Leadership at the school.

The physical factors are quite critical since a lack of resources impinges on the performance of teachers and has a strong bearing on deterring the focus of the learner from learning. For the teacher to be effective,he/sheshould have adequate science equipment, classrooms, textbooks, running water and reliable electricity (Rogan & Aldous, 2005:319; Rogan & Grayson, 2003:1189).Provision of adequate materials and a safe working environment serve as a good springboard for planning and executing one's duties proficiently and learners are likely to benefit more from such a setup. However, Rogan and Aldous (2005:330) contend that there is no relationship between laboratory resources and practical work. This viewpoint is also supported by Hattingh et al. (2007:84) who suggest that the undertaking of practical work doesnot hinge on the availability of physical resources, but rather on teacher motivation. The implication is that those teachers who are motivated to undertake practical work will utilise whatever is available regardless of the school being poorly resourced. In the same vein, de-motivated teachers are unlikely to employ practical work, despite being stationed in well-resourced schools. Consequently, establishing the degree of Zimbabwean physics teachers' motivation or dejection could be valuable in terms of ascertaining the potential to employ practical work in their teaching.

The teacher factors of this construct are concerned with the teachers' competence, acceptance of the innovation and commitment to teaching. Rogan and Grayson (2003:1189) supported by Rogan and Aldous (2005:320) proposethat the ideal situation is where a teacher is qualified to teach the level, has excellent mastery of subject matter, is committed to his/her work and makes an effort to improve himself /herself. These attributes will make a teacher a vital asset tothe school and the learners. Zimbabwean physics teachers have different qualifications, and have been hard-hit by the prevailing economic environment. Consequently their commitment to their work could be questionable (Mushayikwa, 2013:276; Ndawi&Maravanyika, 2011:75). Hence it would be prudent to determine how such situations could hinder or promote their construction of the micro-curriculum and their level of engagement with the learners.

The learners' zeal to learn and their level of preparedness are essential for effective learning to take place in the physics classroom. Rogan and Grayson (2003:1189) project that it is of paramount importance that learners are proficient in the language of instruction, have access to quiet and safe study environments, have parental support and are responsible for their own learning. Learners need to be in control of their destiny, buoyed by adequate parental support and a school environment conducive to learning. To assist the learners in their endeavour to exploit their full potential, teachers need to be awareof their learners' capabilities and backgrounds in order to be in a position to give learners maximum assistance.

The school tone and administrative structures do complement learning and teaching in a significant way. The school should be functional with teachers and learners having a say in how the school is run and the school should have a shared vision (Rogan, 2007:106;Rogan & Grayson, 2003:1190).Once learners and teachers are assured that management is committed to their concerns and welfare,they have room to concentrate on the core business of teaching and learning. The creation of such a situation is a recipe for effective teaching and learning in which learners and the community at large are bound to gain maximum benefits from the exercise.For instance, a school with good leadership and discipline stands a better chance of promoting learning compared to a disorganised school (Rogan,2007:106; Rogan & Grayson, 2003:1187). By the same token it can be argued that provision of good housing with low rentals for teachers in a particular school may go a long way in uplifting their motivation in executing their duties.

Rogan and Grayson (2003:1187) claim that CtI attributes serve as benchmarks indicating the extent to which sound learning and teaching scenarios may be attainable in individual schools. Consequently, getting insight into the existing practices and needsof physics teachers and the context of the innovation would go a long way to clarifying issues that could affect physics classroom instruction and learning.

The school setup and ethos should be able to project an impression which arises from a well-organised specific routine of conducting business. Rogan (2007:104) claims that school activities should be crafted based on a well-organised and systematic routine. This will ensure a smooth progression of teaching and learning most of the time. There should be evidence of involvement of key stakeholders such as teachers and learners in decision-making (Fullan,2007:166; Rogan & Aldous, 205:319; Rogan & Grayson, 2003:1187). For instance physics teachers involving learners in planning physics learning activities. This mechanism is bound to bring harmony and shared responsibility in the physics classroom. For instance,the involvement of learners in creatingphysics laboratory rules will make the learners committed and accountable for their actions. Rogan and Aldous (2005:319) are of the opinion that parents, teachers and learners should have a common vision. This will ensure the accomplishment of school goals, purposes and physics learner attainment targets. Hence it is prudent to establish the prevailing scenarios in Zimbabwean high schools and to determine the extent to which they are promoting or hindering effective teaching and learning of physics. The next construct to be discussed is that of Outside Influences (OIs).

2.2.3 OutsideInfluences

The construct of Outside Influences (OIs) focuses on organisations outside the school that interact with the school in a bid to facilitate the implementation of an innovation (Rogan, 2007:100; Rogan & Grayson 2003:1191).These organisations can be grouped into four categories, namely government departments, donors, non-governmental organisations (NGOs) and unions. The profile of OIs purports to describe the actions undertaken by outside organisations, as well as the ways in which they manifest their intentions (Rogan, 2007:100; Rogan & Grayson, 2003:1191). The influence of the outside organisations can be seen in the use of physical resources, teacher's professional development opportunities, and in support for learners, monitoring services and application of change forces. Ndawi and Maravanyika (2010:72) propose that outside agencies facilitate curriculum implementation bydeveloping and supervising teachers, as well as by determining the administrative tone within which the teacher will execute his/her duties. A positive support base is likely to usher a favourable learning environment into the schools. Negative learning environments may disengage learners from the learning scenarios. Hence, it is prudent to establish how outside agencies promote or hinder the learning and teaching of Advanced Level Physics in Zimbabwean high schools. Against this background, the construct of OIs as projected by Rogan and Grayson's (2003) dimensions and operational dynamics will be employed as the basis of comparison with the existing situation on the ground. Table 2.3 elaborates on thisconstruct.

Table 2.3: Profile of Outside Influences (Rogan & Aldous, 2005)

Level	Physical resources, (categories of resources: buildings, apparatus, curriculum materials, print and electronic,computers, etc.)	Professional development	Direct support to learners	Dominant change force evoked by agency	Monitoring mechanisms
1	Provision of resources supplements what exists, but not enough to support the intended changes. Provision is in one categoryonly.	Information on policy and expected changes are presented to school based personnel. Typical mode is short, one-off workshop	Provision of basic needs, such as lunches and places of study.	Bureaucratic. Change is brought about by top-down directives to bring about change.	Inspections by authorities are undertaken.
2	Provision of resources completely covers what is required to effect the intended change in one category, or partly sufficient in two categories.	Examples of 'new' practices as suggested by the policies are presented to school-based personnel, who are given an opportunity to engage in these practices in a simulated situation. Typical mode is a series of short workshops lasting for one year.	Basic academic needs are catered for in the form of extra lessons.	Charismatic. Change is brought by top-down inspiration and encouragement.	Inspections are undertaken in collaboration with school-based personnel.

3	Provision completely covers what is required to effect the intended change in two categories, or partly sufficient in categories.	Professional development is designed by school based personnel depending on which new practices they wish to implement, and implemented using both inside and outside support. Typical mode consists of both external and school-based INSET for two to three years.	Enriched academic needs are catered for in the form of field trips and other enrichment type activities.	Professional. Change is brought about by encouraging role players to embrace codes of conduct and standards of teaching and learning.	School-based personnel monitor own progress, but report to authorities.
4	Provision completely covers what is required to effect the intended change in three categories, or covers two categories and is partly sufficient in all categories.	Communities of practice take full responsibility for their own continued professional growth, and for school governance and curriculum implementation, calling on outside support as appropriate. Typical mode consists of ongoing school based and directed professional INSET.	Complete academic and personal support is provided, usually in the form of bursaries.	Learning community. Change is brought about by developing communities that develop shared values and goals regarding educational practice and a commitment to put these into practice.	All monitoring is undertaken by school based personnel.

Table 2.3 sets out the levels of OIs indicated from Level 1 to Level 4.The highest level shows the highest state of maturity and at this stage the individual schools could have their destiny in their own hands.It is the intention of this study to critically examine the sub-constructs of professional development, change forces, monitoring and support of learners and establish the extent to which they promote or inhibit effective teaching of physics. As mentioned earlier, the availability of resources is a critical ingredient to effective learning and proper functioning of any learning institution (Ndawi&Maravanyika, 2011:147;Thijs & Van den Akker, 2009:33).A sound support base and school environment conducive to learning are likely to foster effective teaching and learning in a specific school. Teachers and learners need an environment that has the least possible disturbances to their daily activities. For instance, teachers work best in environments where they are supported in terms of staff development and engage with peers within the school or in other institutions in discussing curriculum reform (Fullan, 2007:138). Of paramount importance is the idea that teachers and learners should be convinced that their needs and concerns are being taken seriously and are duly addressed by relevant authorities. This scenario keeps both the teacher and the learner focused on their primary goal,which has a bearing on their existence on the school premises.

For example, learners need to be suppliedwith adequate textbooks and to be given time for remedial lessons if they are facing challenges with their class work.

Teachers need to exhibit a high degree of accountability and responsibility for their actions. To that effect, the education system puts in place some monitoring mechanism to ensure that the intentions of the curriculum are realised within the confines of rules and regulations. There should be clear codes of conduct, standards for teaching and learning and systematic visits by ministry officials and adherence to the laid-down expectations (Rogan & Aldous, 2005:320; Rogan & Grayson, 2003:1194). Teachers are expected to conduct their business professionally and diligently and need to cooperate with their superiors to improve teaching and learning for the benefit of the learner. As the system matures, monitoring becomes more the responsibility of school-based authorities. The monitoring forces assist inidentifying gaps, challenges and strengths within the teaching corps that would form the basis for staff development. Curriculum implementation to a large extent hinges on the pro-activeness of outside agencies. The next section is going to shed light on the importance of a number of propositions postulated by Rogan and Grayson (2003) that are based on the interplay of the three constructs discussed so far, as the basis upon which the curriculum implementation is realised.

2.3 INTERRELATIONSHIPS BETWEENPROFILE OF IMPLEMENTATION, CAPACITYTOINNOVATE AND OUTSIDE INFLUENCES

The authors used the framework to develop propositions that advance relationships between the three constructs. The relevance of Rogan and Grayson's (2003) theory becomes evident when one considers how the interrelationship of the three constructs impacts on curriculum implementation. Rogan and Aldous (2005:322) proposethat the interrelation between the three constructs gives the idea of the possible relationships that may influence each other. For example, if classroom interactions are not related to the ethos and school management practices, then according to this framework, curriculum implementation becomes insignificant.In the same spirit, offering workshops for teachers on science practical work whilefailing to supplythem with the requiredequipment in schools is a futile exercise. It is essential to have an idea of factors emanating from CtI and OIs to source appropriate resources for effective curriculum implementation.

2.3.1 Alignment of the three constructs with the school system

Rogan and Grayson (2003:1201) suggest that implementation is most likely to succeed when there is alignment between the three constructs and the fundamental activity of the system. If the learning experiences are treatedas the fundamental level on the Advanced Level Physics curriculum for example, then outside support should help in a way that results in learners being subjected to higher quality learning activities. Fullan (2007:97) emphasisesthat efforts to improve teachers' competencies should be taken with the goal of improving the learning experience always in mind. Essentially, whatever endeavour is taken on should be targeted at bringing more beneficial learning activities to the learners.

In the same vein, the CtI should be premised on the provision of rich and more effective learning activities for learners (Rogan & Grayson, 2003:1201). The indications are that the CtI should be mobilised towards creatingmeaningful and beneficial learning experiences for the learners. However, Fullan (2007:285) posits that in some instances the CtI does not necessarily transform into beneficial outcomes that benefit learners. He claims that teachers may attend workshops on learner-centred teaching strategies, but decide not to employ them in the classrooms. Such scenarios are prevalent in Zimbabwe and a host of other developing countries (Kazembe &Musarandega, 2012:22; Ramnarain, 2011:99). Despite the fact that learner-centred teaching approaches have been proven to contribute immensely to the CtI, if they are not directly linked to transforming learning activities of learners, then teaching practices remain stagnant. Consequently, there is need to establish what contributes to the stagnation and anticipated ways of eliminating barriers to improve physics teaching in Zimbabwean high schools.

Rogan and Grayson (2003:1201) posit that in the PoI, teachers' actions, assessment and use of resources should all be examined in light of the extent to which they enrich the learning experience. The argument being driven home alludes to the fact that all the teachers' classroom actions, utterances and operations should be scrutinised in terms of quality service delivery to the learner. What matters most is establishing the actions that subscribe to the envisaged implementation operational levels and curriculum intentions.

However, the status of infra-structure, teacher qualifications, Language proficiency and management are hierarchically framed. However, in reality it is possible that a poorly resourced school can perform better than a better resourced school and could have a better management than a better resourced school. Thus, there are a number of possible permutations which are not covered in the Rogan and Grayson's theoretical framework. This is a critical limitation of Rogan and Grayson theory of curriculum implementation.

Rogan and Grayson's theory of curriculum implementation is inspired by ideas by Verspoor(1989), De Feiter, Vonk and van den Akker (1995) and Beeby (1996) who takes due cognisance of different settings. The theory also utilises ideas propounded by Levin (1987) and Loucks-Horsely, Hewson,Love and Stile (1998) who project that concentrating on building and consolidating strengths as opposed tocorrecting the individual's weaknessesis more critical.The idea being projected is focusing on sprouting an individual's strengths pays better dividends than investing resources on rectifying individual weaknesses. Building on strengths requires the establishment contemporary practices emanating from the classroom practioners, learners and school contexts. The raised ideas from the authorities have been a pillar of strength and motivation for Rogan and Grayson's 2003 theory of curriculum implementation. Rogan and Grayson's 2003 theory is hinged on the need to recognise current reality and then move on to reinforce the strengths of different components of the educational system such as learners, teachers and the school context. The theory attempted to broaden the focus of curriculum development and implementation with special attention on the teaching aspects, the teacher as the executer and the school environments. The next section examines the Zone of Feasible Innovation and PoI.

2.3.2 Zone of Feasible Innovation and Profile of Implementation

Rogan (2007:451) claims that the Zone of Feasible Implementation (ZFI) is composed of purported new teaching and learning practices that develop as a reaction to calls for innovation and are feasible and attainable, taking cognisance of the capacity of the school. The ZFI can be taken to be current teacher practices to address the demands of the innovation, which is the area that needs to be focused on. Rogan and Grayson (2003:1195) claim that innovation has better chances of succeeding if it takes place just beyond current practice and is executed within the capacity of the practitioners. Figure 2.2 is an attempt to give a clear indication of routine teacher practices, the ZFI and the curriculum intentions.

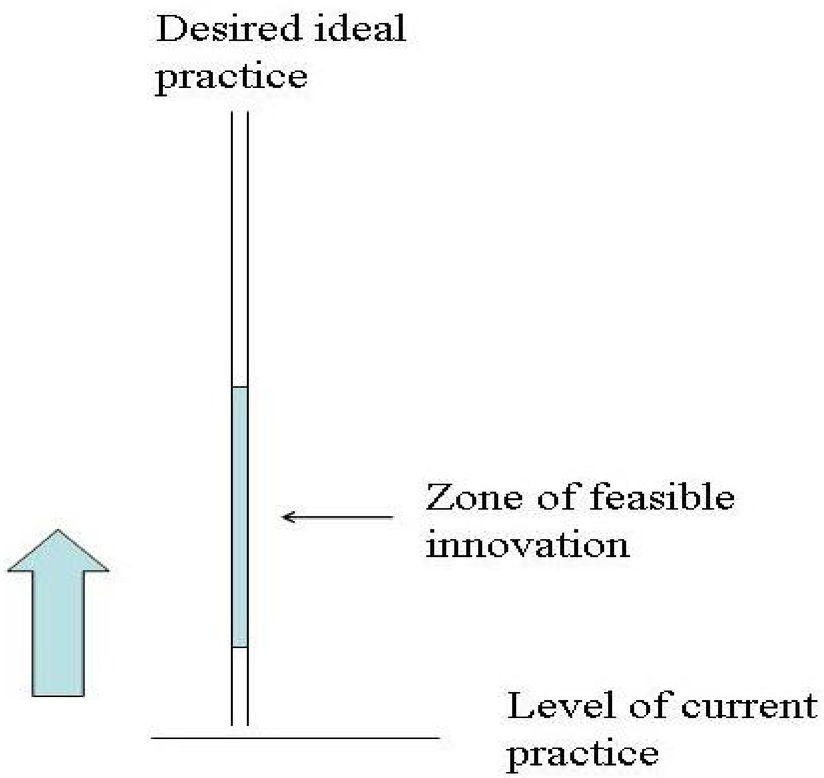

Figure 2.2: The location of ZFI on a continuum (Rogan, 2015).

The ZFI can be considered a series of strategies beyond normal practices that are steps towards the attainment of the envisaged expected curriculum intentions. Based onthe figure,the ZFI could represent a scenario where the physics teacher encourages learners to undertake typical textbook experiments to promote limited inquiry. With respect to classroom interactions, the situation could be likened to Zimbabwean teachers practising transmission strategies to deliver content, but in the process employing learner presentations as a step towards learner-centred teaching strategies. Taking the ZFI as the gap that exists between current practice and the desired curriculum intentions, identifying current Zimbabwean physics teachers' practices will make it possible to locate the ZFI for the revised Zimbabwe Advanced Level Physics curriculum.

However, Rogan (2006:449) claims that the ZFI is based on the assumption that teachers have the final say as to the pace and extent of the introduction of new practices and content. According to Rogan (2006:457), the ZFI is a direct challenge to the practice of mandating implementation policy at the macro level, a practice that is rampant in developing countries typified by Advanced Level Physics. The ZFI is concerned with giving more responsibilities in decision making and implementation strategies on the micro-level. This situation may not be attainable on the ground in the Zimbabwean education system where curriculum development is highly centralised. Nevertheless the importance of the ZFI to this study will be tackled.

The ZFI borrows heavily form the zone of proximal development orchestrated (ZPD) by Vygotsky. The ZPD describes the actual level of development of a learner as ascertained by the individual problem solving capability and the next level attainable through engagement with contextual tools and capable peers, Vygotsky, (1978:86).The idea projected is that persons learn best working collaboratively with others and it is through such collaborative endeavours with more skilled individuals that learners grasp and internalise new concepts. Hence, teaching should be directed towards learning activities within ZPD, which the learner cannot tackle on his/her, own, but has the capability to achieve with the help of capable others. This becomes the basis for promoting and advancing personal learning. Zimbabwe physics teachers could take advantage of knowledgeable colleagues through peer engagement to enrich their current practices and master the physics curriculum intentions.

2.3.2.1 Significance of Zone of Feasible Innovation to the study

The ZFI provides abasis to determine the knowledge base for growth byascertaining success or lack of it in terms of translating the Advanced Level Physics curriculum into practice. It also acts as the optical lens through which one can determine teacher effectiveness with respect to progression made through the levels of operation. In some way it will give a measure of the level of practices or competencies prevailing in the Zimbabwean Advanced Level Physics education course, when measured against respective sub-construct levels of operation. It will also enable the determination of current practices, quality of physics teachers and school authorities currently on the ground, based on the provisions ofthe sub-constructs as to what is considered good practice. Last but not least, it should portray a clear picture of what is achievable in relation to the capacity of the teachers and make it feasible to figure out the ZFI of a particular school.The next section will explore the anticipated relationship between CtI and PoI.

2.3.3 Relationship between Capacity to Innovateand Profile of Implementation

Rogan and Aldous (2005:322) and Rogan and Grayson (2003:1196) suggest that CtI should be developed at the same time with strategies to roll out the PoI. This is supported by Carl (2012:111) who claims that effective dissemination is critical for the creation of an environment conducive for the intended change and preparing all practitioners for it. Curriculum dissemination is the preparation of curriculum users through distribution of information pertaining to the innovation to acquaint them withthe proposed innovation (Carl, 2012:111).The idea isthat all teachers need to be well informed and involved, to prepare them to make informed decisions on executing PoI. Ndawi and Maravanyika (2011:72) claim that the school environment, resource and support availability will shape what a teacher can accomplish or fail to attain, when putting the curriculum into practice. This serves to highlight how the CtI is a critical component of the PoI. It is therefore prudent to establish the contextual situations in Zimbabwe's high schools and determine the extent to which capacity factors influence implementation. Rogan and Aldous (2005:322) predict a relationship between the PoI and the CtI, suggesting that the ZFI will widen as the capacity is increased. This may imply that training teachers in requisite skills focusing on innovation implementation, such as designing experiments, may enhance their capabilities to embrace better teaching practices.

Rogan and Grayson (2003:1196) also warn that too much pre-occupation with aspects of capacity building without linking it to implementation can prove disastrous. Indications are that planning in capacity building should take cognisance of the level of implementation. For instance, it has become common in some Zimbabwean schools to find computers unpacked and locked up in the headmaster's office – unused because there is a lack of trained personnel and electricity (Konyana&Konyana, 2013:9). There is a dire need to establish the level of implementation of the Zimbabwean Advanced Level Physics curriculum and have the capacity in place before more material resources are injected into the high schools. However, CtI is not given due consideration in some developing nations (Fullan, 2007:91; Nkosana, 2013:69). Policy pronouncements are enunciated through syllabus documents and it is incumbent upon the teachers to either fail or succeed. The next section examines the OIs whichaffect the PoI and the CtI.

2.3.4 Outside Influences, Profile of Implementation and Capacity to Innovate

OIs should be based on the potential to implement and on the real implementation process (Rogan & Aldous, 2005:323; Rogan & Grayson, 2003:1197).The prescription being hinted at is that OIs need to be guided by the PoI and the CtI in all cases. In the case of material support for example, it is not necessary to dish out computers to schools that do not have electricity. Likewise, there is no need to conduct seminars for teachers on laboratory work if their schools have neither science laboratories nor equipment. It maybe necessary to offer improvisation techniques and workshopsfor teachers so that they can still do practical work. This option should be pursued. However, OIs should be sought whentheyadd value to the PoI and the CtI. Consequently, it is pertinent to this study to examine the nature of OIs on Zimbabwean high schools and its congruency with the implementation of the Advanced Level Physics curriculum and the capacity to support the suggested reforms. The possible inconsistencies or gaps could be utilised to take informed corrective measures, such as matching the needed outside support to a known level of operational practice and available resource capacity in a particular school.

Rogan and Grayson (2003:1197) go further to assertthat even in situations where support is non-material, OIs should be informed by the PoI and CtI. They cite a scenario where the teachers have weak content knowledge and the school has no material resources and suggested that conducting workshops on assessing laboratory work in such a situation would most likely have no value for the teachers. The idea being emphasised is that OIs should be informed by the level of implementation and the CtI. Rogan (2006:448) claims that professional development should be targeted at the level of implementation determined by the teachers and it should be within the ZFI. Incidentally, it should be highlighted that any intervention should be informed by the teachers' interests and needs and that it should fall within their ZFI, taking advantage of skills already mastered. Establishing the strengths of Zimbabwean Advanced Level Physics teachers through their current practices would be vital in taking them on board to determine their training needs. These could form the basis of a teacher professional development framework. Figure 2.3 shows the relationship between PoI and CtI.

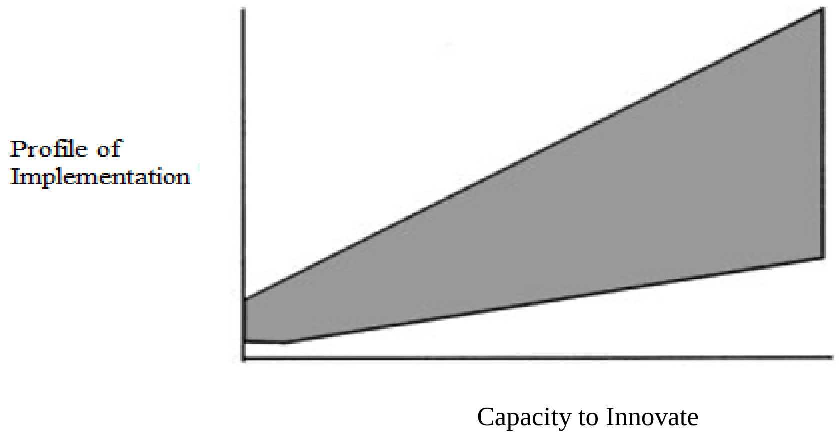

Figure 2.3: The relationship between Profile of Implementation and Capacity to Innovate(Rogan, 2006)

The figure indicates that as the CtI increases it is likely that a greater PoI is attainable.Rogan and Grayson (2003:1197) proposethat there is a need to change the focus of CtI as time goes on. They suggest that the initial stages may concentrate on the development of capacity and then shift more directly towards the PoI. This could be taken to mean that when basic capacity support has been mobilised, it becomes prudent to focus on how existence or non-existence of support efforts in schools support or hinder teacher practices in the Zimbabwean context. The establishment of the support levels or lack of support availed to the physics teachers would determine the possible remedies to be suggested to alleviate the prevailing situation. Rogan and Aldous (2005:323) suggest that outside interventions are often created by OIs and are forced on schools regardless of appropriateness to context. This is an unfortunate development that does not take into consideration the capacity of schools to implement a specific innovation to the expected level. This scenario could be a recipe for disaster. Hence, it is of interest to see how OIs impact on the implementation of the Advanced Level Physics curriculum.

2.3.5 Re-conceptualisation of the revised physics curriculum

Key stakeholders in education, particularly teachers, should be afforded the opportunity to make sense of the intended innovation for their benefit and that of the innovation itself. All key stakeholders, particularly those at the forefront of the implementation process, should be afforded the opportunity to understand and internalise the curriculum changes with due regard totheir own environments (Carl,2012:111;Ndawi&Maravanyika, 2011:71;

Rogan,2007:118; Rogan & Grayson, 2003:1198).Carl (2012:112) claims that effective dissemination is a critical ingredient for effective curriculum implementation whiledefective dissemination is a recipe for ineffective curriculum implementation. The thrust is that key stakeholders, especially those at the forefront like teachers, need to internalise the envisaged changes in curriculum innovation and adapt them into their own school situations.For this purpose, teachers should develop their own understanding of the revised Advanced Level Physics curriculum and put it into practice from their own perspective and their contextual setup. Marshy (2009:80) refers to this process as the acquisition of conceptual clarity and suggests that the conceptual clarity is critical to project success and continuation must be achieved during the process of project dissemination.Fullan (2007:105) supports the idea by warning curriculum designers not to assume that what is on paper is what is going to be translated into action; rather, they should be prepared to negotiate with curriculum implementers during curriculum dissemination. Failure to adequately empower teachers during the dissemination process may lead to defective curriculum implementation. The thrust is on the realisation that what eventually transpires in the classrooms is the Zimbabwean physics teachers' understanding of the Advanced Level Physics curriculum and not necessarily what is prescribed in the syllabus document. Zimbabwean curricula are centrally designed and propagated to schools through circulars and syllabi with very limited teacher consultation; teachers are expected to implement faithfully. This depicts inadequate dissemination, making the implementation of the teacher very difficult. Hence, the physics teachers' understanding of the physics curriculum needs to be established since it has much bearing on the learning experiences that are givento the learners.

Rogan and Grayson (2003:1200) comment that if implementation occurs within the ZFI, and then this zone must be identified by those who are at the forefront of implementing the changes. They further suggest that the PoI can be handy in the process by serving as a roadmap withwhich teachers can monitor progress made and what they are likely to undertake in the near future. In essence the decision to take on board an innovation, when to start, what to practise and the pace of proceeding with the envisaged changes rests with the teachers. According to Carl (2012:117) dissemination enables teachers to overcome their shortcomings, develops confidence and fosters smooth implementation. Consequently, effective dissemination empowers teachers as curriculum implementers. Fullan (2007:91) claims that in some situations adoption is more critical than implementation due to political expedience. Teachers may not be afforded the luxury of making decisions but have to take on board decisions from curriculum designers. Ascertaining environments in which Zimbabwean Advanced Level Physics teachers work, together with determining opportunities and prevailing challenges, can be an opportunity for mapping out possible intervention measures.

2.3.6 Changing teaching and learning practices and school culture

Embracing new teaching and learning strategies should be considered as a change of culture (Fullan, 2007:152; Nkosana, 2013:73; Rogan & Grayson, 2003:1200).This statement suggeststhat changing teaching and learning experiences should be considered as a change of ways to conduct business.Rogan and Grayson (2003:1200) contend that the anticipated changes challenge the existing notion of what constitutes teaching and learning. Implied is the idea that the entrenched beliefs about teaching and learning have to change in view of the new intentions or vision. Of note is the need to move away from traditional transmission of ideas or concepts to learner-centred approaches, which is the current drive in the Advanced Level Physics teaching. This move needs to be embraced and harmonised with the teachers' beliefs and the respective schools' contexts. There is a need to transform the culture of schools, teachers' skills and practices and the local communities' views (Fullan, 2007:111; Ndawi&Maravanyika, 2011:72; Nkosana, 2013:73).

Cultural values are dynamic and the local community has to agree to take new values on board. This process needs time and consultation; it is not an easy task. Nkosana (2013:73) is of the view that educational reform goes beyond mere implementation of a curriculum and may require changing the culture of the whole education system and practices. This involvestaking on board new practices which may require a different approach to the way of conducting business by the teachers and the local community. It is through the cementing of the new shared cultural values that the innovation will take root and bear fruit. The current study intends to determine whether key stakeholderssuch as the teachers, have a shared vision and commitment to the implementation of the revised Advanced Level Physics curriculum.As a nation that is struggling to shake off the deep-rooted implanted values of colonial education, it would be of interest to establish whether Zimbabweans havea common vision.For instance, the idea to embrace the physics teacher as a facilitator rather a transmitter of knowledge should be acceptable to teachers, learners, school authorities and parents. Failure to appreciate this new approach by one or more groups of key stakeholders will result in a discord that is bound to stall progress. The next section examines the position of the teacher in the theoretical framework.

2.4 THE TEACHER AND THE THEORETICAL FRAMEWORK

The teacher is the key player when it comes to puttingthe curriculum into practice. The teacher is critical in ensuring that learners enjoy maximum benefits from learning scenarios. Fullan (2007:129) and Thijs and Van den Akker (2009:34) assert that curriculum innovations are realised through changes in teacher beliefs, practices and thinking. Hence, it is pertinent to have an idea of what the teachers believe in and think since it is the basis of their practices. Thijs and Van den Akker (2009:34) suggest that teachers could benefit from arousing interest through engaging learners in active acquisition of knowledge such as practical work activities, classroom interaction and group work. The preceding strategies have been deemed to be quite pertinent in terms of enriching the teachers' operations and practices leading to maximum residual benefits for both the teacher and the learner. Fullan (2007:97) claims that interaction is the fundamental basis for social learning. Implied is the idea that social sharing of ideas with peers is instrumental to learning within institutions and communities.

Some prominent authorities have elaborated on the need to conceptualise changes according to the school situation and context (Fullan, 2007:153; Rogan, 2007:118).This means understanding the revised Advanced Level Physics curriculum and putting it into proper perspective within the capacity of the school in which one is working. Skills and knowledge gained by teachers as they try out new ideas and strategies may act as motivation for the attainment of the ideal curriculum innovation practices. Teachers should see and realise the need for change for effective implementation to take place. This is likely to be attained when the three constructs are considered concurrently during the implementation.

Thijs and Van den Akker (2009: 29) talk of teachers collaborating bysharing ideas, experiences, working together and helping each other out and spending time in staffroom deliberations. Such platforms are believed to be a critical source of knowledge about how to teach and handle challenging situations in classrooms or scenarios around the general work place. This learning-in-practice phenomenon can be used to ascertain, account for and explain the type and quality of interactions occurring in schools and the level of implementation taking place in different schools.

2.5 FURTHER STUDIES GUIDING THIS RESEARCH

This section deliberates on previous studies deemed relevant to guiding this study. These will take on board studies on curriculum implementation, teaching and learning, innovative teaching approaches, teacher-related factors, school climate indicators and professional development studies. The whole idea is to contextualise and justify the need for the current study and its intended contribution to the existing body of knowledge.

2.5.1 Studies on curriculum implementation

Elmas et al. (2013) studied the effect of science reforms on the teachers who were implementing them in Turkey. The study used interviews and observations to solicit data from 18 secondary science teachers. The main finding was that curriculum innovation intentions were not aligned with the investment made in human capital and material resources. The main limitation of the study was that it relied on qualitative data only and used a small sample. The researcher intends to carry out a similar study in Zimbabwe using a survey and a large sample to ensure the findings are generalisable. Both qualitative and quantitative data will be sought through survey questionnaire, interview guide and documentary analysis to get a holistic picture of the prevailing situation.

Ramnarain and Fortus (2013) undertook a study to establish South African physical science teachers' perceptions of new content in a revised curriculum employing a mixed methods approach. A sample of 660 physical science teachers was engaged. A structured questionnaire and an interview guide were used to gather data. The researchers established that the teachers lacked content knowledge on the new topics which compromised their pedagogical content knowledge. This study intends to extend the findings of the above study by establishing Zimbabwean physics teachers' perceptions of the revised Advanced Level Physics curriculum, which is in a different context and a higher level of operation.

In the same vein, Raselimo and Wilmot (2013:13) studied how teachers interpreted a curriculum reform initiative in Lesotho. They used an interview guide, observation guide and documentary analysis. The study solicited data from 11 teachers in this instance. Theresearchers found that there was lack of alignment between the macro-curriculum intentions and the micro-curriculum construed by the teachers and that the organisational structures within the education system adversely affected curriculum implementation. Thestudy provides insights into how teachers interpret and implement a specific curriculum in a given context. Raselimo and Wilmot (2013:13) suggest that changing the curriculum calls for the creation of supportive structures in the system to handle the change and that there is need for further research on how teachers in other subjects interpret curriculum change. The scenario provides a platform for this study to establish how Zimbabwean physics teachers interpret the physics curriculum with respect to the Zimbabwean context, since very little has been undertaken in this regard.

2.5.2 Studies on teaching and learning

Jetty (2014) investigated the variations observed in secondary science teachers' implementation of reform-based instructional practices in the United States of America. A sequential mixed methods approach was used for the study involving 120 participants. A survey closed questionnaire and an interview guide were employed to collect data. The main finding was that the teachers' professional background, beliefs and the school context had considerable bearing on teachers' utilisation of reform-based instructional practices. This particular study was conducted in a developed country. The currentstudy intends to contribute to literature by extending the Jetty (2014) study to a developing country under a harsh economic environment.

Buabeng (2015) investigated the practices for teaching physics in New Zealand high schools and how they could be improved,usingthe mixed methods approach. The study employed the survey questionnaire, classroom observations and interviews and enlisted the services of 104 participants. One of the key findings was that there was no alignment between curriculum intentions, which promote inquiry-based science teaching and learning, and how physics was actually being taught. This study intends to extend the findings through establishing Zimbabwean physics teachers' current inquiry-based physics teaching practices and the challenges they encounter in a different environment.

Tawana (2009) explored the implementation of the new Botswana government's Certificate in Secondary Education. Specifically the study focused on the teaching practices intended to improve learners' learning of chemistry. A case study research methodology was used that enlisted the participation of 11 chemistry teachers. Rogan and Grayson's (2003) theory of curriculum implementation was used to guide data collection, analysis and interpretation. The main finding was that the chemistry teachers were operating at low levels in the science practical work and contextualisation dimensions. The presentstudy will extend those findings byusing a larger sample and by using a different discipline – physics – as the medium for establishing current teacher experiences and practices in implementing the revised Advanced Level Physics curriculum in Zimbabwe.

Chabalengula and Mumba(2012) studied Zambian teachers' conceptions of inquiry-based learning, inquiry levels in the national science curriculum materials (syllabi, textbooks and practical examinations) and the extent to which inquiry tasks and skills were emphasised in the science curriculum materials. The survey study involved 12 high school teachers and documentary analysis. The main finding was that the Zambian physics teachers have a restricted understanding of inquiry and that there was inconsistency in coverage of inquiry skills levels in the physics curriculum and practical examinations. The limitation of the study is the number of participants. Thecurrent study intends to extend those findings by using a larger sample in a different context to establish teacher interpretation of inquiry levels in physics curriculum, practical examinations questions and inquiry-based physics teaching practices in Zimbabwean high schools.

2.5.3 Studies on teacher factors

Belo et al. (2014) used a survey to study physics teachers' beliefs about the goals and pedagogy of physics education in the Netherlands. They used a sample of 126 physics teachers and enlisted the services of an online questionnaire that was characterised by a low response rate. The study had a limitation in that it relied on only the questionnaire for data collection. One of the study's main findings was that teachers valued both teacher-centred and learner-centred learning approaches. Teachers' perceptions and practices are multi-dimensional constructs usually underpinned by a specific environment.The afore-mentioned study was conducted in a developed country; it would therefore be of interest to investigate how the physics teachers' practices manifest themselves in the Zimbabwean context, complementing the questionnaire with interviews and documentary analysis. Since perceptions inform practice, it would be prudent to establish Zimbabwean physics teachers' perceptions ofthe new teaching and learning initiatives enunciated in the revised physics curriculum against traditional teacher-centred methodologies.

Lim and Pyvis (2012) investigated how Singapore junior college science teachers articulated curriculum reforms, using the grounded theory methodology. The study enlisted the services of twelve 12 participants. One of its main finding was that there was a mismatch between the reform intentions and the anticipated outcomes. From the study it is evident that the contextual settings have a bearing on the way teachers respond to instructional initiatives, hence the need to replicate the study in a different context, enlisting the participation of a larger sample. The Zimbabwe revised Advanced Level Physics curriculum has increased content knowledge when compared to the one it replaced, yet the nature and focus of national examinations has remained unchanged. It would be interesting to establish how physics teachers are reacting and adapting to this scenario and how it is influencing their instructional delivery in the classrooms.

2.5.4 Innovative teaching practices studies

Qhobela and KolitsoeMoru (2014) investigated factors contributing to the use of teacher-centred instructional practices in contrast with learner-centred methodologies in Lesotho high schools. A case study approach involving four physics teachers was adopted for the study. Data was gathered through written responses and audio and video recordings. The main finding of the study was that teachers resorted to teacher-centred instructional strategies as a result of inadequate pedagogical content knowledge. The limitation of the study is that it used a very small number of participants. The researcher intends to replicate that study using a survey with a larger sample to make the findings generalisable.

Ng and Nguyen (2006) investigated the extent to which physics teachers in Vietnam integrated practical work activities and contextual approaches to teaching and learning of physics. The study used a survey questionnaire and enlisted 20 participants. The study had limitations in that it used only the questionnaire for data collection hence there was no room for data triangulation. The study sample was small and as such the results are not generalisable. The main finding of the study was that the Vietnamese teachers cherished the benefits of hands-on activities and contextual instructional approaches to the learning and teaching of physics; however, the prevailing environment was not supportive of the teaching approach. The currentstudy proposesto extend the previous research using a survey questionnaire, an interview guide and document analysis to facilitate data triangulation. A larger sample will be used to make the findings reliable. This study intends to establish current physics teachers' practices in linking physics concepts to everyday life, challenges being faced and possible intervention measures.

Gwekwerere et al. (2013) conducted a study to establish how science teachers were employing contextualised science resources in the teaching of science in Zimbabwe. The study involved three chemistry teachers who had attended the Science Education Development Programme, an in-servicetraining initiative, in Zimbabwe. The three respondents were contactedthrough telephone interviews and e-mails. One of the main findings was that the participants had embraced contextualised science teaching approaches in their science lessons. The study was limited in that the number of respondents wassmall, it did not look into the operational levels of linking science concepts with everyday life, and the researchers did not discuss the area of actual practice. For these reasons,this particular study may not necessarilygive a realistic representation of the perceptions of Zimbabwean teachers who attended the Science Education Development Programme. Hence, there is a need to establish teachers' views, experiences and practices with respect to linking physics concepts to daily life using a larger sample to make it more representative and employing different data collection techniques to authenticatedata collected.

2.5.5 Information Communication Technology studies

Ndibalema (2014) investigated Tanzanian secondary school teachers' attitudes towards the use of ICT as a pedagogical tool. The study used a mixed methods approach, enlisting the services of a survey questionnaire and an interview guide. The study had 80 participants. One of the main findings of the study was that teachers had positive attitudes towards using ICT as a teaching tool, but they did not effectively integrate ICT into theirteaching. One of the limitations of this study was that it did not look into existing teacher practices. The researcher intends to extend this study by examining current ICT integration practices in the teaching of Advanced Level Physics in Zimbabwean high schools.

Aderonmu and Obafemi (2015) studied the physics teaching practices in Nigerian secondary schools. A descriptive survey design was utilised and 92 participants were purposively selected for the study. A survey questionnaire was employed to gather data. One of the main findings was that physics teachers did not use ICT equipment in the teaching of physics. One limitation of the study is that it relied on the questionnaire as the only instrument for data collection. The present study intends to extend that research by using a survey questionnaire, interview guide and document analysis guide to collect data on the actual physics teachers' practices in integrating ICT tools in physics instruction in Zimbabwean high schools.

Mlambo (2007) investigated the use of ICT in Advanced Level Physics teaching in Manicaland, Zimbabwe. The study used a case study approach involving 15 participants. Questionnaires, interviews and focus group discussions were enlisted for the study. One of its main findings was that ICT was not being used effectively in the teaching of Advanced Level Physics. The study involved a relatively small number of participants and was restricted to one region of the country. The current research aims to extend this study by using a larger sample and involving high school physics teachers from four educational provinces of Zimbabwe.

2.5.6 Studies on school climate

Ronfeldt, Farmer and McQueen (2015) studied the type of collaborations that manifested in instructional groups across theMiami-Dade district in America and their relationship to learner attainment. The study utilised a mixed methods approach. They employed a survey that took on board 9000 teachers in 336 schools for a period of two years. Data was solicited through a survey questionnaire, observations and learner test scores. One of the findings was that substantial learner gains were attained in schools that had greater collaborative environments and classes under the guidance of teachers who were good collaborators. This study was conducted in a developed country and it would be of interest to establish the conditions under which the physics teacher clusters are operating in Zimbabwe and their impact on learner achievement.

Oyedele, Chapwanya and Fonnah (2015) investigated the influence of the school headmaster's type of leadership on the performance of teachers in the Bikita school district in Zimbabwe. The study enlisted the services of 10school heads and 60classroom practitioners. Data was sought through a survey questionnaire and a structured interview guide. One of their findings was that the style of leadership employed by the school head had a profound influence on the performance of teachers under their guidance. The study had a limitation in that it was conducted in only one school district in Zimbabwe and findings may not be generalised. The currentstudy intends to extend this study through determining the school climate and how itinfluences the teaching and learning of Advanced Level Physics in four educational provinces of Zimbabwe.

2.5.7 Professional development studies

Grayson and Kriek (2009) studied the effect of the Holistic Professional Development (HPD) model on practising physical science teachers in South Africa. They used aqualitative approach together withmultiple case studies. The study was conducted over four years and had 75 participants. The data collection process involved classroom observations, assignments activities, questionnaires and pre- and post-tests. Grayson and Kriek (2009:199) established that the HPD model was effective in improving teacher competencies in content knowledge, instructional strategies and professional attitudes. The present research intends to re-focusthatresearch byestablishing what opportunities are available to Zimbabwean high school physics teachers for professional development, the needs for professional development, and how and where the teachersexpect to be capacitated in their areas of weakness. This may assist in modifying the current design of the professional development model to address changing needs of physics teachers.

Pitsoe and Maila (2012) conducted a desk study to interrogate professional development in the constructivist framework. They suggested that teacher professional development should be guidedby contextual approaches. This is also supported by Ferreira (2014), who investigated the effectiveness of the context perspective in teacher professional development. The study involved 11 participants undertaking a professional development in a national park with a facilitator. The research utilised observations, focus group discussions with the teachers and interviewswith the facilitators to collect data. The main finding was that the contextual professional development approach was very effective. The researcher advocated for a teacher professional development strategy that is contextualised and interactive. Alimitation of the study may be in the small number of participants involved, making it difficult to generalise the findings. This study intends to use a larger sample and establishing Zimbabwean physics teachers' current professional practices and how they expect these practicesto be improved. To date, very little if any research has been undertaken with respect to Zimbabwean physics teachers' professional development activities. This research intends to engage Zimbabwean physics teachers to identifya needs-based staff development strategy embracing the Zimbabwean context. The strategy would be recommended for use in alleviating the weaknesses identified by the teachers and to enhance their skills and knowledge to teach effectively.

Chavhunduka (2005) used a survey to study the role of resource teachers in improving the teaching of advanced level sciences through professional development in Zimbabwe. He employed a case study approach which enlisted the participation of nine resource teachers. One of his main findings was that the resource teachers were very keen to participate in PCK workshops conducted. He recommended that further research studies be conducted to establish the effect of the skills acquired by the teachers during PC workshops, on their practices in the field. A possibleshortcoming of Chavhunduka'sstudy was the sample size of nine respondents. The presentstudy will extend this research byusing a larger sample to investigate current physics teachers' interpretation and implementation of the physics curriculum against the backdrop of the unprecedented brain drain in Zimbabwe.

2.6 CHAPTERSUMMARY

Rogan and Grayson's (2003) theory of curriculum implementation is the main lens through which the study will be focused. The framework offers a window through which physics teachers' practices can be interpreted and analysed by exploiting the three constructs and establishing areas that require support for teachers to be effective. Very little to date is known about the practices of teachers of Advanced Level Physics in Zimbabwean high schools, and it is hoped the study will add insight into this aspect of education. The framework employed has the potential to unravel gaps that exist in Zimbabwean physics teachers' practices and may shed light on the interplay of the three constructs in the Zimbabwean context. Some studies considered relevant to shaping this study have been highlighted as grounding to inform and guide this study in its endeavour to unravel the Zimbabwean physics teachers' perceptions, experiences and current practices in a holistic manner. The next chapter focuses on the Zimbabweaneducation system, with emphasis on the unfolding of science education.

CHAPTER 3
THE ZIMBABWEAN EDUCATION SYSTEM

3.1 INTRODUCTION

This chapter is going to attempt to bring the dynamics and transformations that have shaped the education system in Zimbabweinto context. This education system has undergone significant changes as it has transformed from a colonial education legacy into a democratic dispensation. The discussion, therefore, traces the development of educationin the country from the pre-independence education system to the existing one. The chapter reveals how some of the precedents and antecedents have had strong bearing on the current beliefs, perceptions, values and practices of Zimbabwean physics teachers.

3.2 PRE-INDEPENDENCE EDUCATION SYSTEM

The pre-independence education system in Zimbabwe was based on the promotion of white supremacy. As such, a dual system of education existed. According to Kanyongo (2005:65) and Shizha and Kariwo (2011:17), this system of education was meant to ensure that the Africans would not be in competition with their colonial masters. This stance ensured that education afforded to Africans would not make them compete with the whites in social, economic and political spheres. This obviously indicates the contempt with which the government of the day held Africans. This was subsequently reflected in the quality of the education given them, which wasconsiderably lower than that of their non-African counterparts. This precedent set the stage for the differences in education provisions in terms of curricula, material, human resources and access to education for different races in the then Rhodesia.

The dual system of education that prevailed ensured that the non-African child was well catered for while the African child was impoverished in terms of education provisions. The African secondary education was designed in such in such a way that it served white interests by ensuring the creation of a large pool of cheap labour (Shizha&Kariwo, 2011:18;Peresuh&Nhundu, 1999:25).This implies that the kind of secondary education Africans received was strategically crafted by the white education administrators to guarantee the existence of an abundant labour force that would maintain the efficient functioning of industry, commerce and agriculture. Gatawa (1998:29), Kanyongo (2005:65), Peresuh and Nhundu (1999:25) and Shizha and Kariwo (2011: 18), claim that the African education in secondary schools mainly focused on the acquisition of elementary skills in agriculture, building and carpentry.Acquisition of such skills was instrumental in ensuring that African school graduates would become lower level service providers in industry and commerce. Those educated beyond these basic skills were presumably of great value in their native communities as they became teachers, nurses, clerks or joined the police force (Gatawa, 1998:29; Mavhunga, 2008:35). In this way, African secondary school graduates were elbowed out of the mainstream economy and the learning of science subjects needed in industry.

As if this was not enough, access and progression from one educational level to another level was highly restricted for the African child.Kanyongo (2005:66) points out that African education was mainly in the hands of missionaries and there were few schools specifically meant for African secondary education. This clearly shows the white government was putting African education at the periphery.

Peresuh and Nhundu (1999:33) as well as Shizha and Kariwo (2011:22) argue that the 1966 Education Plan was merely a consolidation of discriminatory educational policies targeted at restricting access, transition and progression of the African child through various levels of education. In a way, the plan was an entrenchment of racial segregation in education provision. Gatawa (1998:23) and Shizha and Kariwo (2011:22) report that according to the 1966 Education Plan, secondary education was divided into three categories, namely the academic route(F1), the Industrial and Agricultural route (F2), and the non-formal route. They further point out that transition from primary level to secondary level was pegged at 12.5% for F1, at 37.5% for F2 and at 50% for the non-formal route. Such a scenario trivialised African child education provision, and worse still, the 50% (non-formal) candidates did not benefit at all. The 1966 Education Plan serves to give insight into the marginalisation of the African child with regard to education provision.

The 1966 Education Plan also created serious divisions among African children following the F1 and F2 routes respectively. Shizha and Kariwo (2011:23) comment that the F2 system of education was stigmatised as an alternative route for those who were academically challenged. Consequently it generated much resentment on the part of Africans, among both parents and the children who felt degraded by the F2 system of education (Gatawa,1998:23).The F2 system was an unwelcome development that was forced on the Africans by the government of the day and as such was bound to eventually meet its demise. According to Shizha and Kariwo (2011:23), only 2.5% of learners who embarked on the F1 route proceeded to advanced level education and were further critically screened before 0.2% was able to progress to university education. Extensive and robust measures were put in place to ensure that very few African children escaped through the bottle-necked education system.

In sharp contrast, no such restrictions were experienced by the non-African child. According to Kanyongo (2005:66) and Peresuh and Nhundu (1999:31), non-African education was compulsory, well-funded and enjoyed good infrastructure, abundant material resources and highly qualified teachers in almost all subjects. These authors note that there were no restrictions in terms of progression from one level to another since there were no terminal examinations such as those that existed for their African counterparts, such as the Grade 7and Junior Certificate levels. The non-African child's education was spoilt for choice of resources and the system was open for smooth progression from one level to another, in commerce and agriculture (Peresuh&Nhundu, 1999:26; Gatawa, 1998:15; Mavhunga, 2008:34), which guaranteed the learners high chances of success and maximum benefits. The curricula of the non-African education system were quite loaded – designed to churn out champions of industry, commerce and agriculture (Peresuh&Nhundu, 1999:26; Gatawa, 1998:15; Mavhunga, 2008:34).These curricula addressed the basic demands of the economy and ensured firm control of the Africans and the means of production. It was this imbalance between the two systems of education that the curricula of post-independence Zimbabwe sought to address. At the same time, this colonial legacy negatively impacted on the psyche of the Africans and proved to be a hindrance when it came to making informed decisions about what to include in curricula to make them relevant and pertinent to national realities.

In an attempt to diffuse tensions between non-Africans and Africans generated by the dual system of education, the short-lived Zimbabwe-Rhodesia government came up with the 1979 Education Act. One of the underlying motives of this act was to foster some element of integration and reduce polarisation between racial groups (Shizha&Kariwo, 2011:24).The act created three types of schools, these being government schools, community schools and private schools. So in a way, the 1979 Education Act was an attempt to appease restless Africans through a rearrangement of the existing education system setup, which unfortunately was still entangled with the zoning system. The zoning system restricted learners to learning at schools within their residential areas. So racial segregation remained entrenched in the education provision available to the African child. Shizha and Kariwo (2011:24) and Zvobgo (1998:60) state that government schools were further subdivided into three groups, namely Group A, Group B, and Group C, identified by the following features.

Group A schools

These were expensive schools attended by non-African students only. They were located in white suburbs where Africans were not allowed to own houses. They were also well-resourced in material and human terms, and enjoyed a low teacher–student ratio. Proficiency in English and academic ability were prerequisites for entry.

Group B schools

These had low fees, were designed for African students and were located in African residential areas. The infrastructure was substandard compared to that of schools in non-African areas.

Group C schools

Education in these schools was free, but parents were expected to contribute building materials, uniforms, books and stationery. They were mainly located in rural areas where the majority of Africans lived.

Judging by the features of the prescribed group of schools and the promulgated zoning system, the 1979 Education Act failed to promote integration because access was restricted by residence and financial muscle. Consequently, Group A schools remained non-African in terms of both the teachers' and learners' population. If anything, the 1979 Education Act managed to reinforce racial segregation in the education sector as it perpetuated the prevailing racial setup. However, the Act had far-reaching consequences in terms of labelling schools as A, B and C, and in its failure to respond to new realities. Attaching labels to schools may have instilled attitudes in people with respect to school capacities and capabilities to offer sound learning experiences and possibly an array of avenues of employment opportunities.

The pre-independence education provision for the African child was racially inspired and designed for the maintenance of white supremacy. The African children had very little in terms of access or material support, whilethe whites enjoyed unlimited access to well-funded and well-resourced schools. The curriculum was heavily skewed in favour of whites, with Africans subjected to a rudimentary curriculum which prepared them for menial jobs. This scenario set the stage for drastic changes in a bid to overhaul the education system soon after the attainment of independence.

3.3 POST-INDEPENDENCE EDUCATION IN ZIMBABWE

The new post-independent Zimbabwe African National Union (ZANU) government decided to utilise education as a medium for social transformation. According to Gatawa (1998:16), Kanyongo (2005:66) and Runhare in Shizha (2013:17), the new government was guided by scientific socialism and education was declared a basic human right. This implied that every Zimbabwean citizen could access and enjoy education. The new government took upon itself to establish schools in rural areas and disadvantaged urban areas. This was a mammoth task; however, the new government had a strong conviction that education would be the bedrock for economic growth, effective land use and for raising the living standards of citizens, as well as creating employment opportunities (Gatawa, 1998:16). However, Gatawa (1998:16) maintains that in the effort to democratise education, sciences and practical subjects requiring specialist rooms and skilled teachers suffered. The lack of science laboratories, equipment and qualified science teachers laid a poor foundation for the teaching of sciences at higher levels. However, it should be acknowledged that at least some milestones in terms of availing opportunities and access to education for most African children had been reached. The massive expansion in school enrolments was, however, not matched by a corresponding investment in human and material resources; hence the quality of teaching and learning was affected, especially with regard to science subjects at senior secondary level.

Maravanyika (1990:16) and Mavhunga (2008:40) argue that the unprecedented mushrooming of private schools with high fees occurred to discourage Africans from intruding into the predominantly white schools. In this way, segregation remained entrenched based on parents' financial muscle. Very few African children, apart from the offspring the new crop of African leaders and company executives, could afford the exorbitant fees charged by these private schools. Quality education remained a preserve of the privileged few. Kanyongo (2005:66) notes that the overwhelming enrolment of students in urban day schools required these schools to resort to double sessions. The school infrastructure and material resources were subjected to serious pressure, leading to fast dilapidation of buildings and a critical shortage of trained teaching staff. All this had a strong bearing on the quality of education provided to the learners at the end of the day. Resorting to double sessions meant reducing the learning time of the learners, which had serious consequences on the provision of science and mathematics education in the schools. This scenario laid a shaky foundation for the learning of science and mathematics at the senior secondary level.

To substantiate the massive educational expansion and enrolments experienced in schools, the following serves as a classic example of the scenario. According to Mudhenge(2008:4), the number of primary schools increased from 2401 in 1980 to 5 690 in 2008, while learner enrolment jumped by from 819 586 in 1980 to 2 445520 in 2008. He further argues that number of secondary schools increased from 177 in 1980 to 2 182 in 2008, and that Advanced Level schools increased from a paltry 58 in 1980 to 711 in 2008. This was a phenomenal rise that left the government of the day with the daunting task of providing adequate infrastructure, material and human resources. In an attempt to address the human capital gap, the government took on board several initiatives, some of which are discussed below.

In a bid to address the critical shortage of teachers in the primary school sector, the government introduced the Zimbabwe Integrated National Teacher Education Course (ZINTEC) in January 1981. According to Zvobgo (1998:85) ZINTEC was premised on teacher training techniques utilised in refugee camps during the liberation war in Mozambique and Zambia. Zvobgo pointsout that the course revolved around the integration of theory with practice and guaranteed that the student teacher learnt the skills of the trade on the job. This, it can be argued, was a home-grown programme designed to solve a specific need in a particular environment. Maravanyika (1990:17) and Zvobgo (1998:85) posit that the ZINTEC programme stipulated that the student teachers were to have more time in the schools with the learners and a shorter stint doing theory at college. The student teachers spent the first 16weeks in college before they were sent out to schools, and they continued to learn while in full control of a class at their stations. So the learners had the student teachers to guide them in just the basics in terms of learning theories, as opposed to entirely untrained teachers. However, it can be argued that the ZINTEC programme subjected the learners to half-baked teachers who may have done more harm than good in the long term. Whatever the case, the government should be commended for a spirited effort in ensuring that some informed para-professionals took care of the learners during such critical periods.

Chivore (1990:20) argues that the ZINTEC programme is one of the most celebrated post-independence innovations as it managed to reduce the shortage of primary teachers to a large extent. He goes further to suggest that its success was instrumental to the institutionalisation of the four-year teacher training programmes in Zimbabwean education colleges. This suggests that the ZINTEC programme was a relative success and produced tangible results. Currently, all Zimbabwean primary teacher training colleges have adopted a four-year teacher training programme, though the ZINTEC model has been somewhat modified. The student teachers now spend the initial two terms and final two terms in college and five terms in the schools under the guidance of a mentor (Musingafi&Mafumbate, 2014:35). This is an acknowledgement that the ZINTEC model of training teachers was quite instrumental and effective for the Zimbabwean primary school teacher training. What could be more pertinent to this study is the fact that the ZINTEC programme helped to provide qualified personnel at the primary school level. This was quite critical in establishing quality teaching at the foundation level, which could, in turn, provide a solid base for learning at the senior secondary level.

According to Maravanyika (1990:17), for the conventional teacher training colleges a four-year training programme was mooted, in which the student teacher had to undergo two years of theory and another two of teaching practice. Teaching practice was done during the second and fourth years. This arrangement ensured that the student teachers would spent more time with learners in the schools, boosting the number of skilled personnel and assisting the learners in both primary and secondary schools. For the secondary sector this was a worthwhile move since it provided a sound and solid teaching and learning foundation in preparation for senior secondary schooling. On the whole, the decision-makers made a great effort to ensure that skilled human personnel were available for the learners during such difficult times.

To address the critical shortage of Advanced Level teachers, a two-year Bachelor of Education course was introduced to upgrade science and mathematics teachers to prepare them to handle senior secondary classes. According to Maravanyika (1990:17) the programme was introduced at the University of Zimbabwe specifically to address the critical shortage of Advanced Level mathematics and science teachers. This was a welcome development, though given the magnitude of the increased number of learners it was a drop in the ocean. Maravanyika (1990:17) reports that the government embarked on the Cuban science teacher training programme, in which Ordinary Level graduates were sent to Cuba for five years to train as science and mathematics teachers. The student teachers were trained in a foreign language (Spanish) and were exposed to resources that were not available in Zimbabwean secondary school science laboratories. This proved to be a serious drawback when the new graduates returned to face the realities in the schools back home. However, the efforts to train science and mathematics teachers to handle the numerous high schools that had sprouted across the country were a move in the right direction. A reasonable number of teachers were produced to meet the learners' needs through these initiatives.

The inherited colonial curriculum had largely been condemned as irrelevant to the African child, since it was accused of being based on a capitalist philosophy. As a result the new government focused its energies on re-vamping the curricula to reflect new realities and relevance to the new social order. The government adopted Karl Marx's concept of polytechnic education with its envisaged thrust of marrying theory with practice. According to Chung and Ngara (1985:105), polytechnic education was designed to manifest itself through the concept of 'Education with Production' (EWP) throughout the education curriculum. It was strongly believed that EWP would give the Zimbabwean education system a new purpose. Chung and Ngara (1985:105) and Gatawa (1998:17) assert that EWP was supposed to ensure that all academic subjects had a practical component. Every subject studied at school was expected to demonstrate the link of the theory learnt with practice. It was a noble idea meant to transform Zimbabwean society through utilising education to solve societal problems.

According to Chung and Ngara (1985:106), EWP was first established in refugee camps in Mozambique and Zambia where it proved very successful. In the refugee camps learners spent half the day on academic work and the other half on productive work. The successes of the programme could have been motivated by the need to provide accommodation, furniture and food for the survival of the people concerned. Both teachers and learners involved were well informed on the fundamentals of the concept of EWP. The idea of EWP was brought into the new education system with the hope that it would produce the results that had been obtained in the refugee camps during the war period. However, Chitate, (2015:47) and Maravanyika (1990:19) maintain that EWP was poorly articulated by most teachers and varied interpretations of the concept were evident. Makaye (2014:98) and Maravanyika, (1990:19) suggest that EWP was limited to gardening and the rearing of chickens and rabbits in most schools. Apparently, such activities were closely related to the F2 system of education the Africans strongly objected to during the colonial era. Hence, EWP died a natural death due to poor understanding of the idea by both teachers and the society at large. The new government failed to do a proper job of enunciating the concept of EWP to the teachers and local communities, resulting in the demise of the idea. In essence unlike agriculture, science teaching and learning did not benefit from EWP at all.

Globally, science education is considered to be a significant contributor to socio-economic development. According to Vhurumuku, Holtman, Mikalsen and Kolsto in Holtman and Marshall (2008:223), investment in science education in developing countries is taken as a viable option to poverty alleviation, good health and participatory democracy. In this way, science education is a key ingredient to a good and prosperous social life in general. Zimbabwe was not to be an exception to this phenomenon, taking cognisance of the fact that the majority of the African population had been denied access to science education by the colonial government. In a bid to match other developing countries, Zimbabwe Science (ZIM-SCI) was introduced in 1981 to ensure that every child at secondary school had access to science education in an ordinary classroom.

According to Maravanyika and Ndawi (2011:157), the ZIM-SCI project was focused mainly on rural day secondary schools that lacked science laboratories, electricity and basic equipment for learning science. Maravanyika and Ndawi (2011:157) also posit that the ZIM-SCI project was an adoption of the research of Allan Dock, then a University of Zimbabwe lecturer, targeted at providing science education through distance learning. They further assert that basic kits of apparatus and chemicals accompanied with detailed teacher and student manuals were produced and distributed to schools. Quite a full package was prepared for possible meaningful teaching and learning of the ZIM-SCI course in the schools in an ordinary classroom by an untrained teacher. A handful of teachers were orientated to the innovative science teaching approach and were expected to go and pass on knowledge to their colleagues at their respective schools (Maravanyika&Ndawi, 2011:158). This represented

some effort interms of ensuring the innovative science teaching approach took root in teachers; however more could have been done by involving a larger number of teachers.
Maravanyika and Ndawi (2011:158) argue that the ZIM-SCI programme was riddled with its own fundamental challenges, among which were the following:

- there were few qualified teachers who actually understood what they were leading the learners through;
- equipment did not reach the schools in time;
- trained teachers found the guides too prescriptive as itrestricted their personal input;
- replacement of chemicals and broken items proved to be far more difficult than obtaining original kits;
- rural schools welcomed the project while mission schools and urban schools preferred to continue with the conventional approaches;
- cheap equipment caused people to be sceptical of ZIM-SCI, and preferred sending their children to established schools that taught science using the conventional approaches.

Despite the numerous challenges encountered in executing the programme, the learners in rural day secondary schools were able to access science education in the comfort of their schools. The ZIM-SCI programme exposed all learners to the three major disciplines of science (biology, physics, chemistry) forming the foundation for senior secondary sciences study. However, the quality of teaching and learning executed by mainly unqualified teachers and primary-trained teachers created a poor foundation for Advanced Level science learning. The cheap science tag associated with the ZIM-SCI was an unfortunate development that may possibly have undermined some of the gains made through this innovative science teaching strategy.

The post-independent Zimbabwe education system was characterised by massive expansion in terms of access to education by previously disadvantaged groups and abolition of racial segregation. However, quality education provision remained elusive for the majority of the African learners. In the same vein, efforts to reform the curriculum to make it more relevant to the new realities failed to bear any fruit hence the inherited colonial curriculum remained the bedrock of the Zimbabwean education system. While government intentions appeared noble, they were seriously affected by poor planning and implementation strategies. What is of significance, though, is the effort made in investing in teacher quality especially at Primary and Ordinary Levels that indicates commitment to provide quality education at the base, which is the ultimate feeder for the learning of science at the Advanced Level.

3.4 THE CURRENT STRUCTUREOF ZIMBABWE'S EDUCATION SYSTEM

Zimbabwe has two education ministries, namely the Ministry of Primary and Secondary Education, and the Ministry of Higher, Tertiary Education, Science and Technology Development. The Ministry of Primary and Secondary Education is responsible for early childhood development (ECD), primary and secondary education, while the other ministry is responsible for higher, tertiary and vocational education. The system starts with a two-year ECD, moves to a seven-year primary education, four-year Ordinary Level, two-year Advanced Level secondary education and tertiary education. Figure 3.1 below shows the structure of the Zimbabwean education system.

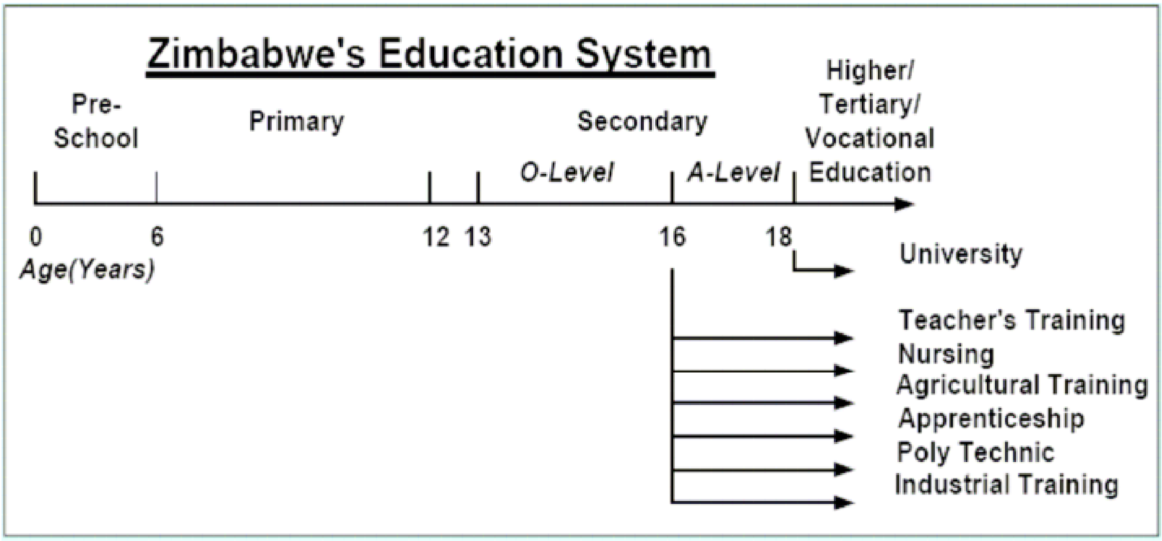

Figure 3.1: Zimbabwe's Education System (Chigwedere, 2005)

3.4.1 Primary education

The primary school level is a seven-year period and the official entry age is six years. It starts with Grade 1 and ends with Grade 7. Before enrolling for Grade 1, children are expected to go through ECD for two years. According to Mahere (2004:3) every primary school is expected to have at least one ECD class composed of four-to-five-year-olds, referred to as ECD (B) who would then proceed to Grade 1 in the following year. This is a preparatory class for Grade 1. He goes further to suggest that there should also be another class of three-to-four-year-olds known as ECD (A) whose graduates would proceed to ECD (B) the following year. So the learners are expected to spend at least two years in preschool. The maximum class size of the ECD class is 20and this scenario leaves numerous learners out of the care of the ministry (Boora, 2011:2).The government in a way is admitting failure to play its role in ensuring that children access preschool education. Boora (2011:2) further considers that the government has made very little progress in the attainment of this target; private players have taken advantage of the prevailing situation to offer preschool education in unregistered ECD centres. Mangwaya,Blignaut and Pillay (2016:799) and Moyo, Wadesango and Kurebwa (2012:148) lament the lack of basic resources, and the presence of poorly qualified teachers and large teacher–pupil ratios in rural centres as recipe for ineffective teaching.By failing to cater for every child, the government has put parents and children at the mercy of unscrupulous players. This turns quality ECD into a privilege of the few children whose parents can afford to send them to private centres. This is an unfortunate development since it fosters a shaky foundation for the majority of children, which may not augur well for intended future learning at senior levels.

However, Mudhenge (2008:9) points out that quite a number of positives have been scored in the provision of ECD education to the majority, considering that about 77% of primary schools have opened their doors by offering ECD classes. He goes further to point out that an ECD teacher training programme at Diploma Level is now institutionalised in 11 primary teacher training institutions and that ECD degrees are now being offered in some universities. The government has established an ECD provincial model centre in each of the 10 provinces in the country. This demonstrates government's commitment to see ECD access and availability to the majority of the Zimbabwean children a success. Dzvova and Dyanda (2012:64) reiterate that ECD training with respect to teaching personnel has made tremendous strides with regard to its nature and scope.This is quite fundamental as it ensures that the majority of children are in capable hands for sound grooming for formal learning.

According to Kanyongo (2005:67), the primary school curriculum is centrally designed and planned by the Curriculum Development Unit (CDU) under the wing of the Ministry of

Primary and Secondary Education. The CDU is solely responsible for designing syllabi and resource materials to be used in the primary schools. The primary school currently offers the following subjects: Shona and Ndebele (Indigenous languages), Mathematics, English and a general paper that covers Environmental Science, Social Studies, and Religious Education. The teacher–learner ratio is 1:40 and most teachers in this sector possess a Diploma in Education. Untrained teachers still provide services in the primary schools, particularly in remote areas and farm schools, which are shunned by trained teachers (Kanyongo, 2005:67). A number of learners are still disadvantaged in terms of primary education provision owing to their location and the financial status of their parents. This could worsen with the dwindling government funding, which has resulted in significantly reduced resource allocations to schools that have to rely on contributions from the local communities.

Of interest to this study is the teaching of environmental science in the primary school using the Better Environment Science Teaching (BEST) approach.BEST has made the teaching of environmental science more enriching to the learners by providing a broader and wider perspective to the subject. A number of teachers have been trained in using the BEST approach and all primary teacher training colleges have adopted the model. This is a very good example of building the capacity for quality teaching in primary schools. The development sets a very good base for the teaching of sciences at higher levels.

At the completion of primary school, learners are assessed in four subject areas. A Kanyongo (2005:67) point out that government has made primary education mandatory and has put in place mechanisms for unhindered progress. As such, the performance of learners inGrade 7does not affect their progression to secondary education. However, some secondary schools have come up with their own selection mechanism (entrance exams) for Grade 7graduates entering their institutions (Kanyongo 2005:67). This has been propagated as a means of maintaining standards in the respective schools and ensuring that they recruit learners of the calibre that they require.

3.4.2 Secondary education

Secondary education begins in Form 1 and ends in Form 6.According to Mahere (2004:2) the secondary sector has three levels of two-year education, namely: junior secondary school, Ordinary Level and Advanced Level. The junior secondary school provides a broad-based curriculum, which is the basis for channelling learners into the Ordinary Level. Parents can send their children to private schools, government boarding schools or day schools. Day schools are usually cheaper and poorly equipped in terms of material and human resources. Consequently, education in day schools is usually of a low quality. However, under the flagship of the CDU, all schools in Zimbabwe have similar curricula in the form of business/commercial subjects, humanities, technical/vocational subjects and computer studies (Mahere, 2004:3).This shows that learners enjoy a broad range of subjects to cater for their varied interests, aptitudes and intellectual capabilities. Learners proceed to the middle secondary level through school-based continuous assessment.

At the Ordinary Level, the learner is expected to do a minimum of eight subjects among which the following six subjects are mandatory: English, Shona or Ndebele, History, Science, Geography and Computer Studies. At the end of the two-year cycle learners are expected to sit for the Ordinary Level Certificate of Education, which is a basic requirement for any formalised further training. The Ordinary Level graduate is expected to pass five subjects among which should be English, Mathematics and Science. After completing Ordinary level some graduates can proceed to tertiary institutions, while others pursue Advanced Level in preparation for university studies (Mahere, 2004:4). Ordinary Level is a basic requirement for any further training or possible employment opportunities.

To prepare learners for embarking on senior level science studies, the middle secondary offers pure science disciplines in the form of Physical Science, Biology, Chemistry and Physics. Learners who aspire to do sciences at Advanced Level or to embark on a science-related career are expected to take at least two of these subjects depending on their aptitude and interest. Physical Science and Physics are the basis upon which a learner is prepared for the study of Physics at Advanced Level. This, if done properly, should provide the learner with a solid understanding and grounding to be able to embark on his/her Advanced Level Physics studies and succeed. Mushayikwa (2013:276) suggests that the localisation of the Ordinary Level examinations in 1998 was accompanied by a shift in perspective with emphasis on the physics content as a new syllabus was introduced. He further suggests that there was a transitional gap between what was learnt at Ordinary Level and teacher expectations at the start of the Advanced Level Physics subject. Hence, the reforms that were introduced may have somewhat compromised the quality of Ordinary Level Physics for graduates – which does not augur well for the Advanced Level Physics preparation of the learner. It might also be prudent to note that Ordinary Level is examinations-driven and there are higher chances that giving justice to the mastery of concepts may not be the main pre-occupation of the teachers at this point. Just to give an insight on how rigorous the Ordinary Level examinations are, Table 3.1 shows the pass rate from 2005 to 2015.

Table 3.1: Ordinary Level pass rate in Zimbabwe (Rafamoyo, 2014; Mawonde, 2016)

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Pass rate (%)	21.5	23.4	16.9	12.6	19.7	16.5	19.5	18.4	20.72	22.5	27.8

An average of 20% of the Ordinary Level candidates managed to pass the basic five subjects required to proceed to the Advanced Level studies. From among these few, a rigorous selection is done based on the quality of passes and availability of places for the learners to proceed to Advanced Level.

3.4.3 Advanced Level

Entry into the Advanced Level is determined by the performance of the learner at the Ordinary Level. Kanyongo (2005:68) foundthat entry into Advanced Level studies is strictly based on merit and accomplishment of prescribed selection criteria. The best candidates are usually preferred in most cases, mainly those who would have obtained a B or better in the selected subjects for study. The learners are expected to undertake a minimum of three subjects that could be in sciences, arts, commercial or technical subjects. The subjects selected are based on the learner’s prospective career options, influencing what is to be studied at university.

The government, with the assistance of the Netherlands government, set up 10 regional resource centres dedicated to science and mathematics under the Science Education In-service Teacher Training (SEITT). According to Chavhunduka (2005:8) and Gwekwerere et al. (2013:3), the SEITT project was targeted at improving the quality of science and mathematics education at Advanced Level. This approach focused on teaching to ensure mastery and understanding of material learnt through enhancement of PCK.Each of the 10 centres was run by a trained centre manager who was responsible for conducting workshops,to reflect on practice and share experiences with peers in the region. This approach resulted in substantial improvements in terms of science and mathematics education at Advanced Level. However, with the withdrawal of the Netherlands government funding, the economic meltdown in Zimbabwe and the subsequent brain drain from the country, some of the gains made took a downward turn.

3.4.4 University education

Zimbabwean universities accept Advanced Level graduates and those from polytechnics and other tertiary training institutions. The bulk of university students are Advanced Level graduates who would have passed at least two subjects. Several new universities have now taken part, with a view to meet the human capital development needs of the country. However, science-related programmes face the challenge of failing to attract adequate learners as a result of the low intake of science learners at Advanced Level, particularly Physics students. There have been concerns raised about the quality of Advanced Level graduates making it to universities. Hence, there is need to ascertain the state of the teaching and learning of Physics at Advanced Level with a view to improve teaching and learning and attract more learners to the subject. Such a move is anticipated to gradually improve the uptake of Physics at Advanced Level and eventually address the low intake of physics-related courses at universities. The next section discusses Physics as a course at Advanced Level.

3.5 PHYSICS AS A COURSE OF STUDY AT ADVANCED LEVEL

It may be prudent to highlight the key difference between Advanced Level and Ordinary level physics. The first difference is attributed to structure and content. Ordinary level physics is defined by a set of concepts, whereas Advanced Level physics consists of Ordinary level physics concepts and additional concepts.In short Advanced Level physics is more loaded with respect to content. Secondly, Advanced Level and Ordinary Level physics differ with respect to depth and treatment. Ordinary Level physics focuses on the overview of physics concepts and their applications to everyday life. On the other hand, Advanced Level physics is ceased with a deeper and more quantitative treatment of physics concepts. Last but not least the two physics levels differ with regards to mathematical treatment. At the Ordinary

Level it is expected that equations must be known and utilised. At the Advanced Level it is expected that on some given scenarios equations must be derived and other equations are known and used. Consequently, Advanced Level physics is more demanding and challenging than Ordinary Level physics.

Physics at Advanced Level is one science course that is both challenging and fascinating. It is designed to allow learners to confidently develop the requisite skills and attitudes for embarking on university education. It provides the grounding for physics-related vocations and engineering courses at universities and other tertiary institutions. Advanced Level Physics can be studied with two other subjects that are selected from among Mathematics, Chemistry, Biology, Computing and Geography. The current Zimbabwean Physics syllabus 9188 for the years 2013–2016 is the third in a series that replaced the Cambridge 9243 with effect from 2003. Private schools have kept faithful adherence to the 9243 Cambridge syllabus to date. High performers in Ordinary Level enrol for the Advanced Level Physics course. Usually the learners would have attained a B or better in Physics or Physical Science. Those learners who take a combination of Mathematics, Physics and Chemistry are highly respected and are expected to do well at the end of the senior secondary school cycle. One basic requirement for the study of the physics course is that it should be undertaken in a physics laboratory with adequate equipment to facilitate effective concept mastery. Some of the equipment includes the cathode ray oscilloscope, signal generator, veneer callipers, stopwatch, voltmeters, ammeters, and micrometre screw gauge. The prerequisites for studying Physics are mathematical skills, especially algebra and geometry and information communication technology. This indicates that the study of Advanced Level Physics in Zimbabwe is in accordance with international accepted standards of provision and hence the teacher practices should conform to internationally recognised benchmarks. The next section focuses on the revised Advanced Level Physics curriculum.

3.6 WHY CHANGE THE ADVANCED LEVEL PHYSICS CURRICULUM?

Since this study focuses on physics education it becomes inevitable to deliberate on the development of the revised Physics curriculum. A number of years after attainment of independence, there was mounting pressure from parents, learners and the government to have a home-grown physics curriculum. This was largely motivated by the desire of Zimbabweans to control their own destiny by making the curriculum more relevant to the

Zimbabwean context. Economically it was considered positive as it saved critical foreign currency reserves that were being paid out to the University of Cambridge International Local Syndicate for examination fees and other curriculum materials. By 2000 a pool of experts led by the CDU, was tasked to come up with a home-grown physics curriculum by adapting the University Cambridge syllabus within the shortest possible time (Musarurwa&Chimhenga, 2011:175). Very little if any consultation with physics teachers was done. By the year 2001, the new revised Physics curriculum was in place.

3.7 THE REVISED ADVANCED LEVEL PHYSICS CURRICULUM

The revised Advanced Level physics curriculum was driven by the philosophy learner-centred teaching practices. This was orchestrated by the needs of the Zimbabwean revolving around relevance. The concept of relevance is applied in different dimensions such as relevance of subject matter, relevance to economic development and relevance to the society. The revised Advanced Level physics curriculum was indeed an attempt to address the needs and aspirations of the nation. Among the driving factors were the socio-economic situation and dictates of science and technology. The ideals of the revised Advanced Level physics curriculum emphasises on the on the process which is consistent with Rogan and Grayson's 2003 theory of curriculum implementation. For instance, the sub-constructs of POI, namely (a) the nature of classroom interactions, (b) use and nature of practical work, (c) incorporation of science in society and (d) assessment practices. The sub-constructs are related to the ideals of the Advanced Level physics curriculum.

The Cambridge Physics syllabus had five core subjects, namely General Physics, Newtonian Mechanics, Oscillations and Waves, Electricity and Magnetism, and Matter, together with seven optional topics, namely Astrophysics and Cosmology, The Physics of Materials, Electronics, The Physics of Fluids, Medical Physics, Environmental Physics and Tele-communications. Of these seven options, the teacher and learners were required to select two options in order to prepare for examinations that were based on teacher expertise, the availability of materials and equipment and the learners' interest and aptitude. The new Physics curriculum retained the five core sections with some additions where necessary, and the options section was removed. Some options and some subtopics that were deemed relevant to the needs of the learners and the Zimbabwean society were incorporated in some sections of the new curriculum. For instance, the option for Electronics was included under

Electricity and Magnetism, while the Physics of Fluids was incorporated under Matter. In the same vein, the subtopic of X-rays from Medical Physics was brought into Electromagnetic Waves, and Optical Fibres (also from Medical Physics) was incorporated into Radioactivity, to mention just a few examples.

On the whole, the new curriculum has more content knowledge than the old curriculum. The inclusion of the material from the options in the core sections could create some challenges for those teachers who might not have covered these areas during their teacher-training, or who may have no interest in them. This possible scenario may contribute to the teachers concerned failing to teach these sections effectively. Consequently, learners under their guidance will be disadvantaged in thelearning of such topics and concepts. The additions made may also force some schools to source necessary equipment for the effective teaching of the content. Failure to acquire the equipment could have serious implications for the teaching and learning of the consolidated content. Last but not least, the removal of the Options section has denied learners the freedom to choose what to learn with respect to their interest, aptitude and maybe prospective career path. This is a violation of the democratisation of education principle. For instance, a learner might have opted for Medical Physics with the intention to study medicine at university.

The new revised Advanced Level Physics curriculum has broader aims for the whole course, as well as objectives for each topic. The broader aims of the Physics curriculum as stipulated by ZIMSEC (2013–2016:2–3) are as follows:

1. To provide, through well-designed studies of experimental and practical science, a worthwhile educational experience for all students, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to

    1.1 become confident citizens in a technological world and be able to take or develop an informed interest in matters of scientific import;
    1.2 recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life,
    1.3 be suitably prepared for studies beyond Advanced Level in physics, in Engineering or in physics-dependent vocational courses.

2. To develop abilities and skills that
   - 2.1 are relevant to the study and practice of science;
   - 2.2 are useful in everyday life;
   - 2.3 encourage efficient and safe practice;
   - 2.4 encourage effective communication.

3. To develop attitudes relevant to science such as
   - 3.1 concern for accuracy and precision;
   - 3.2 objectivity;
   - 3.3 integrity;
   - 3.4 the skills of enquiry;
   - 3.5 initiative;
   - 3.6 inventiveness.

4. To stimulate interest in, and care for, the environment in relation to the environmental impact of physics and its applications.

5. To promote awareness
   - 5.1 that the study and practice of physics are co-operative and cumulative activities, and are subject to social, economic, technological, ethical and cultural influences and limitations;
   - 5.2 that the implications of physics may be both beneficial and detrimental to the individual, the community and the environment;

6. To stimulate students and create a sustained interest in physics so that the study of the subject is enjoyable and satisfying.

One notable oversight made with respect to the general aims that were in the old curriculum relates to use of Information Technology (IT), which was stated as: “to promote an awareness of the important use of IT for communications, as an aid to experiments and as a tool for the interpretation of experimental and theoretical results”, (UCLES,2000:47). In this world of technological advancement, the use of IT in learning situations is being advocated, particularly in the learning of physics. Hence, the deliberate omission of the use of IT in the learning of physics could be a handicap to the effective learning of the subject, thereby disadvantaging the learners. The next section dwells on the ideal teaching and learning approaches with respect to the outlined goals of the revised Physics curriculum.

3.8 INNOVATIVE TEACHING

With due respect to the goals of the new Physics curriculum, it is evident that learner-centred approaches are being advocated. Physics teachers are being called upon to create conducive classroom situations in which learning experiences have a bearing on real-life situations and to make learning more meaningful and interesting to learners (ZIMSEC, 2013–2016:2). Teachers are being summoned to plan for vibrant learning experiences in the form of practical work, classroom interactions and group work that promote active learning and foster reflective discussions. Thus, this enables the democratic space in the classroom that the nation is striving to achieve.

3.9 CHAPTER SUMMARY

The chapter focused on bringing the Zimbabwean education system into context. It elaborated on the revolutionary approach taken to expand education provision as opposed to evolutionary change and the subsequent deterioration of educational quality standards. Localisation of curricula and examinations was designed to make schooling affordable and relevant to the Zimbabwean context. Most of the changes concerning science education occurred at the Primary and Ordinary Level. In trying to build a sound foundation at the Ordinary Level for all learners, the government made science education accessible to every learner. This move however, compromised the quality of education on offer. Learner-centred pedagogy was argued for as opposed to lecture method. The central role played by science in economic and technological development has made it mandatory that the government strives towards the provision of quality science education as much as it is able to, given the financial and human resources available. However, quality science education provision has remained elusive. This study intends to investigate teacher perceptions, experiences and practices with respect to the Advanced Level Physics curriculum in view of the intentions of the curriculum planners. The next chapter focuses on the research methodology that is relevant to this study.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 INTRODUCTION

In the preceding chapter on the literature review, the researcher examined literature on the historical developments of the school curriculum from the colonial era to the democratic dispensation in Zimbabwe, with special emphasis on developments in the science curricula. The examined literature provided a background to the problem and issues contributing to ineffective curriculum implementation in secondary schools in Zimbabwe. It also provided theoretical answers to the research questions to be embarked on in this study. This chapter focuses on a detailed action plan and procedures to provide empirical evidence to answer the research questions raised.

A detailed description is provided of the research design to be employed to generate data to address the research questions of the study. In addition, the chapter describes the procedures to be followed in selecting appropriate methods, sites and respondents, in gaining access to research sites and respondents, for data collection and analysis, as well as validity, reliability and ethical issues. Apart from elaborating on and justifying the design of the investigation and the methods of information-gathering, this chapter reiterates the main question and sub-questions.

4.2 RESEARCH QUESTIONS

The central question to the study is: How do Zimbabwean physics teachers translate the Advanced Level Physics curriculum into practice?

The sub-questions are:

- What are the perceptions of Zimbabwean physics teachers of the Advanced Level Physics curriculum?
- What is the level of preparedness of teachers to implement innovative teaching strategies in the physics classroom?

- How do Zimbabwean teachers teach inquiry skills in Advanced Level Physics lessons?
- How is the teaching and learning of physics concepts being related to Zimbabwean everyday life?
- How are ICTs applied in the learning and teaching of the Advanced Level Physics curriculum?
- How does the school climate influence the implementation of the Advanced Level Physics curriculum?
- What is the nature of professional development opportunities availed to teachers in the schools?

The study is a direct investigation of teachers' instructional practices as and their experiencesof high school physics. It seeks to understand how the teachers construct meaning from their instructional practices. Consequently, based on the main research question and the sub-questions, it is the conviction of the researcher that employing a mixed methods design would enable one to take advantage of the strengths of both the quantitative and the qualitative research methods to facilitate better understanding of the problem being studied (Creswell, 2007:18; Creswell & Plano Clark, 2011:12). As a point of departure, the pragmatist paradigm is briefly discussed as it directs the research study agenda.

4.3 RESEARCH PHILOSOPHY

The study is guided by the pragmatist paradigm. MacArthur (2010:1) concedes that generally pragmatists posit that pragmatism is the idea that value is determined by feasible consequences. McDermid (2006:1) also opines that the meaning of a concept rests in its discernible repercussions rather than its philosophy. Morgan (2014:1050) suggests that pragmatism is concerned with the pursuit of meaningful goals and the application of suitable methods. One can deduce that for pragmatists, truth is based on usefulness and helpfulness of ideas and methods. As such, ideas that are not workable or relevant to a situation are deemed false. Pragmatism hinges on practicality and effectiveness of ideas and methods on solving requisite problems.

Creswell and Plano Clark (2011:41) and Denscombe (2010:148) are of the opinion that pragmatism is premised on four principles that focus on the consequences of the research. This implies that when judging ideas, we should base decisions on their empirical and practical effects. Useful research findings may help in deciding on the type of action to be taken to improve the situation or to move forward. The four principles of the pragmatist research philosophy are examined below.

The first principle is that it is critical to focus on the research question asked rather than on the method or the philosophy underlying the method. This view is shared by Shannon-Baker (2015:13) who finds that pragmatism calls for serious attention to be accorded to research questions. Research methods should suit the research question by promoting great chances of obtaining relevant answers to the question. From Creswell and Plano Clark (2011:41) “truth” is viewed as what works in a specific time period. The mixed methods approach in this study will be used to provide what works for teachers that experience difficulties in transforming the curriculum into practice. This is consistent with the pragmatic world view.

The second principle is that it is vital to use multiple methods to inform the problems under investigation. The principle advocates for a pluralist approach in soliciting all data sets appropriate to answering the research question. Gray (2009:213) believes that the use of multiple methods ensures that the weaknesses of one measure are compensated for by the strengths inherent in another. Consequently, employing multiple methods in a study can ensure that data gathered is complementary. For instance, in this study a questionnaire will be implemented to collect quantitative data and an interview guide will be used to obtain qualitative data. This will give a broader picture of the teachers’ perceptions, experiences and concerns in the teaching of Advanced Level Physics. This approach may ensure that a more holistic picture of the prevailing situation is obtained.

The third principle states that a realworldview is practice-orientated. A practical and feasible research philosophy should guide methodological choices. In essence the principle advocates employing both quantitative and qualitative methods to be used in a single study. The thrust is that quantitative and qualitative methods are compatible. Cameron (2012:101), Creswell and Plano Clark, (2011:12) and Denscombe (2010:141) argue that combining qualitative and quantitative methods can serve as a recipe for viewing the problem from alternative perspectives and enhances the attainment of a complete understanding of the subject under study. For instance, by looking at the inquiry skills addressed by physics teachers in the classroom, quantitative data may look at the extent to which the teachers address inquiry skills in the classroom while qualitative data could look at what motivates teachers to address these inquiry skills. The researcher intends to collect data guided by methods that work best and are appropriate to answer the research questions. The fourth principle will be examined in the next paragraph.

According to Johnson and Onwuegbuzie (2004:18), the pragmatist paradigm also acknowledges that the values of the researcher may play a significant part in the interpretation of the results of the study. This stance is also supported by Shannon-Baker (2015:13) who argues that pragmatism advocates for a balancing act between subjectivity and objectivity during the research study. In this particular study, the researcher’s experience as a physics teacher will assist in the planning of the study. The researcher’s experiences, those of the Zimbabwean physics teachers and the context of Advanced Level Physics teaching, will be critical for this study to develop interventions and experiences that will benefit teachers and learners.

It is anticipated that the preceding principles will guide the researcher in his endeavour to plan and execute procedures that will enable him to obtain credible and valid data to address the research questions as expounded by the study. The next section will examine the research approach to be employed to execute the study.

4.4 RESEARCH APPROACH

This study will adopt the mixed methods approach. According to Gray (2009:204) mixed methods research entails the process of collecting, analysing and mixing quantitative and qualitative data within a single study or multiple studies, in order to understand a research problem more completely. In support of this stance, Johnson, Onwuegbuzie and Turner (2007:123) contend that mixed methods research is a type of research in which a researcher, or team of researchers, blends features of qualitative and quantitative research paradigms such as data collection and analysis techniques with the motive of depth of comprehension and corroboration. What is apparent in the ideas from these authorities is that mixed methods originate from both qualitative and quantitative approaches and that its stance is that the two approaches are compatible. This compatibility is visualised through the design, data collection methods, analysis techniques and interpretation with a view to get a better interrogation and understanding of the research problem being focused on. The researcher intends to briefly outline both the qualitative and quantitative approaches.

The quantitative approach is guided by the positivist philosophy. Gray (2009:18) argues that positivism projects that the social world exists externally to the researcher and its properties can be measured directly through observation. Gray (2009:18) goes further to suggest that positivism is based on the premise that reality is made up of what can be tapped through the senses, that inquiry should hinge on scientific observations and empirical evidence, and that natural and human sciences share some methodical principles, focusing on facts but not values. Ideas can be attested as valid knowledge once they have passed the rigorous test of empirical evidence and would have been sourced through the senses. The key issue is that all data of interest is quantifiable and that the generation of knowledge should be attained through use of quantitative methods.

The quantitative research approach is one in which the researcher decides what to study, asks specific narrow questions, collects quantifiable data from participants, analyses these numbers using statistics, and conducts the inquiry in an unbiased, objective manner (Fischler, 2014:5). In support of this view, McMillan and Schumacher (2014:2) define the quantitative approach as a research approach in which objective data is collected and scrutinised numerically. From these scholars one can safely assume that the quantitative approach is very objective, depends on numerical data and relies heavily on statistical analysis to come up with informed decisions. The quantitative methodology utilises performance tests, personality measures, questionnaires and content analysis as data collection methods (Fischler, 2014:3; Kothari, 2011:5). These methodologies are usually associated with collection of “hard” data. Consequently, the quantitative paradigm is underpinned by singular reality, objectivity and deductive reasoning.

On the other hand, the qualitative approach is guided by the constructivist paradigm. Muijs and Reynolds (2011:77) concede that generally constructivists believe all knowledge is generated rather than directly discerned through the senses. In support of this idea, Ornstein and Hunkins (1998) contend that knowledge is not passively received but actively built up by the cognising subject, and that the function of cognition is adaptive and serve the organisation of the experimental world, not the discovery of ontological reality. One can deduce that constructivists hold the idea that reality is socially constructed through human interactions. Gray (2009:18) argues that constructivism is based on the premise that learning is a product of mental construction; hence, verity and meaning do not occur in some outside world but are generated by the questions within. He goes further to suggest that subjects come up with meanings in varied ways, even regarding the same phenomenon. This implies participants engaging the same phenomenon should ultimately come up with varied meanings derived from it. Data meanings are inferred from the respondent's perspective and researchers make efforts to comprehend the sphere from the respondent's frame of reference and attach meaning to it (Gray, 2009:18). Consequently the focus of the researcher is to solicit for teachers' perspectives of their classroom practices and experiences and their thoughts on innovative instructional strategies. Making sense and meaning of such social activities can best be solicited through qualitative research methods.

Fischer (2014:7) argues that the qualitative approach is one in which the researcher depends on the standpoints of respondents, asks open-ended questions, gathers verbal information from participants, synthesises the verbal data for themes, and carries out the study in a very subjective way. Kothari (2011:5) finds that the qualitative approach is preoccupied with subjective determination of attitudes, views and behaviour. Of significance are the ideas that the qualitative paradigm to research is subjective, and values multiple realities and inductive reasoning. The qualitative approach employs interviews; open-ended questions; observations; content analysis and focus groups as key data collection methods (Fischler, 2014:9; Kothari, (2011:5). The qualitative approach is guided by constructivism, which values multiple realities, bias and inductive analysis. Muijis and Reynolds (2011:77) concede that generally constructivists subscribe to the idea that cognition is created rather than discerned directly through the senses. This gives rise to a dire need to listen to the respondent's standpoint and to subject the gathered information to analytic induction and extract own meaning from the context.

For purists in both the qualitative and quantitative paradigms, the two approaches to research are incompatible. However, this stance has been strongly disputed by several social scientists who posit that there is no major study area that should be investigated solely with a single research method (Terrell, 2012:258). In support of this view, Creswell and Plano Clark (2011:26) and Johnson and Onwuegbuzie (2004:17) are of the opinion that the mixed methods paradigm is an effort to legitimise the utilisation of multiple approaches in addressing research problems. They maintain that mixed methods should be guided by research questions and transcend traditional boundaries by mixing practical methods to solve research problems according to the dictates of specific situations. This situation can enhance the realisation of a detailed account of the prevailing situation on the ground through the exploitation of the strengths of both quantitative and qualitative methods. For instance, in this study a questionnaire composed of closed questions will be enlisted to solicit for factual aspects of teacher practices, whereas interviews utilising open-ended questions will be used to explore the perceptions, beliefs, experiences and factors that may be influencing their interpretation of the curriculum. These methods measure related aspects as well as varied aspects of teacher practices, with the anticipation that results from one method will support those from the other. The researcher is convinced that the combining of methods of data gathering and analysis will generate a better understanding of teacher perceptions, concerns and experiences.

As the mixed methods approach comes from both qualitative and qualitative paradigms, it calls for extra effort, expertise and solid grounding in both qualitative and quantitative approaches (Creswell and Plano Clark, 2011:80). This stance suggests that the mixed methods approach is quite challenging, fascinating and robust. The mixed methods research approach is deemed ideal to investigate the current physics teacher practices in teaching the revised Advanced Level Physics curriculum in Zimbabwean high schools.

4.5 RESEARCH DESIGN

According to Creswell and Plano Clark (2011:53), a research design is an action plan for gathering, analysing, providing meaning and communicating data in research investigations. This view is also supported by Kothari (2011:31) who proposes that a research design is a framework for conducting research, consisting of the strategy for data gathering, measurement and examining. The two definitions from authorities give an indication that a research design may be considered as a detailed plan indicating how data is going to be collected, methods to be utilised, and ways of analysing and communicating the findings. It can be argued that the purpose of the research design is to keep the researcher focused and to ensure the collected data addresses the research questions convincingly. So, it is a road map that facilitates the realisation of the study goal**.**

As alluded to earlier, the mixed methods research approach adopted for this study has a convergent parallel design. According to Creswell and Plano Clark (2011:70) and Fischler(2014:22) the convergent parallel design occurs when the researcher collects quantitative and qualitative data concurrently, analyses the two data sets separately and mixes the two data sets by merging the results during interpretation. From this perspective it can be argued that the mixing is of the data collection methods and data interpretation. It may be argued that the main thrust of the convergent parallel design is to gather different but complementary information on the research problem (Creswell & Plano Clark, 2011:77). In this way, the design ensures corroboration within the conduct of the same study. Figure 4.1 sets out the convergent parallel design.

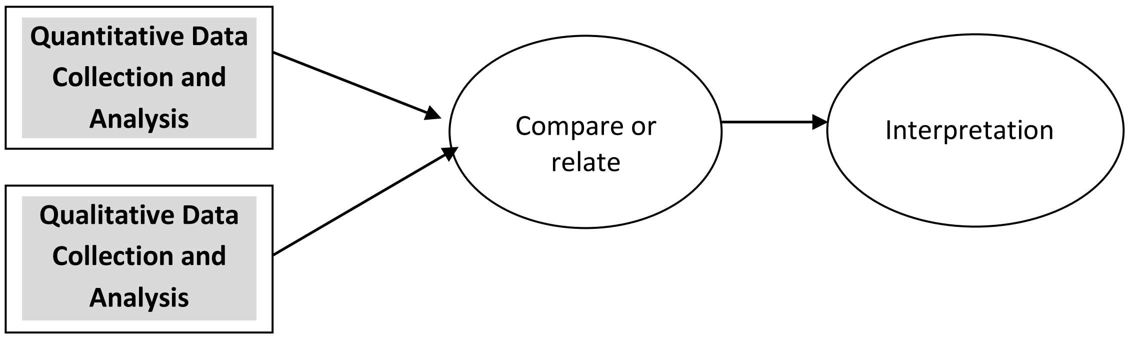

Figure 4.1: The convergent parallel mixed methods design (Creswell & Plano Clark, (2011)

From Figure 4.1 it can be deduced that qualitative and quantitative data are collected at the same time and accorded equal status. The collected data is analysed independently and then compared. Finally, the analysed qualitative and quantitative data is merged for interpretation purposes.

Creswell and Plano Clark (2011:78) and Terrell (2012:268) note that when implementing the convergent mixed methods design, the researcher collects concurrently both quantitative and qualitative data about the research problem. Creswell and Plano (2011:78) go further to suggest that the two data sets should have equal priority to address the research problem being investigated. The researcher intends to accord the quantitative and qualitative data equal status in addressing teacher practices in interpreting the Advanced Level Physics curriculum and to collect both qualitative and quantitative data roughly at the same time. Creswell and Plano Clark (2011:78) mention that the researcher should analyse the two datasets separately and independently, employing typical quantitative and qualitative analytic procedures. Data is analysed independently to extract detailed meaning and emerging themes for comparison. During the last implementation stage the researcher interprets the extent to which the two data sets converge; diverge from one another; relate to each other and/or combine to facilitate a better understanding of the research problem (Creswell & Plano Clark, 2011:78). The preceding statements serve as guidelines for the implementation of the convergent mixed methods parallel design the researcher intends to follow to obtain credible results that address the challenges experienced by Advanced Level Physics teachers in Zimbabwean high schools.

As discussed in the preceding paragraphs, equal status will be given to both qualitative and quantitative approaches in this study. Data was collected at the same time, analysed separately and then merged. The study explored factors such as teaching experience, school location, teacher perceptions towards the physics curriculum, use of inquiry-based physics teaching, capacity to link physics concepts to everyday life, teachers' use of ICT as a pedagogical tool in teaching physics, school support for the teaching and the quality of professional development opportunities availed to teachers. Figure 4.2 gives an idea of the implementation matrix of the convergent research design that the researcher utilised in this study.

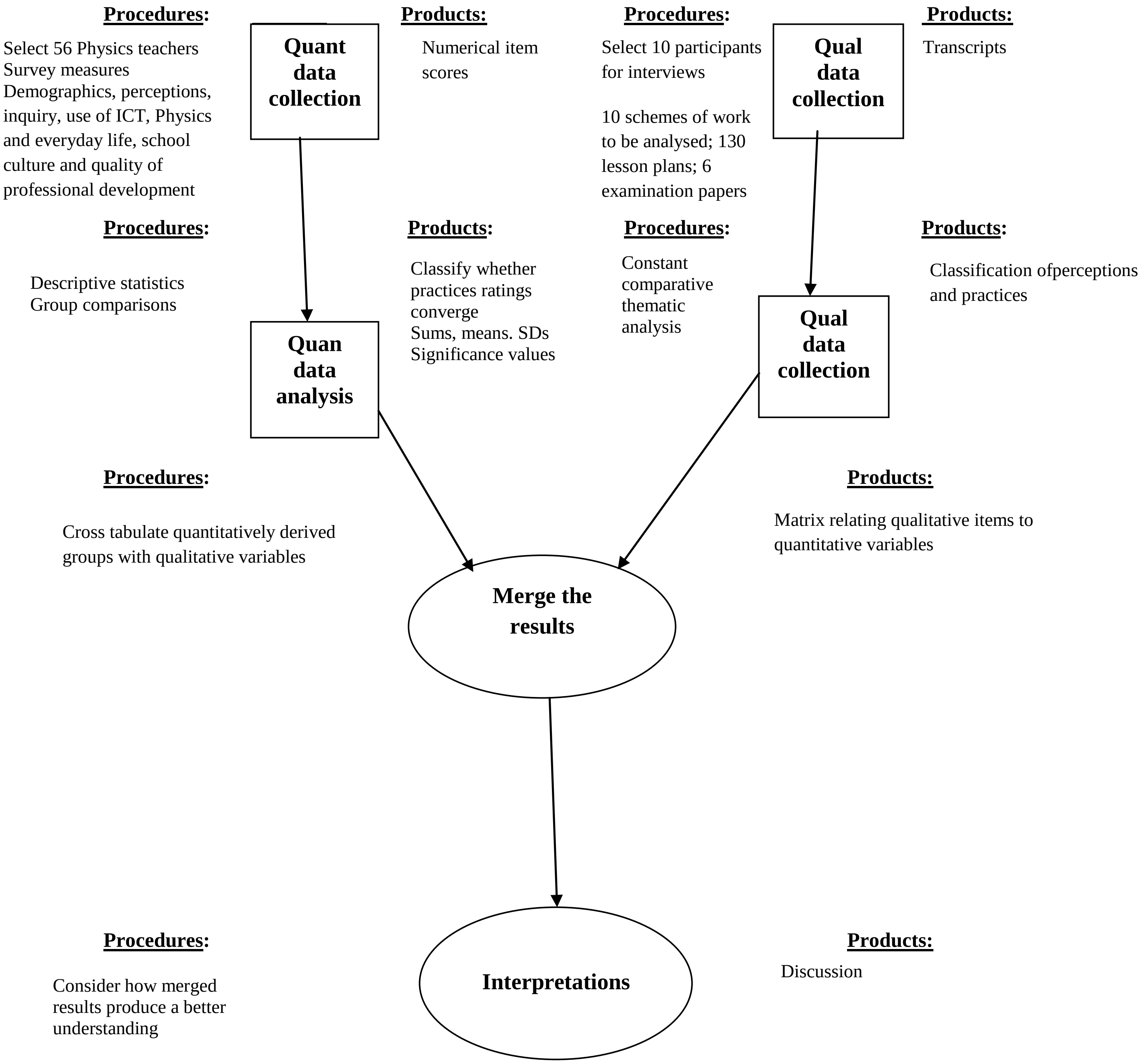

Figure: 4.2: Congruent Design Procedures matrix (Adapted from Creswell & Plano Clark, 2011)

In Figure 4.2, quantitative data-gathering and analysis are on the left side of the diagram and qualitative information collection and analysis is depicted on the right side. The quantitative and qualitative strands are to be implemented during the same phase of the research execution process. The two data sets and their respective results will be merged using a comparison matrix, to come up with an overall interpretation as depicted by the two ovals. This gives the interface of the qualitative and quantitative data synthesis and interpretation. The researcher's strict adherence to this research design implementation matrix will effectively guide the research process and keep the researcher on track.

4.6 RATIONALE FOR MIXED METHODS DESIGN

A research design that seeks to take advantage of a mixedmethodology is regarded as seeking knowledge from a wider perspective, giving room to weigh alternative viewpoints and justify mixing of decisions (Creswell & Plano Clark, 2011:61). In the same vein, Graff (2013:47) is of the view that mixed methods researchers may engage with respondents from an objective or subjective perspective based on whether they are in the quantitative or qualitative component of their investigation. Consequently, the utilisation of the mixed methods research design advocates the merger of methods from both quantitative and qualitative research for the attainment of better understanding from two data sets and corroboration of results from different methods (Fischler, 2014:22; Terrell, 2012:268). The quantitative component of the study gives a general understanding of the research problem, while the qualitative component gives depth and breadth to the quantitative findings by taking on board respondents' views and feelings (Creswell & Plano Clark, 2011; Denscombe, 2009:141). The weaknesses of the quantitative approach are then offset by the strengths of the qualitative approach. Jonson and Onwuegbuzie (2004:123) and Teddlie and Tashakkori (2009:4), riding on the purported strengths of the combination of quantitative and qualitative research methodologies, propose that the mixed methods research should unequivocally be accepted in education research as the third dominant research approach. Based on these arguments the researcher is convinced that the mixed methods approach is appropriate in studying the perceptions, experiences and classroom practices and in coming up with feasible intervention measures.

Scholars have suggested several benefits pertaining to the utilisation of the mixed methods paradigm, regardless of the fact that collecting and analysing both qualitative and quantitative data is time-consuming and extensive. Considering the complexities associated with research problems in educational and social research settings, it may be prudent to go beyond mere description of the problem by unravelling the interrelationships and overlapping facets associated with the components of the study problem (Shannon-Baker, 2015:2). It should be acknowledged that in pursuing such research exploits in complex educational contexts, a mono qualitative or quantitative paradigm may be inadequate to fully unravel the research phenomenon under study (Creswell & Plano Clark, 2011:78; Graff, 2013:47; Shannon-Barker, 2015:2). These authors suggest that combining qualitative and quantitative data sets may add more rigorous analysis and better insights into the research question under focus. Fischler (2014:9) and Graff (2013:48) are of the view that the use of the mixed methods approach enhances a complete understanding of the study problem compared to either qualitative or quantitative on its own. Considering the different personalities of teachers, their values, beliefs and experiences, it seems appropriate for the researcher to use the mixed methods approach to unravel the physics teaching scenarios in the schools and factors deemed responsible for perceptions.

In this study the researcher collected and analysed data from a survey of 56 high school physics teachers. The quantitative statistical analysed data gave a general picture of the research problem and the analysed qualitative data refined and added insights into numerical findings by exploring respondents' opinions in-depth (Creswell & Plano Clark, 2011:12). In the current study, quantitative numerical data shed light and give insights on how teachers interpret the revised Advanced Level Physics curriculum and the influence of the anticipated variations existing in the teacher practices. The researcher anticipates that quantitative data may unravel the how and why ofphysics teacher practises and the factors attributed to the variations in teacher practices for the benefit of key stakeholders such as curriculum designers, teachers, learners and policy-makers. Quantitative data alone would be inadequate to offer holistic explanations for variations in teacher practices. Consequently, qualitative data is essential to the study to complement the quantitative data by providing insight, depth and breadth through how and why questions, establishing relationships between variables. By so doing the researcher capitalises on the strengths of both quantitative and qualitative research methods and reduces their weaknesses.

4.7 METHODS OF DATA COLLECTION

Permission was sought from the Ministry of Primary and Secondary Education, regional, district officials and respective school headmasters at least a month before data collection. Data was gathered for a considerable period spanning a minimum of five months from August to December 2015. The research design used the questionnaire, interviews and document analysis. The survey, interviews and document analysis were enlisted to solicit information that pertains to practices and circumstances underpinning the interpretation and implementation of the physics curriculum. The information obtained through the quantitative study was further interrogated and deepened through the qualitative study.

4.7.1 Administration of questionnaire

Preliminary visits were made to the 56 schools a month before the data collection exercise to familiarise the researcher with the participants and their working environments. On the day of actual business the researcher explained the purpose of the visit to the participants. The researcher explained to each participant that he or she was free to withdraw from the study at any time and that participation in the study would require commitment since it has demands on the participant's time. The teachers completed the questionnaires after their consent had been enlisted and having gone through the instructions of the questionnaire with the researcher. The questionnaire was handed to the researcher as soon as each respondent had completed it. The researcher checked each completed questionnaire to ensure all sections and spaces had in fact been completed. Where questions were unanswered, respondents were asked to either fill them in or were asked whether they were left out deliberately. This process was designed to ensure that there was completeness of data in each questionnaire submitted by the respondents.

4.7.2 Implementation of the interviews

The researcher used face-to-face interviews with participants. This was premised on the basis that it would be easy to organise since it coincided with the diaries of the researcher and participants (Denscombe, 2010:176). The interviews were conducted soon after the researcher had checked on thecompleteness of the completed questionnaire if the respondent expressed willingness to be interviewed.The researcher had to focus on one individual's ideas at a time. Hence, the face-to-face interview was deemed ideal by the researcher and was anticipated to bring maximum reliable and authentic information to the study. Notwithstanding interviewer and interviewee bias, the researcher made an effort to remain focused on the points of interest and guided the participants to stick to issues that were pertinent to the study.

The researcher explained the purpose of the interview and the anticipated benefits of the study. This rich and in-depth information gathering was made possible by helping respondents relax by asking them general questions related to the teaching of physics. The researcher would then solicit permission to record the proceedings of the interview, assuring the respondent of the confidentiality of the data gathered and any other information shared with the researcher and the anonymity of each participant. The researcher insisted on completeness of issues or ideas raised by the respondent on his/her perceptions and teaching practices and sought clarification where necessary. All interviews were recorded with a digital recorder and lasted between 30 and 45 minutes per session. During the course of the interview the researcher took down notes with respect to facial expressions and body language, and encouraged responses through occasional nodding of the head (Turner, 2010:6). The interviews were held in the teacher's physics preparatory room or any free room available in the school to minimise disturbances.

4.7.3 Collection of documents for document analysis

The researcher requested permission from the participants and obtained copies of their schemes of work to examine teachers' purported classroom practices together with past examinations papers, and compared these to the official Advanced Level Physics curriculum. Zimbabwean teachers have autonomy to adjust the content, methodology and timing of content of current curricula, but are tied to concepts and nature of experiments. The schemes of work and past examination papers were obtained in electronic format or hard copy. The researcher took the documents for analysis, confidentiality and safe-keeping. During analysis, various aspects of the teaching of physics were considered, for example, the application of physics concepts to everyday life. In the scheme of work the researcher examined how the Advanced Level Physics curriculum was being implemented. Analysis of past examination papers revealed whether prescribed intentions in the physics curriculum were being examined or not and the frequency of this occurrence. Examining the official physics curriculum provided the basis of the curriculum intentions and showed the expectations curriculum designers had of teachers to use innovative teaching approaches. The documents were used in conjunction with other sources. The rationale for using the documents was to assist in data validation through triangulation. In this particular study, document findings were triangulated with two other data sources, namely the questionnaire and face-to-face interviews.

4.8 DEVELOPMENT OF DATA COLLECTION INSTRUMENTS

The research design utilised three data collection methods: administering questionnaires, collecting documents for document analysis and conducting face-to-face interviews. Data was collected over a period of five months ranging from August to December 2015. The three data collection methods will be elaborated below.

4.8.1 Questionnaire

Close-ended questionnaires refer to research instruments through which individuals are required to respond to the same set of questions in a pre-set order and providing responses which fit into categories that would have been prescribed in advance by the researcher (Denscombe, 2010:166; Gray, 2009:337). The implications are that there are pre-specified questions that respondents have to answer in an anticipated and chronological sequence. The researcher has seen it fit to use a closed questionnaire in this study because the tool ensures fast data inflow, and low cost with regard to both time and financial resources, even in situations where the participants are widespread (Gray, 2009:338; Kothari, 2011:101). The closed questionnaire also facilitates speedy collection, quantification, analysis and comparison of data. However, participants may find closed questions frustrating since they are not afforded opportunities to freely express their views (Denscombe, 2010). To minimise the frustrations, participants were invited to participate in interviews where they could freely express their opinions and views. Questionnaires were administered to 56physics teachers with the assistance of two research assistants. The physics teachers wererandomly selected to ensure rich data was obtained.

4.8.1.1 Demographic data

Demographic data of Zimbabwean Advanced Level Physics teachers was sought through a survey with questionnaire items focusing on gender, age, experience in physics teaching, school location, highest qualification obtained and average physics class size. The demographic data was anticipated to give insight into the respondents' background and prevailing work environment, which may have a significant influence on teacher instructional practices in the classroom.

4.8.1.2 Teachers' perception of the Advanced Level Physics curriculum

Physics teachers' perceptions about the revised Advanced Level Physics curriculum were sought through a survey. Teachers' opinions on the whole physics curriculum, factors that may affect its implementation and suggestions on how their perceptions could be enhanced, were sought. A questionnaire consisting of closed questions wasdeveloped. The closed questions – targeting teachers' perceptions of the relevance of the content, purpose of the curriculum and purported difficulties in the implementation of the curriculumwere adapted from Elmas et al. (2014:7) and Kang, Lee, Jin, Ahn and Yoo (2015:155). The Likert scale items soliciting information on physics teachers' perceptions and experiences of teaching the revised Advanced Level Physics curriculum ranged from 1=Strongly Disagree to 5=Strongly Agree. These items solicited teachers' perceptions of the educational value of the content in the curriculum and the challenges they encounter during the implementation of the physics curriculum. The closed questions were restructured to meet the context of the study. The items were selected from Elmas et al. (2014:7) and Kang et al. (2015:155) based on the understanding that these items have been tried and tested in the field and produced tangible findings. The researcher was convinced that by using them in this study, the chances of collecting relevant and credible data would be enhanced. The adapted statements follow:

Statements

- The curriculum content fosters cutting-edge technology
- The content fosters problem-solving and critical thinking skills
- My learners find the curriculum content interesting
- The curriculum content helps learners in career pioneering
- The content is excessive compared to the allotted teaching time
- The curriculum content has concepts which are difficult for me to understand
- My content knowledge of topics in physics curriculum is sound
- I have difficulties in providing effective instruction
- The teaching approach is compatible with the final assessment

4.8.1.3 Sense of preparedness to teach science

The physics teachers' sense of preparedness to teach with innovative strategies was determined using items from the Surveys of Enacted Curriculum (SEC) (Jetty, 2014:73). The items were created using the SEC survey instrument scale, known as Teacher Preparedness for Using Innovative Teaching Strategies. This scale was created from six items on the SEC intended to measure level of preparedness. Some of the statements were personalised so as to speak directly to the respondent. The teachers were requested to respond to a four-point Likert scale indicating how well they were prepared for the innovative instructional strategies with 1=not well prepared (NWP); 2=Somewhat prepared (SP); 3=Well prepared (WP) and 4=Very well prepared (VWP). A total sum score for each respondent is generated to measure this construct. The scale used here was based on the premise that it had been evaluated using the Cronbach's Alpha and was found to have a Cronbach's alpha of 0.799 (Jetty, 2014:81). A scale is considered to have sound internal consistency reliability when the reliability coefficient alpha is above 0.7. Based on the strength of the reliability analysis the scale was deemed suitable for use. Some of the statements were changed slightly to make them suitable to the Zimbabwean context. The total sum score for each respondent was used to measure the sense of preparedness to engage innovative teaching strategies in the Advanced Level Physics classroom. The six statements are given below:

Statements

- Indicate the extent to which you are prepared to teach physics at advanced level (SEC Item 83)
- Indicate the extent to which you are prepared to integrate physics with other subjects (SEC Item 84)
- Indicate the extent to which you are prepared to provide science instruction that meets science content standards (national) (SEC Item 85)
- Indicate the extent to which you are prepared to use a variety of assessment strategies (including objective and open-ended formats) (SEC Item 86)
- Indicate the extent to which you are prepared to managing a class of learners who are using hands-on or laboratory activities (SEC Item 87)

- Indicate the extent to which you are prepared to take into account students' prior conceptions about natural phenomena when planning (SEC Item 88)

4.8.1.4 Inquiry-based science teaching strategies

The physics teachers' instructional approaches and what they consider important pertaining to inquiry-based teaching in the classroom was sought through a Likert scale in which 1=Not Important (NI); 2=Somewhat Important (SI); 3=Important (I) and 4=Very Important (VI). The scale was generated using 10 items adapted from Dibiase and MacDonald (2015:9) to contextualise them to the Zimbabwean situation. The items were personalised in a bid to makethem speak directly to the respondents. The statements were used on the basis that the instrument was pilot-tested; its reliability ascertained and used in a survey in which reliable data was collected. Hence, the researcher was convinced that taking advantage of the questions on teachers' instructional practices based on inquiry practices was a fruitful exercise. The statements below solicit data on teachers' instructional practices with regard to inquiry-based physics teaching.

Statements

- I afford learners the opportunity to explore and construct meaning from inquiry experiences such as engaging in open-ended questions and group discussion
- I involve learners with physics experiments with known outcomes
- I prepare daily lesson plans with the textbook
- I teach learners guided by the national examinations
- I encourage learners to design their own laboratory investigation to solve a scientific question
- I use inquiry in physics instruction
- I teach facts as the primary goal of physics instruction
- I teach the processes of physics as the primary goal of physics instruction
- I use multiple-choice questions as the main strategy to evaluate student learning
- I use open-ended (essay, problems) questions as the main strategy to evaluate learner learning
- I encourage learners to work in collaborative groups on investigations

4.8.1.5 Link physics concepts to everyday life

A survey was enlisted to gather data on the teachers' perceptions and experiences in linking physics concepts with everyday life. Questions focused on the importance of linking physics concepts to everyday life and the resources needed for effective linking of everyday life with physics. The questions on a Likert scale, using 1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree and 5=Strongly Agree responses, were adapted from questions developed by Tymos (2010:57) and Ng and Nguyen (2006:45). The statements that follow were adapted on the basis that they have been applied to other studies and have been found to be reliable and credible.

Statements

- It is important to link physics concepts to real world contexts and global issues such as energy consumption and climate change
- Linking physics to real world contexts will encourage more learners to study physics
- Linking physics to everyday life will help learners understand concepts better
- Linking physics concepts to everyday life will assist learners to see the practical life of physics theories in everyday life
- Linking physics concepts to everyday life will help learners learn physics in a meaningful way
- Linking physics concepts to everyday life will help learners to be more creative
- The resources provided by the school make it easier for me to link my teaching to real world issues
- The resources provided by the school make physics more interesting to my learners
- The contexts and issues presented in the resources are relevant to my learners
- I am likely to make substantial changes to the way I teach physics based on the resources at my disposal
- Linking physics to real world contexts need diverse resources (internet, websites, problem sets)

4.8.1.6 Use of ICT as a pedagogical tool in physics classrooms

The survey was used to determine teachers' instructional practices with regard to using ICT as a pedagogical tool in the physics classroom. Questions focusing on the use of ICT as a pedagogical tool (adapted from Ndibalema, 2014:7) were based on Likert scale where 1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree and 5=Strongly Agree. The statements were adopted since they have been found to be instrumental in collecting reliable data in secondary schools in a similar environment to Zimbabwean secondary schools. The 10 statements that follow give a measure of physics teachers' capabilities or appreciation of ICT as a pedagogical tool in teaching physics.

Statements

- I can create visual presentation, graphics, charts, drawings and type assignments for learners by using ICT
- I can download teaching materials regarding my subject
- I can use computer-based programs in developing the scheme of work and lesson plan
- I use email to ask for and send assignments to my learners if possible
- I am able to search for files on computer system and organise them into folders
- I am able to use a learning management system (such as Web CT) to support teaching
- I can connect the computer to its peripherals
- I can access and share information on CD/DVD/flash disc
- I can create a basic presentation package and print to various networked printers
- I can set up and use liquid crystal display (LCD) or a multimedia projector for classroom delivery

4.8.1.7 Teachers' perceptions of school organisational climate

Teachers' perceptions of their schools' organisational climate were sought through employing a scale created from the SEC instrument. This scale was created utilising eight items, based on SEC items 95–102. The teachers were requested to respond to these questions utilising a five-point Likert scale depicting how collegial their peers and school authorities are, trust that prevails, and perceptions of support, with 1=Strongly Disagree that these conditions prevail, and 5=Strongly Agree that the scenarios exist. Item 96 was rephrased to depict the trend in other questions. A total sum score for each respondent was generated to measure this variable. The Likert scale questions on school climate and culture were adapted on the basis that the reliability of the scale had been evaluated employing Cronbach's Alpha and was found to have the Cronbach's alpha of 0.832 (Jetty, 2014:81). A scale is deemed to have sound internal consistency reliability when the reliability coefficient alpha is above 0.7. Based on the reliability analysis the scale was considered suitable for use.

Statements

- I am supported by colleagues to try out new ideas (SEC Item 95)
- I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning science (SEC Item 96)
- Science teachers in this school regularly observe each other teaching classes (SEC Item 97)
- Science teachers in this school trust each other (SEC Item 98)
- It's acceptable in this school to discuss feelings, worries, and frustrations with other science teachers (SEC Item 99)
- Science teachers respect other teachers who take the lead in school improvement efforts (SEC Item 100)
- It's accepted practice in this school to discuss feelings, worries, and frustrations with the headmaster (SEC Item 101)
- My headmaster takes a personal interest in the professional development of the teachers (SEC Item 102)

4.8.1.8 Nature and quality of professional development opportunities

The nature and quality of professional development opportunities available to physics teachers in this study were operationalised by adapting one separate scale from the SEC survey (questions 113–125) (Jetty,2014:76).The items were personalised to ensure that they speak directly to the respondents. In these items the teachers are asked to respond to a four-point Likert scale, where 1=Never (N); 2=Rarely (R); 3=Sometimes (S) and 4=Often (O).

Questions 121–125 included a "Not applicable" response which was collapsed with the "Never" category for analysis in this particular study. Some of the items were personalised so that they could speak directly to the respondents. The total sum of the item responses was utilised to create a measure of the quality of the teachers' professional development experiences. The scale was adapted based on the premise that it had been evaluated using the Cronbach's Alpha and found to have a Cronbach's alpha of 0.846 (Jetty, 2014:81). A scale is adjudged to have sound internal consistency reliability when the reliability coefficient alpha is above 0.7. Based on the reliability analysis the scale was deemed suitable for use. The information below shows the professional development scale employed to solicit information on the quality of professional experiences from the teachers.

Statements

- I observed demonstrations of teaching techniques (SEC Item 113)
- I led group discussion (SEC Item 114)
- I developed curricula or lesson plans, which other participants or the activity leader reviewed (SEC Item 115)
- I reviewed learner work or scored assessments (SEC Item 116)
- I developed assessments or tasks (SEC Item 117)
- I practised what I learned and received feedback (SEC Item 118)
- I received coaching or mentoring in the classroom (SEC Item 119)
- I gave a lecture or presentation to colleagues (SEC Item 120)
- My school's professional development activities are designed to support the school-wide improvement plan adopted by my school (SEC Item 121)
- My school's professional development activities that are consistent with my science department or form level plan to improve teaching (SEC Item 122)
- My school's professional development workshops that are consistent with my own goals for my professional development (SEC Item 123)
- My school's professional development activities are based explicitly on what I had learned in earlier professional development activities (SEC Item 124)
- I followed up the school professional development activities with related activities that built upon what I had learned as part of the activity (SEC Item 125)

At the end of the questionnaire, respondents were asked to comment on any item in the questionnaire and indicate their willingness to be engaged in an interview. The positive responses were used as the basis for selecting participants for the interview.

4.8.2 Semi-structured interview schedule

With a semi-structured interview the researcher has a specific number of questions to put to the interviewee, but there is room for the researcher to probe emergent themes raised by the interviewee (Denscombe, 2010:175). Denscombe (2010:175) and Turner (2010:756) propose that the researcher allows the interviewee room to develop and elaborate on issues raised by the interviewer. The researcher opted for the semi-structured interview based on its ability to give the participant room to elaborate and perhaps give examples in areas of vested interest. Through the semi-structured interview the researcher was in a position to ask probing questions as follow-up to issues raised by the participant, and the interviewee was able to spell out details pertaining to his/her perceptions, concerns and practices, which was ideal for the study (Gray, 2009:373). Collection of detailed descriptions from participants enabled the researcher to bring out the meaning the teachers attached to their instructional practices. Notwithstanding possible bias, the researcher made an effort to be as neutral aspossible.

Interviews are an in-depth, rich and detailed form of gathering information, rather than gathering answer categories to specified questions (Flick, 2014:167). An interview can be considered as a talk between two persons, where one of the persons is playing the researcher’s role (Gray, 2009:370). Gray (2009:370) goes further to point out that interviewing affords the researcher the opportunity to delve into the ideas, feelings, values, responses and motives of the participant’s lived experiences. Flick (2014:167) and Gray (2009:370) highlight that interviews are a potential source of rich, relevant and pertinent data. In this particular study, interviews were conducted to explore emerging themes for teachers, perceptions of the physics curriculum, inquiry-based physics teaching, use of ICT in the physics classroom, linking of physics concepts with everyday life, school climate, school support for the teaching of physics, and school efforts towards teacher professional development. The researcher took advantage of interviews to gather verbal data to answer questions related to teacher perceptions, experiences, values and the beliefs that shape their teaching practices. The interviews afforded the researcher the opportunity to probe further on particular issues and to take note of the body language of respondents as they reflected on their experiences. The interview schedule was developed to addsomething separate and new to what was collected from the questionnaire to add an in-depth dimension. It also allowed participants to freely express themselves and give thick descriptions of their instructional practices. The interview questions focused on the same focus areas as those in the questionnaire.

The interview questions were guided by the study themes. Hence, the proposed questions were either direct or indirect depending on the specific theme guiding the questions' construction. To facilitate easy focusing of the participant on research issues raised, more than one question was designed to measure each research construct. Content validity was ensured and developed by taking the sample questions to two curriculum experts for scrutiny. The same questions were also given to one language expert to enhance clarity of questions. Advice received from the three experts was considered by the researcher when crafting the interview questions. The questions had been grouped under the thematic areas as they were developed.

4.8.2.1 Teachers' perceptions of the revised Advanced Level Physics curriculum

The following open-ended questions intended to solicit teachers' perceptions of the value of the whole revised physics curriculum, factors promoting or inhibiting its implementation and areas for possible improvement of the current curriculum. It was anticipated that the qualitative data obtained would add depth and breadth for better understanding of teachers' perceptions towards the revised physics curriculum.

- What is your opinion of the entire physics curriculum?
- Which areas in the physics curriculum need to be improved? Why do you say so?
- What are the factors that promote or inhibit the implementation of the physics curriculum in your school? Why do you say so?

4.8.2.2 Teacher preparedness

In an attempt to collect detailed data on the level of preparedness to teach Advanced Level physics, three open-ended questions were asked to deepen the researcher understands of teachers' level of preparedness. The open-ended questions sought to solicit qualitative data that would enrich and deepen understanding of physics teachers' level of preparedness to handle content, manage the classroom activities and possible areas of improving the quality of learning experience undergone by the teachers during their training. The following questions revealed this:

- How well did your pre-service teacher education prepare you to teach Advanced Level Physics? Explain your response.
- What suggestions would you make to improve the quality of learning experiences in your initial teacher training course?

4.8.2.3 Inquiry-based science teaching strategies

In a bid to collect detailed data on inquiry-based science teaching strategies, open-ended questions were generated to deepen the researcher's understanding of teachers' instructional practices with regard to inquiry-based teaching, limitations to inquiry practices and possible areas of improvement. The open-ended questions sought to solicit informative qualitative data to enrich and deepen the understanding of physics teachers' inquiry practices in the classroom. These were the questions asked:

- What instructional strategies do you use in your classroom to impart inquiry skills?
- What do you consider as limitations to using inquiry-based teaching in your classroom?
- What form of support would you need to promote inquiry-based physics teaching?

4.8.2.4 Linking physics concepts to everyday life

With respect to the idea of linking physics concepts to everyday life, open-ended questions focused on teachers' instructional strategies, teachers' limitations in linking concepts to everyday life, and suggestions to improving teachers' capabilities in linking everyday life with physics phenomena. It was anticipated that the following open-ended questions would add depth to teachers' classroom activities and experiences in linking physics concepts to everyday life in their work stations.

- What instructional strategies do you use for linking physics concepts to everyday life in the classroom?
- What challenges do you face in linking physics concepts to everyday life?
- Suggest what could be done to improve teachers' capabilities to link physics concepts to everyday life?

4.8.2.5 Use of ICT as a pedagogical tool in the classroom

To broaden understanding of ICT use in physics teachers' instructional practice, the following questions were put to the interviewees:

- To what extent do you use ICT as an instructional tool in your physics classroom? How do you use it?
- What are the barriers to ICT integration in the teaching of physics?
- Suggest measures schools may undertake to integrate ICT in the teaching of physics.

4.8.2.6 School organisational climate

Pertaining to the school organisational climate/culture, open-ended questions were generated to facilitate broader understanding of teachers' views on the importance of the school's organisational climate:

- How do you rate your school's organisational climate?
- In what ways does your school support and facilitate the teaching of Advanced Level Physics?
- What can your school management do to improve the teaching of physics?

4.8.2.7 Quality of professional development opportunities

Cognisant of teachers' need for professional development support, open-ended questions were intended to give insight into teachers' perceptions of the quality of professional development activities undergone in the school, district or national level and their expectations. Professional development opportunities enhance teachers' knowledge, skills and experiences for improved curriculum implementation and may change their beliefs and instructional practices. Frequencies of themes emanating from the responses given were used to measure teachers' perceptions of the quality of professional development experiences beliefs, and expectations. The questions that focused on the quality of professional development opportunities are given below:

- In which aspects of your teaching would you like further in-service training?
- How would you expect this in-service training to be conducted and where?
- Suggest how professional development activities could be enhanced at your school to improve the teaching of physics.

4.8.3 Document analysis

Document analysis may be considered as the systematic scrutiny of instructional documents such as syllabi, schemes of work, past examination papers and lesson notes to figure out instructional needs and challenges (Denscombe, 2010:217). Document analysis is the process of examining documents to establish intentions and trends in practices. Embarking on document analysis may facilitate gaining insight about the nature of an instructional strategy or activity and offer a window to examine trends and consistency associated with instructional documents. The data in instructional documents is considered authoritative and credible since it is produced by the state utilising a large pool of resources and professional expertise (Denscombe, 2010:217). It can be assumed that such documents are objective, factual and relevant for study purposes. The researcher intended to use clear rating criteria, for instance, checking the frequency of use of discussion as a teaching strategy that was rated as none, little, medium or extensive.

As mentioned earlier, besides the official physics syllabus (9188), teachers' schemes of work were sought to check on the provisions of the Advanced Level Physics curriculum with respect to linking concepts with everyday life, and to examine teachers' purported classroom practices linking physics concepts to everyday life. Additionally, the national examination questions were critically scrutinised on how they linked physics concepts with everyday life and how far they went beyond information in the textbooks.

4.9 PILOT STUDY

The teacher survey questionnaire was pilot-tested with six teachers in Makonde school district, in the Mashonaland West Province of Zimbabwe, for both content and constructs validity. Interview questions were pilot-tested with four teachers to establish the level of understanding of questions raised in the study. The pilot study served as a barometer for establishing if there were flaws, weaknesses or limitations in the instruments' construction design, and allowed for corrections before implementation of the full-scale study (Creswell & Plano Clark, 2011:189). The feedback from the piloting of instruments also helped in the refinement of the proposed research questions. The Makonde school district was selected on the basis of accessibility and that the high schools offered Advanced Level physics. Thephysics teachers who participated in the pilot study did not participate in the main study. Based on the responses to the survey questionnaires and comments from the interviewees, appropriate corrections were made by the researcher in agreement with the supervisor. For instance, Question 62 on the survey questionnaire which read as: "The headmaster takes personal interest in the professional development of teachers" was changed to: "My headmaster takes personal interest in the professional development of the teachers". The change was made to give the researcher room for further probing to get detailed responses from the interviewees. It was considered necessary to personalise and contextualise the statement. Question 2 on the interview guide which read as: "What are factors that inhibit the implementation of the physics curriculum in your school?" was changed to read as: "What are the factors that inhibit the implementation of the physics curriculum in your school and why do you say so?" The pilot study provided the researcher with the opportunity for the best possible question formulation. Thereafter the research instruments were deemed appropriate for the research study.

4.10 SAMPLE SELECTION AND ITS DESCRIPTION

The process of selecting research participants from a population must be done in such a way that the selected persons are a true representative of the large group. According to Kothari (2011:152), sampling is concerned with the selection of a section of the total population, basing on it the decisions to be made about the population. In essence sampling refers to the business of soliciting information about a total population through studying a section of it. Prospective contributors to the study comprised all 150 Advanced Level Physics centres' teachers. The sample frame was made up of 56 physics teachers from four educational provinces of Zimbabwe. Multistage sampling strategies were employed in selecting the respondents for the study. This was done to reduce the variance associated with parameter estimate and to maximise the possibility of engaging the maximum number of participants with the sought characteristic (teaching physics in this particular study), with due regard to financial limitations in conducting the study in all the 150 high schools in all Zimbabwean educational provinces.

Taking cognisance of the geographical spread across Zimbabwe, it was not feasible to employ simple random sampling for the whole country's high schools. This scenario may make data collection impractical due to time and financial implications (Flick, 2014:167). The schools were considered as clusters and the list of schools in each cluster was sourced from the Ministry of Primary and Secondary Education. The two clusters are the urban and rural schools. Equal sized samples were allocated to each cluster and simple random sampling was employed to select the required number of participants from the clusters. The name of each school in a cluster was written on a slip of paper, the slips were put in a box and mixed thoroughly and then the required number of slips was drawn in succession without replacement (Kothari, 2011:60). The exercise was repeated for the other cluster. The successive drawing of remaining elements ensures that the participants are accorded the same chance of being picked. It was anticipated that taking this route would minimise costs and ensure efficient data collection. The next paragraph details how the participants were selected from the schools.

For this study, four provinces were purposively selected from the 10 provinces. These provinces are: Harare, Mashonaland West, Mashonaland Central, Mashonaland East, Manicaland, Masvingo, Midlands, Bulawayo, Matabeleland North and Matabeleland South. The selected provinces were Harare, Mashonaland Central, Mashonaland East and Mashonaland West. Harare is largely urban and Mashonaland Central, Mashonaland East and Mashonaland West are largely rural. Based on the ZIMSEC data base for the registration of the Advanced Level Physics curriculum (9188) in November 2014, Harare has 39 centres, Mashonaland West has 14, Mashonaland East has 17 and Mashonaland Central has eight centres. Proportional representation was used for the largely rural provinces. The sample was representative of both categories of high schools found in Zimbabwe located in socio-economically diverse communities. The representative sample comprised 28 urban schools and 28 rural schools. Simple random sampling was used to select the participating school districts in the selected provinces. The school districts were numbered and put in a box. A colleague was asked to pick out six districts from each province which would participate in the study. The participating schools were purposively selected and teachers teaching Advanced Level Physics in the selected schools participated in the study. The schools were selected on the basis of accessibility, availability and matching the criterion of offering Advanced Level Physics. Teachers participated on the basis that they are teaching Advanced Level Physics at their stations. Fifty-six physics teachers were expected to participate in the study.

4.11 DATA ANALYSIS

Data gathered was extensive and as such was analysed using both quantitative and qualitative methods. Creswell and Plano Clark (2011:207) advise that data analysis aims to make sense of massive amounts of data, reduce volume of information, identify significant information and construct a framework for communicating the meaning of what the data unravels.

4.11.1 Questionnaires

Data from the teachers' questionnaires was analysed using descriptive statistical methods involving percentages, means and standard deviations where appropriate. For instance, biographic data percentages were computed with the intention to define characteristics of the sample for interpretation, generalisability and unravel data patterns associated with other analysis of practices tests. Responses on the Likert scale items were coded in relation to the response levels and calculated using the SPSS 16.0 statistical package. For example, the idea of linking physics concepts to everyday life was computed by taking the six variables (items) and taking the average. The six items were considered singly or combined when deemed appropriate. Independent chi-square tests were conducted to determine whether significant differences exist in specific practices and in some variables from the demographic data of the physics teachers. The chi-square static was compared against a critical value from the chi-square distribution value. This enabled the researcher to ascertain whether the association between the variables in the sample was likely to represent ac actual relationship between the variables in the physics teachers.

4.11.2 Interviews

Flick (2014:370) argues that analysis of qualitative data is concerned with the interpretation and classification of verbal information with the intention of making the material complete and explicit. This could be considered as making the information clear and understandable for easy consumption. To facilitate better understanding of issues raised, responses to open-ended questions were coded into themes, and frequencies of teachers' responses in each theme were determined. The qualitative data was further organised into themes reflecting the purpose of the study. Narrative descriptions were used to expound on emerging themes. The data was transcribed verbatim taking cognisance of recurrent issues and compared with field notes generated during the interview sessions. The data was then coded into themes, patterns, and categories establishing emerging concepts (Creswell & Plano Clark, 2011:208; Flick, 2014:282). The researcher would go through the interview transcripts making tallies of emerging themes and collate the frequencies. Data was grouped into similar dimensions and the dimensions were compared to derive similarities and differences.The research established patterns in data and developed relationships. The established themes were in line with common ideas given by the participants. The emerging themes were grouped into larger perspectives and related to provide solutions to the teachers' interpretations and practices, and to provide detailed information with regard to the context and validated the quantitative data. The interview data themes were constantly corroborated with data from questionnaires and document analysis.

4.11.3 Document analysis

The researcher obtained state and school curriculum documents from provincial officers and school teachers. The curriculum documents collected included the National Physics syllabus (9188); past physics examination papers and teachers' schemes of work. The physics syllabuswas checked for curriculum ideals and intentions; schemes of work gave a measure of teacher practices, and examination papers gave indications of what was being examined. Since schemes of work are socially generated products to serve particular schools, they may contain biases which may not do justice to the research agenda. To ensure the quality of documents was worthwhile for the study, the documents were checked for authenticity (through the school stamp), credibility (accuracy of information), representativeness (whether they are covering the desired period) and meaning (clarity and logic for instructional practices) before being used (Flick, 2015:258). These attributes formed the basis of deciding whether curriculum intentions had been put into practice. The schemes of work were then utilised to establish the extent of the physics curriculum intentions in classroom instructional practice. The researcher went through each lesson plan checking the suggested teaching strategy and related teaching activities.A total of 143 lesson plans were analysed. From these the researcher was in a position to pick on the limitations, discrepancies or inconsistencies and their frequencies between official curriculum intentions, teachers' practices and the examination system.

4.12 RELIABILITY AND VALIDITY

According to Gray (2009:193) reliability refers to the stability of findings. Reliability was guaranteed through data triangulation. This was achieved through the use of multiple data-gathering tools such as the questionnaire, interview guide and document analysis. Gray (2009:155) observes that for validity, a research instrument must measure what it is intended to measure. To ensure validity the research instruments were pilot-tested on four purposively selected physics teachers not included in the samplethat completed the questionnaire. The responses were scrutinised for clarity and whether they measured what they were intended to measure. Some of the statements were rephrasedto make them completely understandable to the physics teachers. To establish the trustworthiness of the interview guide, it was given to two colleagues who are experts in physics education to review the questions. The purpose was to minimise ambiguity, leading, emotive and stressful questions. The feedback obtained was incorporated into the interview guide. In addition, two physics teachers in Makonde school district, Mashonaland West Province were interviewed using the designed interview schedule. Feedback obtained was used to improve the data-gathering instruments prior to use in the field. The findings were provided to the research participants in follow-up feedback sessions. In addition the findings were shared with colleagues and presented at conferences for peer review.

4.13 ETHICAL CONSIDERATIONS

In research there is a moral obligation to build trust between the researcher and the participants (Creswell, 2009:89). First, the issue of access to both the subjects/participants and institutions was considered. Permission was sought from relevant authorities from the

Ministry of Primary and Secondary Education, at provincial, district and school level where the study was undertaken. The issue of confidentiality was guaranteed through assurance of anonymity and it was hoped the respondents would open up and provide honest and reliable responses to questions in the questionnaires and interviews based on confidentiality and anonymity. The importance of the participants' right to knowledge, privacy and participation was fully explained before their cooperation was sought. The purpose of the study was explained to each participant as well as his/her right to refuse to participate or to choose to withdraw at any stage of the study. This was to ensure informed consent of the participants. Clearance was also obtained from the University of South Africa's College of Education Research Ethical Clearance Committee prior to data collection.

4.14 ANTICIPATED LIMITATIONS

The study was conducted in a relatively volatile environment in the history of the Zimbabwean education system, owing to many changes that are anticipated. It is possible that recommendations emanating from the study may be overtaken by events since major changes in the practice of education are envisaged. To minimise these limitations the researcher remained focused on exploring the major concept of the teachers' interpretation and implementation of the Advanced Level Physics curriculum. Through careful planning by the researcher and professional guidance by the supervisor, it was hoped these cited limitations would not curtail the study's success.

The participants may find the checking of their working documents, specifically schemes of work, irritating and disrespectful of their professional credentials. To guard against this scenario, the researcher made efforts to create a free and amicable environment for the teachers by visiting the respective schools prior to data collection to liaise with the teachers. The financial implications of the study were fairly high, which inhibited extensive travelling to distant schools. The researcher made efforts to source funding so that financial constraints did not affect the study negatively.

Sometimes participants do not accurately report their opinions or views in a survey. Hence, information from the respondents may be biased, not well reconstructed or may give inaccurate accounts of the existing situations. To ensure that such eventualities did not distort the study findings, data obtained from different sources was corroborated through the triangulation of interviews, questionnaires and documentary analysis data.

The study may be constrained by using mixed methods as the research approach. The mixed methods approach requires the researcher to develop and practise skills embedded in both qualitative and quantitative paradigms (Denscombe, 2010:151; Creswell & Plano Clark, 2011:80). This is a demanding and challenging task for the researcher. To overcome this challenge, the researcher called on his experience in previous research and made a concerted effort to develop his skills in both qualitative and quantitative research, soliciting guidance from the supervisor to ensure the study remained focused on solving the research problem.

The study's lack of classroom observations in that validation of findings on teacher's practices may be found wanting. The richness and detail of observation data could have contributed to a more nuanced perspective into the classroom practice of teachers and informed further on factors impacting curriculum implementation. To minimise the impact of lack of classroom observations the researcher analysed the lesson plans for one school tern for on physics teachers. However, it is appreciated that what teachers plan is not necessarily what they may practise in the classrooms with the learners. It was assumed teachers as professional take their lesson planning serious and make efforts to implement their plans, though there is room for deviation. Hence document analysis of teachers' lesson plans was anticipated to give a credible measure of physics teachers' envisaged teaching practices.

4.15 CHAPTER SUMMARY

The study was designed to describe the methodology to investigate the identified research question and sub-questions and to make recommendations for possible interventions. The research approach adopted is the mixed methods paradigm guided by the pragmatist worldview and was executed through the congruent parallel design. Data for actual physics learning experiences was generated by employing teacher survey questionnaires, interviewing the teachers and document analysis of the Advanced Level Physics syllabus, teachers' schemes of work and past physics examination papers. Quantitative and qualitative data was collected at the same time, analysed independently and merged during the interpretation of the findings. The next chapter will focus on examining the collected data and discussing the findings.

CHAPTER 5
DATA PRESENTATION, ANALYSIS AND DISCUSSION

5.1 INTRODUCTION

The chapter presents the results from the quantitative and qualitative data collected. The results presented include the description of the sample, descriptive statistics and inferential statistics methods for key variables, including percentages, frequencies, means, standard deviations and chi-square. Qualitative data from interviews was decoded, listened to on numerous occasions and transcribed. Analysis was discussed in the previous chapter. For purposes of anonymity the interviewees were given pseudonyms in the form of letters A to I. The data analysis is presented with due respect to data collected from the physics teachers. In situations where quotes are employed, these are representative of teachers' sentiments in verbatim. Indeed, the presentation of an accurate and verbatim transcript is a critical ingredient to enhance the credibility and trustworthiness of the information gathered. In the same vein it enables the researcher to delve deeper into issues that may not be explored using only questionnaires.

Rogan and Grayson's (2003) theory of curriculum implementation was employed as the lens through which teacher practices were scrutinised and to ascertain what the Zone of Feasible Innovation (ZFI) for the particular teachers was at the time the study was conducted. The constructs of the Profile of Implementation (PoI), Capacity to Innovate (CtI) and Outside Influences (OI) are operationalised to determine the teachers' levels of practices and context against expected standards of operation. The sub-constructs of PoI, CtI and OI as depicted in Tables 2.1, 2.2 and 2.3 were evoked and used as the analysis framework guidelines depending on the nature of teacher practices and context of practice being analysed. For the construct PoI, the sub-constructs under focus are 'science practical work' and 'science in society'. The construct CtI is underpinned by the sub-constructs 'teacher factors' and 'school ecology'. The construct OI is driven by the sub-constructs 'professional development' and 'direct support to learners'. Levels 1–4 of operation of the respective sub-construct were used to rate the current physics teacher practices. The comparison of current physics teachers' practices against the expected levels of operation may give gaps in teacher practices and possibly guidance on areas that may require attention for redress. The documents in the form of the syllabus, examination papers and schemes of work were analysed in terms of intended teaching methods, objectives, assessment criteria against instructional practices as portrayed by the teachers. The teachers' background information was co-related to some of the practices to establish if there could be any relationships. The findings presented in this chapter are cross-referenced to literature for knowledge harmonisation. The discussion starts by giving the selected provinces, the sampled schools and the response rate.

The selected provinces were Harare, Mashonaland West, Mashonaland East, and Mashonaland Central. Harare province has the highest concentration of high schools totalling 39. The four provinces have a total of 78 high schools, of which 56 were sampled for the survey. The 56 survey questionnaires were returned and four incomplete responses from the questionnaires were excluded from the data analysis. The complete questionnaires represent a completion rate of 93.3%. The next section focuses on the physics teachers' characteristics.

5.2 TEACHER CHARACTERISTICS

The demographic data was analysed to bring insights into the participants' background, teaching experience, highest qualifications, prevailing work environment and context. The majority of the physics teachers who participated in the survey were male (87.5%). Approximately 86% of the participants were above 30 years of age and all the teachers had earned at least a minimum of a first degree qualification. About 93% of the respondents had specialised in physics and 75% of the respondents had an education qualification component, obtained from a university's education faculty. The majority of the teachers were rated on operation level 3 of the teacher factor sub-construct, indicating that the teachers are qualified for their positions and have sound understanding of subject content (Rogan & Grayson, 2003:1189). All the participants are teaching physics in a high school and were deemed competent to participate in the study. The characteristics associated with the physics teachers who responded to the questionnaire are presented in Table 5.1.

Table 5.1: Demographic data of the respondents

Variable		Frequency	Percentage
Gender			
	Male	49	87.5
	Female	7	12.5
Age group			
	21-30	8	14.3
	31-40	24	42.9
	41-50	20	35.7
	51-60	3	5.4
	61+	1	1.8
School location			
	Urban	28	50
	Rural	28	50
Highest qualification			
	Bachelor of Education	18	32.1
	Bachelor's degree (non-education)	10	17.9
	Bachelor's degree (with education)	20	37.5
	Master's degree (non-education)	4	7.1
	Master of Education degree	4	7.1
Area of specialisation			
	Physics	54	96.4
	Chemistry	2	3.6
Teaching experience in years			
	0-5	19	33.9
	6-10	17	30.4
	11-15	9	16.1
	16-20	7	12.5
	21+	4	7.1
Average physics class size			
	1-5	1	1.8
	6-10	9	16.1
	11-15	19	33.9
	16-20	10	17.9
	21+	17	30.4

The majority of the physics teachers (64.3%) had 10 years or less teaching experience. This finding is consistent with Mushayikwa (2013:274) and Kazembe and Musarandega (2012:4) who opined that the bulk of the experienced science and mathematics teachers had left for greener pastures due to the economic meltdown prevailing in the country. The low level of experience in teaching Advanced Level Physics may be a hindrance to effective delivery of teaching in the classrooms owing to restricted PCK. The majority of the physics teachers (about 75%) have some form of pedagogical training. This finding is consistent with Chavhunduka (2005:4) who claims that Zimbabwean science teachers had the requisite pedagogical competences. This is encouraging and should augur well for good physics curriculum interpretation and sound instructional practices in the physics classrooms. The majority of the teachers (about 96%) specialised in physics at university and as such are expected to have a good grounding in the physics content knowledge. The teachers should also be able to interpret physics concepts and ideas effectively. The average physics class size of 20 and below in the majority (70%) of the schools is consistent with the expectations of the Ministry of Primary and Secondary Education. The class size would augur well for affording adequate space for learners doing practical work activities and effective supervision and guidance from the teacher during the exercises. This prevailing teaching environment may go a long way in enhancing teachers' effectiveness in developing learners' conceptual understanding of physics.

The interviews with 10 respondents were done using an interview guide (Appendix I). The interviews were audio recorded, and decoded several times to ensure the authenticity of the information gathered. The data was then collated and coded into themes for the discussion. The respondents were assigned letters from A to J to keep them anonymous. Some of the sentiments of the respondents are given verbatim to ensure credibility of the gathered data. The document analysis guide (Appendix J) was employed on six past examinations practical papers and 10 teachers' schemes of work for one school term. The qualitative data adds depth to the understanding of issues being investigated in this study. The analysis and discussion was done with respect to the research questions.

5.3 TEACHERS' PERCEPTIONS OF THE PHYSICS CURRICULUM

The first question sought to explore the Zimbabwean physics teachers' perceptions of the Advanced Level Physics curriculum. This question was premised on the idea that perceptions informpractice and therefore guide conceptual interpretations and instructional practices. Information pertaining to the teachers' perceptions of the physics curriculum was solicited through the teachers' self-reported questionnaire. The questionnaire used closed statements that focused on how the teachers perceive the physics curriculum. The responses to the questionnaire statements were categorised and scaled as 1 (strongly disagree) to 5 (strongly agree). The self-reported responses were subjected to statistical analysis. The interview questions were focused on the areas of the physics curriculum that may need to be improved. The questions were premised on content relevance, modern technology-related trends and factors that may be inhibiting the effective implementation of the curriculum. Table 5.2 showsthe frequencies, percentages, means, modes and standard deviations.

Table 5.2: Frequency, percentage and descriptive statistics of the teachers' perceptions of the physics curriculum

	Frequencies, percentages and descriptive statistics (N = 56)							
Statement	**1**	**2**	**3**	**4**	**5**	**Mode**	**Mean (M)**	**Standard Deviation (SD)**
The curriculum content fosters cutting-edge technology	4 (7.1)	10 (17.9)	21 (37.5)	21 (37.5)	0	3	3.05	0.92
My learners find the curriculum content interesting	0	3 (5.4)	9 (16.1)	34 (60.7)	10 (17.9)	4	3.91	0.75
The content fosters problem–solving and critical thinking skills	0	3 (5.4)	6 (10.7)	38 (67.9)	9 (16.1)	4	3.95	0.70
The curriculum content helps learners in career pioneering	1 (1.8)	5 (8.9)	11 (19.6)	25 (44.6)	14 (25)	4	3.82	0.97
The curriculum content has concepts which are difficult for me to understand	22 (39.3)	26 (46.4)	7 (11.25)	1 (1.8)	0	2	1.77	0.74
My content knowledge of topics in Physics curriculum is sound	2 (3.6)	1 (1.8)	4 (7.1)	25 (44.6)	24 (42.9)	4	4.20	0.93
The content is excessive compared to the allotted time	7 (12.5)	18 (32.1)	12 (21.4)	15 (26.8)	4 (7.1)	2	2.84	1.17
I have difficulties in providing effective instruction	16 (28.6)	31 (55.4)	3 (5.4)	6 (10.7)	0	2	1.98	0.88
The teaching approach is compatible with the final assessment	(5.4)	5 (8.9)	5 (8.9).	31 (55.4)	12 (21.4)	4	3.79	1.06
Average scores							3.26	0.90

From Table 5.2 it can be deduced that the teachers' perceptions of the physics curriculum are positive as indicated by the overall mean score of 3.26 and average standard deviation of 0.90. This could be an indication of the teachers' acceptance of the revised physics curriculum, which bodes well for effective teaching and learning. This finding resonates well with Elmas et al. (2014:11) who established that Turkish physics teachers had positive perceptions about the revised curriculum content and the suggested teaching approach in that country. The item “My content knowledge of topics in the physics curriculum is sound” (M=4.20; SD= 0.93) was highly rated. This could be evidence that the physics teachers believe that they have a sound grounding in physics subject matter and are adapting well to the demands of the revised physics curriculum. This finding is consistent with Fullan (2007:272) who argues that teachers who are adequately prepared in both their area of specialisation and pedagogy are likely to be confident in their work. The item “The content fosters problem solving and critical thinking skills” (M=3.95; SD=0.70) was also highly rated. This may be an indication that the physics teachers are convinced that the current physics curriculum has what it takes to instil problem solving and critical thinking competencies in the learners.

The item “The curriculum content has concepts which are difficult for me to understand” (M=1.77; SD=0.74) and the item “I have difficulties in providing effective instruction”, (M=1.98; SD=0.88) were lowly rated. This suggests that the teachers are comfortable with the physics curriculum concepts and have little or no problems with developing effective teaching strategies. The positive perceptions about a curriculum harboured by the teachers serve as fertile ground for possibilities of effective curriculum implementation. However, it may be a reflection of ineffective self-evaluation by the current physics teachers. If this is the case, then it could be a reflection of poor teaching practices.

A chi-square test exploring the relationship between the level of teachers’ perceptions towards the Advanced Level Physics curriculum and the teachers’ characteristics was conducted. The results obtained indicated no significant association with respect to gender, age, school location, teachers’ highest qualification, average class size and teaching experience. For the relationship between the teachers’ area of specialisation and the level of teacher perceptions, chi-square value (χ) of 56.0 was obtained with 10 degrees of freedom (df) at 0.05 level of Confidence; a significance level (p) of 0.00 was attained. It can therefore be concluded that there is a significant association between the teachers’ area of specialisation and the level of teachers’ perceptions towards the curriculum. For the relationship between the highest qualification obtained by the teacher and perceptions towards the physics curriculum, the chi-square value (χ) of 62.63 was obtained with 40 (df); a (p) of 0.013 was achieved at 0.05 level of Confidence. Hence it can safely be concluded that there is a significant association between the physics teachers' highest qualification and their perceptions towards the physics curriculum.

Despite the positive perceptions harboured by the teachers towards the physics curriculum, sentiments from the interviews underscored four areas of concern. Among the emerging themes were that the curriculum is found wanting with respect to issues that deal with 'modern technology', the 'length of the curriculum', 'limited practical work activities' and 'limited resources'. The first concern to be explored is the perceived inadequacy of modern technology-related content in the Advanced Level Physics curriculum.

5.3.1 Inadequate modern technology-related content

Modern technology is the thrust of economic development and social transformation. It is anticipated that knowledge and effective use of modern technology form the pillars for scientific development and enhancement of the economic performance of any nation. Consequently, inclusion of modern technologies in any science curriculum is regarded as a prerequisite to promote economic development and emancipation. The majority of the interviewees reported perceived inadequacy of the Advanced Level Physics curriculum with respect to addressing modern technologies. The sentiments that follow illustrate the ideas raised by some of the respondents.

> *"The physics syllabus should include latest technology, like incorporating the modern communication technology"* (Teacher A).
>
> *"Ah – maybe I would talk of some current applications, like use of the cell phone being part of the physics syllabus and also need to improve on electronics"* (Teacher C).
>
> *"So far, I do not see the need for change. It is okay as it is*" (Teacher F).

Although most of the teachers would prefer more technology to be included, not all teachers were in agreement. Overall, this suggests that there may be a need to incorporate new technological developments in the Advanced Level Physics curriculum. Such a move will ensure that the learners are not disadvantaged with regard to current modern communication technologies in the global arena and in local industrial processes. Teaching such aspects in the physics curriculum may enable the learners to compete in global markets and provide a strong foundation for industrial and commercial development for the country. Consequently, curriculum designers may need to revisit the physics curriculum and find an appropriate way of including the relevant areas in a future physics curriculum. This may make the envisaged physics curriculum more appealing, relevant and interesting to the learners. Learners are likely to benefit from such a curriculum, and economic and technological advancement prospects of the nation are likely to be assured.

5.3.2 Limited suggested practical activities

Hands-on learning activities are the cornerstone of enhancing the conceptual development of science concepts and understanding in learners. Limiting such hands-on activities could be a serious hindrance to effective teaching and learning of physics. The sentiments below from some of the teachers serve to illustrate that the physics curriculum may lack detailed specifications of the expected practical activities to be undertaken by learners.

> *"I think the practical aspect can be improved. You know what the problem is that there are many books for theory, but when it comes to practical activities they are not matching"* (Teacher G).

> *"Okay, like in radioactivity, there is too much theory in the syllabus, there is need for practical activities for effective teaching. For instance, learners need to do the practical activity with the radioactive source seeing the background radiation count. We are simply theorising in the schools"* (Teacher B).

> *"In modern physics, radioactivity, photo electricity, we go through the chapters without carrying outexperiments"* (Teacher E).

Based on these responses, there is need for the inclusion of more practical activities in the physics curriculum to adequately guide the teachers. This would make the teachers' work easier and enhance effective planning of classroom activities. However, the teachers need to be encouraged to innovate and come up with their own practical work activities relevant to the concepts being taught. The teachers may need to be assisted with this in the form of a handbook suited to their context, or through in-service training.

5.3.3 Limited resources

Relevant and appropriate modern equipment available in sufficient quantities in the schools is a prerequisite for effective translation of the physics curriculum into practice. The ideal situation would be one in which learners can be in a position to undertake practical work individually to promote hands-on experience. However, practical work activities can also be undertaken in small groups to enhance sharing of ideas, or as a demonstration when equipment is in short supply. Resource availability makes the life of the teacher easier by reducing planning constraints. The majority of the teachers bemoaned the critical shortage of relevant apparatus suggested in the physics curriculum. The shortage of modern equipment in the schools has a strong bearing on teachers' perceptions of the physics curriculum. The comments from some of the respondents portray the prevailing situation in the high schools.

> *"Availability of resources is a major factor. I have been in this school since 2010 and up to now we have not managed to buy a cathode ray oscilloscope"* (Teacher A).

> *"There is a serious shortage of apparatus in our school such that learners undertake group practicals rather than doing them individually and in some cases abandoning it altogether due to lack of equipment"* (Teacher B).

These sentiments indicate that the teachers experience an acute shortage of equipment for effective planning and execution of meaningful teaching and practical work activities. This situation is not desirable since practical work activities are essential for good mastery of physics concepts. The prevailing scenario may frustrate the teachers with regard to effective interpreting of the curriculum. This finding is not consistent with that of Hattingh et al. (2007:84) who contend that undertaking practical work is not significantly based on the availability of laboratory equipment. Rather, the implication is that those with the capacity to innovate will find ways to organise practical work for the learners even in poorly resourced schools. Being innovative and resourceful may lead teachers to better understand the curriculum demands and to develop more positive perceptions about the physics curriculum. This may highlight the need to focus on innovative teaching strategies and to provide teachers with examples as an alternative.

5.3.4 Length of the physics curriculum

The length of a programme and its demands may have a substantial influence on the teaching approaches used to cover the learning material in the given time. If the syllabus is judged to be too long by the majority of the teachers, this may lead to rushed content knowledge coverage. Such a scenario may result in surface treatment of the content knowledge, creating a lack of deep understanding of concepts by the learners. This could result in serious misconceptions, which are detrimental to the learners' future undertakings in physics-related disciplines. Some of the teachers were concerned about the length of the current physics curriculum.

> *"The physics syllabus is too long to be covered in five school teaching terms"* (Teacher J).

> *"The syllabus is just too long. There is too much content"* (Teacher A).

These statements suggest that the content to be covered in the physics curriculum appears not to be commensurate with the allocated time. This may encourage the physics teachers to resort to traditional transmission methods at the expense of learner-centred teaching approaches suggested in the physics curriculum. This may not be a good precedent for ensuring objective interpretation of the physics curriculum and instilling positive teacher perceptions of the physics curriculum.

The survey findings indicate that teachers feel positive about the physics curriculum. The interview findings highlight teachers' concerns with the physics curriculum such as the lack of incorporation of modern technology, limited practical work activities, limited resources and the length of the curriculum. These issues need to be addressed to improve the teachers' perceptions of the physics curriculum and ultimately their teaching efficacy. The next aspect to be discussed is the physics teachers' anticipated levels of preparedness to teach physics.

5.4 TEACHERS' LEVEL OF PREPAREDNESS

This section explores the level of preparedness of teachers to implement innovative teaching strategies in the physics classroom. This question was hypothesised with the view that the level of teachers' preparedness has much bearing on the teachers' skills to enact innovative instructional strategies in a specific environment. The level of teacher preparedness rests on the training that a particular teacher would have undergone and how much he/she may have benefited from the system. To that end, six statements on the survey questionnaire seeking the teacher's opinion on his/her state of preparedness to teach physics were enlisted. The interview guide questions focused on the teacher's level of preparedness to teach Advanced Level Physics and possible areas of improvement with respect to pre-service teacher training. The responses to the closed questionnaire questions were categorised and scaled as 1 (not well prepared) to 4(very well prepared). Table 5.3 gives the descriptive statistics of the teachers' survey self-reported responses with respect to their perceived state of preparedness to teach physics.

Table 5.3: Frequencies and statistics of teachers' perceived state of preparedness

	Frequencies, percentages and descriptive statistics (N = 56)						
Statement	1	2	3	4	Mode	Mean	Std Dev
Indicate the extent to which you are prepared to teach physics at Advanced Level	0	4 (7.1)	21 (37.5)	31 (55.4)	4	3.48	0.63
Indicate the extent to which you are prepared to integrate physics with other subjects	0	9 (16.1)	28 (50.0)	19 (33.9)	3	3.18	0.69
Indicate the extent to which you are prepared to provide physics instruction that meets physics content standards at national level	0	5 (8.9)	25 (44.6)	26 (46.4)	4	3.38	.65
Indicate the extent to which you are prepared to use a variety of assessment strategies (including objective and open-ended formats)	0	11 (19.6)	28 (50.0)	17 (30.4)	3	3.11	0.71
Indicate the extent to which you are prepared to manage a class of learners who are using hands-on or laboratory activities	0	3 (5.4)	24 (42.9)	29 (51.8)	4	3.46	0.60
Indicate the extent to which you are prepared to take into account learners' prior conceptions about natural phenomena when planning	2 (3.6)	12 (21.4)	25 (44.6)	17 (30.4)	3	3.02	0.82
Average scores						3.27	0.69

From Table5.3 it can be deduced that the teachers are adequately prepared to handle Advanced Level classes. The overall mean score and standard deviation for the teachers' sense of level of preparedness to teach physics were: M=3.27 and SD=0.68 respectively. This shows that teachers in the study believed they were adequately prepared to handle the physics curriculum and the learners. The mean scores for each item are above 3. The item: "Indicate the extent to which you are prepared to teach physics at Advanced Level" (M=3.48; SD=0.63) and the item: "Indicate the extent to which you are prepared to manage a class of learners who are using hands-on or laboratory activities" (M=3.46; SD=0.60) were rated very highly. About 93.7% of the respondents indicated they were well-prepared to handle a class that was undertaking practical work activities. This may be attributed to the fact that about 85% of the respondents had undergone teacher education training offered by faculties of education in universities. This finding is consistent with Fullan (2007:272) who contends that teachers who are adequately prepared in the subject discipline and pedagogy are more likely to do well in their classroom responsibilities.

A chi-square test exploring the relationship between the level of teacher preparedness to teach Advanced Level physics and the teachers' characteristics was conducted. The results obtained indicated no significant association with respect to gender, age, school location, teachers' highest qualification, area of speciality or teaching experience. For the relationship between the class size and the level of teacher preparedness, chi-square value (χ) of 16.87 was obtained with 8 (df) at 0.05 level of Confidence; a (p) of 0.03 was attained. It can therefore be concluded that there is a significant association between the class size and the level of teachers' preparedness. This may be attributed to the idea that the teachers handling a large class feel challenged and have to thoroughly prepare themselves for any eventuality to minimise personal embarrassment.

During the interviews, a few issues and concerns were raised about the teachers' anticipated state of preparedness to teach physics at Advanced Level. Three thematic areas emerged from the interviews, namely the 'duration of teaching practice', 'inappropriate content knowledge' and the 'traditional lecture approach'. Prominent among these were the short time given to the teaching practicum,and the over-reliance on the traditional lecture method. On a positive note, the majority of the interviewees acknowledged and appreciated the importance of the educational foundation courses they had undergone. However, there was general feeling that more could have been done in terms of innovative teaching strategies. The first issue to be explored is the duration of the teaching practicum.

5.4.1 Teaching practicum

Teaching practice is a very critical component of teacher education offered by universities' faculties of education. It gives the pre-service teachers a feel of their intended working environment when they are provided with the opportunity to handle a class for a full school term. Teaching practicum gives the student teachers time to interact with learners and learn from seasoned colleagues in the field. This situation gives the student teachers grounding to be effective in their intended profession after qualification. However, the teachers involved in this study lamented that the teaching practicum period was too short. The teachers argued strongly that their teaching practice stint did not adequately prepare them for teaching and better understanding of the learners and the work environment. The following sentiments from some of the respondents give a measure of their perceived frustrations with the single school term teaching practicum.

> *"I would urge the teacher training institutions to have a longer period for teaching practice, right from first year to be in constant touch with learners"* (Teacher C).

> *"I think maybe teacher training institutions need to increase the duration of the teaching practice"* (Teacher D).

A longer period of teaching practice may better facilitate the student teachers' improved understanding of the learner diversity and the dynamics of the teaching context. A developmental approach could possibly be employed where in progressive years or school terms a specific aspect of the teaching practice is targeted. For instance, in a particular school term the focus may be on teaching practice observation and in another term on the actual teaching practice.

5.4.2 Content knowledge

Sound CK is one of the critical ingredients for effective teaching. Sound content mastery enables the teacher to plan and facilitate learning experiences with confidence and guarantees trust of the learners. Universities are autonomous and design their programmes according to their perceived student needs. Graduates from the different universities are likely to have been exposed to different content coverage during their studies. The universities are also privileged in having modern and sophisticated equipment which is non-existent in the schools. This may contribute to difficulties in adjusting to the school contexts. It is quite possible that different universities may have prepared the practising teachers differently. Hence, the teachers may not have benefited from their teacher training to the same extent. Varied sentiments raised by the interviewees serve to illustrate that some of the respondents were satisfied with the way universities had prepared them for their responsibilities, while others were not.

> *"Yeah, the programme was quite intense it really capacitated me in terms of both theory and practical work activities to teach at this level"* (Teacher E).

> *"The teacher training programme aspect did a great deal in preparing me for teaching Advanced Level Physics"* (Teacher F).

> *"Teacher training did not adequately prepare me to teach Advanced Level Physics. What we did is not linked to what. I am teaching. I am actually reading on my own"* (Teacher B).

Although a few teachers critiqued their training, most of the teachers involved in this study are of the opinion that they have been adequately prepared to execute their professional responsibilities effectively at high school with respect to CK. This finding is inconsistent with Buabeng (2015:249) who maintained that university physics departments rarely provide sufficient preparation for students to teach in high schools. A few of the respondents also believed that universities need to do more with respect to teaching CK.

5.4.3 Traditional lecture approach

The majority of the interview respondents indicated inadequacy in learner-centred teaching approaches. Their view was that their training was mainly orchestrated though teacher-centred methodologies. Some of the opinions raised by the interviewees express the frustration they felt during their teacher training.

> *"I strongly feel there is need to put more emphasis on teaching methods. During my training it was more of physics content, they did not emphasise the methods"* (Teacher F).

> *"Pre-service training was okay, but of course in terms of content, but not in terms of methodology"* (Teacher F).

> *"My teacher training was adequate, it was very comprehensive in subject matter and a little bit of pedagogy, mainly looking at the teaching of Advanced Level Physics"* (Teacher I).

Based on the preceding sentiments it seems that a number of teachers are satisfied with their level of preparedness, but a few were of the opinion that there is need for teacher training institutions to concentrate more on methodology. This finding resonates well with Buabeng (2015:16) who argues that teacher training programmes should not only strive to deepen teacher PCK, but also focus on teaching strategies and their execution in practice. This may adequately prepare pre-service teachers with requisite competencies to detect and appropriately respond to learner diversity. The student teachers may be equipped to create instructional strategies that are learner-centred and focused on learner needs and interests. Ultimately the learners may benefit more from the learning experiences provided by the teachers.

The survey findings reflect that the teachers are adequately prepared to teach physics, but the interviews raise a few concerns on the nature of the teacher training programmes. The interviews highlighted areas of the teacher training that may make it more enriching if appropriately adjusted. These include increasing the length of the teaching practice, making physics content more relevant and minimising use of the traditional lectures by focusing on other methodologies during teacher training. Hence, there is a need to standardise teacher training in Zimbabwe as a way of harmonising and expanding CK and instructional approaches. The next section is going to focus on inquiry-based science teaching as practised in Zimbabwean high schools.

5.5 TEACHERS' INQUIRY-BASED PHYSICS PRACTICES

This discussion is centred on the research question: "How do Zimbabwean teachers teach inquiry skills in Advanced Physics lessons?" This question seeks to address current teacher practices with respect to current inquiry instructional practices, contributing factors and possible areas of improvement if any. The data was solicited through 11self-reported items on the survey questionnaire, an interview guide and a document analysis guide (Appendix H). The document analysis guide targeted 10 schemes of work for one school term, and six practical Paper 4 examination questions. The PoIsub-constructs of 'science practical work and assessment' and CtI sub-construct of 'physical resources' Levels 1–4 of operation were evoked as the scale to rate the physics teachers practices. The teachers' responses to the closed statements in the questionnaire were categorised and ranked as 1 (not important) to 4 (very important). Table 5.4 depicts the frequencies and descriptive statistics of the self-reported items on the teachers' perceived inquiry-based physics teaching practices.

Table 5.4 shows that the teachers attached great importance to strategies for using inquiry-based science teaching in the classrooms as indicated by the overall mean score (M=3.05;SD=0.77). The items: "I encourage to work in collaborative groups on investigations" (M=3.57; SD=0.60) and "I encourage learners to design their own investigations to solve a scientific question" (M=3.45; SD=0.85), were rated highly. This indicates that the teachers consider learners collaborating in groups on investigations and designing own experiments to solve scientific problems as critical aspects of inquiry-based physics teaching. This finding is consistent with the National Research Council (NRC) (2012:42) who argues that open inquiry provides learners with the best opportunities fordeeper understanding of scientific concepts. The item: "I use multiple–choice questions as the main strategy to evaluate learning" (M=2.07; SD=0.91) was the least rated. This shows that teachers do not value the use of multiple choice questions as a strategy of imparting inquiry skills to learners. This finding resonates well with the NRC (2012:262), who argues that multiple choice items have limitations in assessing inquiry skills. Consequently multiple choice questions should not be utilised frequently for assessing inquiry skills.

Table 5.4: Percentages, frequencies and mean scores of perceived importance of inquiry-based physics instruction

	Frequencies, percentages and means (N = 56)						
Statement	**1**	**2**	**3**	**4**	**Mode**	**Mean**	**Std Dev**
I afford learners the opportunities to construct meaning from inquiry experiences such as engaging in open-ended questions and group discussions	2 (3.6)	3 (5.4)	24 (42.9)	27 (48.2)	4	3.36	0.75
I involve learners with physics experiments with known outcomes	1 (1.8)	7 (12.5)	22 (39.3)	27 (48.2)	3	3.18	0.69
I prepare daily lesson plans guided by textbooks	3 (5.4)	14 (25)	24 (42.9)	15 (26.8)	3	2.91	0.86
I encourage learners to design their own investigations to solve a scientific question	3 (5.4)	4 (7.1)	14 (25)	35 62.5	4	3.45	0.85
I teach learners guided by national examinations	1 (1.8)	12 (21.4)	15 (26.8)	28 (50.0)	4	3.25	0.86
I use inquiry method in physics instruction	1 (1.8)	5 (8.9)	34 (60.7)	16 (28.6)	3	3.16	0.65
I teach facts as the primary goal of physics instruction	0	12 (21.4)	30 (53.6)	14 (25.0)	3	3.04	0.69
I teach the processes of physics as the primary goal of physics instruction	2 (3.6)	9 (16.1)	35 (62.5)	10 (17.9)	3	2.95	0.70
I use multiple-choice questions as the main strategy to evaluate learner learning	17 (30.4)	22 (39.3)	13 (23.2)	4 (7.1)	2	2.07	0.91
I use of open-ended (essay, problems) questions as the main strategy to evaluate learner learning	5 (8.9)	11 (19.6)	29 (51.8)	11 (19.6)	3	2.82	0.86
I encourage learners to work in collaborative groups on investigations	0	2 (3.6)	21 (37.5)	33 (58.9)	4	3.57	0.60
Average mean scores						3.05	0.77

About 87% of the respondents rated the item: "I involve learners with physics experiments with known outcomes" as important and very important. This indicated evidence of the physics teachers' narrow conception of inquiry-based skills classroom activities. This finding is consistent with Chabalengula and Mumba (2012:320), who posit that teachers focusing more on learners undertaking confirmatory experiments are operating on low levels of inquiry. Teachers need to engage learners more in high order inquiry skills to enhance effective learning of physics and to ensure better understanding of concepts by the learners.

The data from the interviews corroborated the findings from the survey that very little was being done in the schools with respect to inquiry physics teaching. The data was collated into emerging themes for analysis and discussion purposes. The three themes collated are the ‘limited time’,‘teachers’ prior conceptions of learners’ and ‘assessment demands’. The limited time allotted to teaching and learning of physics is the first theme to be explored.

5.5.1 Limited time

Inquiry-based activities need both teachers and learners to invest time in affording learners opportunities to undertake the inquiry activities at their own pace and understanding. Content coverage is a peripheral issue. What is critical is effective conceptual and competencies development in learners. The following sentiments from some of the respondents may give the picture of the prevailing scenario in the Zimbabwean high schools.

> *“Time is limited for students to grasp all concepts they need. Like ours is a day school, there are many activities and the time for teaching and learning is limited”* (Teacher G).

> *“Time is the main constraint; we would like to involve learners in undertaking projects to promote better understanding of concepts”* (Teacher A).

> *“Time is not on my side to use inquiry-based teaching methodologies, the syllabus is too long. I need to adequately prepare learners for the examinations so I mainly resort to the lecture method. My headmaster and parents are interested in good grades learners obtain in the final examinations, which is what matters”* (Teacher J).

It would appear that the teachers dedicate most of their time to preparing learners for public examinations. This distracts their attention from preparing interesting and enriching learning experiences for the learners. This is consistent with Buabeng (2015:220), who posits that in examination-driven education systems, teachers spend a large chunk of their time preparing learners for assessment. This is detrimental to planning and facilitation of relevant and interesting lessons that enhance understanding of concepts. There is need for reality definers to change the assessment criteria to promote interactive learning.

5.5.2 Teachers' prior conceptions of learners

Most of the interview respondents believe their learners have a shaky physics foundation. The argument is premised on the idea that at the Junior Level and the Ordinary Level the learners are taught science disciplines by non-physics specialists. As a result, the teachers do not perceive their learners to be well-grounded in basic physics concepts. The learners are considered ill-prepared to engage in sophisticated and highly demanding physics practical work. The sentiments from some of the teachers bemoan the perceived lack of strong physics background as orchestrated at the Junior and Ordinary Levels.

> *"Learners lack skills to do practical work in physics due to the fact that at the Ordinary Level they are simply drilled to pass examinations"* (Teacher I).

> *"The learners doing physical science are in most cases taught by non-physics specialists at the Ordinary Level and as such display a lot of physics misconceptions when they come to study Advanced Level Physics"* (Teacher A).

The concerns raised by some of the respondents indicate their strong beliefs in the idea that the learners are inadequately prepared at the Junior Level to tackle physics at the Advanced Level. This coincides with Buabeng's (2015: 11) point of view, who suggests that learners were restricted to a few opportunities to the teaching and learning of physics during their junior science courses. This may be an indication that the way Ordinary Level Physical Science and General Science at the Junior Level are currently taught in Zimbabwean high schools may not be adequately preparing learners to pursue Physics at Advanced Level.

5.5.3 Assessment

The manner in which learners are judged at the end of the course and their performance in public examinations is paramount. Teachers are judged by the performance of their learners and their credibility is at stake. As a result teachers may be forced to work to meet the clients' and key stakeholders' expectations. Some of the interview respondents had the following to say:

> *"The assessment of the practical paper has a predictable pattern. Question 1 is always on oscillations; Question 2 on electricity and Question 3, the design question, is basically a theoretical question since it does not demand the carrying out of the designed experiment"* (Teacher D).
>
> *"We teach to complete the syllabus in time, so that the learners are prepared for the final examinations"* (Teacher B).
>
> *"I rely on my experience as an examiner. I assist in national examinations item-writing, which helps me in teaching theory and my learners pass very well"* (Teacher I).

The above statements indicate that teaching and learning is driven by public examinations rather that learner interest. Teachers are subjected to extreme pressure to cover the physics curriculum and produce good grades, so that learners can find their way into institutions of higher learning. The excessive pressure to cover the curriculum hinders the adoption of inquiry-based methodologies in the physics classroom. This is in accordance with findings by Buabeng (2015:11) and Ramnarain (2016:15) who argue that teachers give priority to covering content for assessment purposes at the expense of teaching inquiry skills in the schools. The situation promotes rote learning to the detriment of conceptual development processes, which is a setback to efforts to enhance effective teaching and learning of physics using science inquiry-based approaches. This may be an indication that inquiry-based teaching propagated by the curriculum is not in line with the assessment. Therefore, there is need to revisit the assessment criteria to change the current inquiry-based teaching practices.

Synthesis of the above arguments may lead to the idea that some teachers are doing what works for them and for the system. If the system assessed inquiry-based learning, the teachers would adapt. The prevailing situation may not be conducive to the effective teaching of inquiry skills in the physics classrooms. The physics teachers may neglect planning for inquiry-based practical work activities in other areas of the physics curriculum that they deem not to be the focus of public examinations. This practice is a hindrance to the effective acquisition of physics concepts in the neglected sections. Such practices result in learners getting into tertiary institutions with serious physics misconceptions. Teachersmay need to be empowered in terms of competencies in inquiry-based science instruction strategies, possibly through staff development seminars. Such moves may capacitate teachers to promote deep physics learning and the learners could benefit more from the envisaged learning experiences.

5.5.3.1 Analysis of physics practical

Based on the Paper 4 examinations from November 2012 to November 2015 that were analysed, it was established that Question 1 was based on oscillations, Question 2 on electricity and Question 3 a design question from any section of the syllabus. Questions 1 and 2 each carry 18 marks to be done in an hour each while Question 3, which should be completed in half an hour, carries 14 marks. The design question is weighted less than the other two questions and the learner can pass the practical examination without having attempted the design question. This scenario may cause teachers and learners to disregard the design practical work aspect. This may have serious repercussions on the teaching of high order inquiry skills. Affording learners opportunities to design and execute their own experiments, to reflect on the process and to interpret data, allows them operate at Level 4 (Rogan & Grayson, 2003:1185). It would be ideal to enable learners to construct their own meaning and foster explanations based on their undertakings.

One design question was scrutinised to give an idea of its demands and expectations. The November 2013 Paper 4 design question guides the learner that water exhibits anomalous volume change in the temperature range 0°C to 10°C, which makes it an unsuitable thermometric substance for this range. The learner was then tasked to design an experiment to study the volume change of water in the temperature range of -5°C to 10°C. The learner was advised to pay particular attention to the procedure to be followed, control variables, precautions and safety measures in the write-up. One can deduce that the candidate is expected to know how instruments are appropriately used, limitations of physical theories, safety precautions, apply concepts in a new environment and provide a solution. So in some way the design question is basically rooted in theoretical knowledge since the learner does not execute the plan. Overall the question is limited in terms of testing for high order inquiry skills, which may restrict physics teachers to focus their energies on low order inquiry skills rather than on higher order inquiry skills. The practical work assessment is consistent with Rogan and Aldous' (2005:316) operational Level 3. The framework guidelines stipulate that learners are expected to undertake guided discovery practical work culminating in a scientific report based on collected data (Rogan & Aldous, 2005:316). A possible reason why teachers focus on low level inquiry skills may be that the physicscurriculum does not prescribe the scope and depth of the learning experiences. The physics curriculum also lacks suggested inquiry activities and how to enact inquiry-based physics teaching.

5.5.3.2 Analysis of the Physics Paper 4 (9188/4) guided experiment question

A guided experiment from the November 2012 Paper 4, Question 2 was analysed for its demands and expectations. The question, based on electricity, required the learners to determine the internal resistance (r) and the electromotive force (e.m.f) of a power source. A circuit diagram was given to the learners to set up. The resistance, R, in the circuit diagram is 100 ohms. The circuit diagram is shown Figure 5.1.

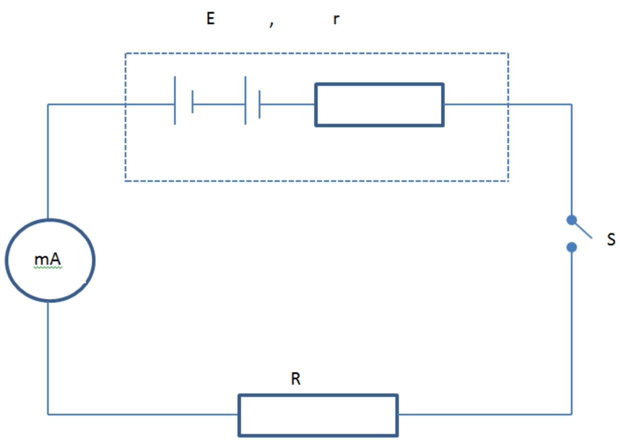

Figure 5.1: Circuit diagram (ZIMSEC, 2012, 9188/4:6)

The learner was provided with three resistors of known resistances. The learner was then requested to close the switch and record values of current, I and resistance, R. The learner was instructed to vary R in the circuit and record new values of I and R, using the different combinations of the provided resistors in series or parallel. The learner had to repeat the exercise until he/she had six sets of readings of I and R. The relationship between I and R was given by $\frac{1}{I} = \frac{R}{E} + \frac{r}{E}$

The learner was then required to plot a graph of $\frac{1}{I}$ (y-axis) against R (x-axis) and to use the graph drawn to determine the: (a) gradient, (b) e.m.f, E, of the source, (c) intercept, (d) internal resistance, r, of the source.

The question expects the candidate to follow instructions, use apparatus effectively, take measurements, record measurements, manipulate, analyse, interpret and evaluate data and draw inferences. On the whole one can conclude that the demands of the practical assessment paper are consistent with the demands and expectations of the Advanced Level Physics curriculum (ZIMSEC, 2013–2016:5). However, these demands fall short of the high order inquiry skills as stipulated by the NRC (2012:170) and Rogan and Grayson (2003:1189). These authorities suggest that activities like designing own experiments, conducting them, developing explanations based on evidence and communicating findings foster higher order inquiry skills. Such activities have been proven to enhance science concepts development in learners. The curriculum designers need to revisit the curriculum and address this gap to make the curriculum more responsive to higher order inquiry skills.

5.5.3.3 Analysis of the practical assessment

An analysis of the 18 questions from the practical paper (9188/4) from 2010 to 2015 revealed that 12 questions were found to be structured inquiry and verification inquiry. The other six questions were focused on guided inquiry. The Table 5.5 shows the distribution of examination practical questions focus areas from November 2010 to November 2015.

Table 5.5: The practical paper question focus area analysis from 2010 to 2015

Year	Question 1	Question 2	Question 3

Nov2010	Modern physics(rate of rise of water in a beaker)	Electricity	capacitance (electricity & magnetism
Nov2011	Oscillations	Electricity	Mechanics
Nov 2012	Oscillations	Electricity	Electricity& magnetism
Nov 2013	Oscillations	Capacitance	atomic physics
Nov 2014	Oscillations	Electricity	Waves
Nov 2015	Oscillations	Electricity	modern physics

From Table 5.5 it can be concluded that Question 1 is mainly based on oscillations, Question 2 on electricity, while Question 3 has some diversity. This creates room for teachers to easily manoeuvre and predict the type of experiments that are likely to be in the practical examinations and the requisite skills to do well in the examinations. The predicament of this scenario is that the teachers may decide to teach specific inquiry skills and ignore others, particularly higher order inquiry skills. Alternatively the teachers may just concentrate on practical work activities on those content areas on which the practical examinations are most likely to be targeting in the public examinations at the expense of other topics. Such situations hinder the effective teaching of inquiry skills.

However, from another perspective the harmonisation in inquiry skills emphasised in the physics curriculum, the examinations and the teachers' schemes of work is a fascinating attribute as it guarantees curriculum validity. At least the basic inquiry instruction practices are being observed, although much more is expected from the teachers to engage learners in higher order levels of operation in inquiry skills. It is anticipated that the teachers would challenge the learners to design and undertake their own practical work, reflect on the quality of the design, gather data and make adjustments to the design. Such a development would enhance learner conceptualisation of physics concepts and form an excellent grounding for the pursuit of physics-dependent disciplines in higher education institutions.

5.5.4 Analysis of schemes of work

The 10 teachers' schemes of work were analysed to determine the teaching strategies they use to enhance inquiry skills in the learners. The schemes of work had been stamped by school authorities for authenticity and were for the third term of 2015. The five teaching instructional strategies that emerged from the 143 lesson plans analysed. The data was extrapolated from methods andactivities section of the lesson plans and are shown in Table 5.6.

Table 5.6: Distribution of the physics teachers' methods and frequencies

Teaching strategy	Frequency	Percentage (%)
Traditional lecture	56	39.16
Class solve mathematical problems	35	24.47
Group discussions	30	20.98
Guided inquiry	16	11.19
Learners design &carry out own experiments	6	4.20

The traditional lecture is the teaching method that is used most by the physics teachers. This is despite overwhelming evidence pointing to the fact that the traditional lecture is the least effective in teaching inquiry competencies (Tesfaye& White 2012:4). The least employed instructional strategy is giving learners opportunities to design and conduct their own experiments (4.20%). This finding is consistent with that of Buabeng (2015:9), who established that learners were subjected to very few opportunities to plan and conduct their own practical work investigations. This scenario does not augur well for pragmatic teaching and learning of physics inquiry skills. The teachers need to avail themselves of more opportunities for learners to design their own experiments, carry them out and evaluate their undertakings.

The survey findings suggest teachers are aware of inquiry-based science teaching approaches, yet findings from the interviews and document analysis depict low inquiry-based physics demands and practices. The low inquiry-based physics teacher practices could be attributed to external forces such as assessment demands, teachers' prior conceptions of the learners and limited time. If assessment demands could be changed to focus more on inquiry-based skills, the teachers would adapt accordingly. The next section will explore how the physics teachers link the physics concepts to everyday life.

5.6 LINKING OF PHYSICS CONCEPTS WITH EVERYDAY LIFE

This section explores how physics teachers view and practice the concept of linking physics concepts with everyday life. The research question to be addressed is: “How is the teaching and learning of physics concepts being related to Zimbabwean everyday life?” The data from the survey questionnaires and interviews were used to elaborate on issues related to linking physics concepts to everyday life. The questions focused on the teachers’ instructional strategies for linking physics concepts to daily life, challenges faced by the teachers and possible intervention measures. Descriptive statistics was the method employed to elaborate quantitative data, and qualitative data was collated into emerging themes for purposes of analysis and discussion. The self-reported responses from the questionnaire statements soliciting for the teachers’ practices pertaining to linking physics concepts to everyday life were ranked and scaled as 1 (strongly disagree) to 5 (strongly agree).Table 5.7 shows the descriptive statistics with respect to items linking physics concepts and everyday life.

From Table 5.7 the overall scores of M=4.32 and SD= 0.75 confirm that the teachers attach a great importance to linking physics concepts to everyday life. The item: “It is important to link physics concepts to real-world contexts and global issues such as energy consumption and climate change” (M=4.75; SD=0.69) and the item: “Linking physics to everyday life helps learners understand concepts better” (M=0.75; SD=0.51), were rated very highly. This indicates the teachers are aware that linking physics concepts with everyday life scenarios to facilitate better understanding of physics concepts. This finding is consistent with Ng and Nguya (2006:40) who claim that physics teaching should be related to real-life situations capitalising on the learners’ personal experiences. The least popular item was: “The resources provided by the school make it easier for me to link my teaching to real-world issues” (M=3.46; SD=0.98). This may indicate that resources provided to the teachers in high schools do not assist them much in linking the physics concepts with everyday life scenarios within their environments. This stance may be attributed to the fact that most of the textbooks used by the teachers are foreign and may not be articulating contextual issues well. Teachers need to be encouraged to write their own modules individually or collectively depicting the local context. Writing their own modules may promote growth in the teachers, reduce dependence on foreign texts and make the linking of physics concepts to daily life more relevant and appropriate to the learners.

Table 5.7: The descriptive statistics of physics teachers’ degree of importance attached to linking physics concepts with everyday life

	Frequencies, percentages and descriptive statistics							
Statement	**1**	**2**	**3**	**4**	**5**	**Mode**	**Mean**	**Std Dev**
It is important to link physics concepts to real-world contexts and global issues such as energy consumption and climate change	0	2 (3.6)	2 (3.6)	4 (7.1)	48 (85.7)	5	4.75	0.69
Linking physics to real-world contexts will encourage more learners to study physics	0	1 (1.8)	3 (5.4)	313 (23.2)	39 (69.6)	5	4.61	0.68
Linking physics to everyday life helps learners understand concepts better	0	0	2 (3.6)	10 (17.9)	44 (78.6)	5	4.75	0.51
Linking physics concepts to everyday life assists learners to see the practical life of physics theories in everyday life	0	1 (1.8)	2 (3.6)	10 (17.9)	43 (76.8)	5	4.70	0.63
Linking physics concepts to everyday life will help learners learn physics in a meaningful way	0	0	3 (5.4)	11 (19.6)	42 (75.0)	5	4.70	0.57
Linking physics concepts to everyday life will help learners to be more creative	0	0	3 (5.4)	12 (21.4)	41 (73.2)	5	4.68	0.58
The resources provided by the school make it easier for me to link my teaching to real-world issues	1 (1.8)	8 (14.3)	19 (33.9)	20 (35.7)	8 (14.3)	4	3.46	0.97
The resources provided by the school will make physics more interesting to learners.	0	6 (10.7)	20 (35.7)	18 (32.1)	12 (21.4)	3	3.64	0.94
The contexts and issues presented in the resources are relevant to my learners	0	6 (10.7)	15 (26.8)	22 (39.3)	13 (23.2)	4	3.75	0.94
I am likely to make substantial changes to the way I teach physics based on the resources at my disposal	1 (1.8)	4 (7.1)	10 (17.9)	21 (37.5)	20 (35.7)	4	3.98	1.00
Linking physics to real-world contexts need diverse resources (internet, websites, problem sets)	0	0	6 (10.7)	15 (26.8)	35 (62.5)	5	4.52	0.69
Averagemean scores							4.32	0,75

The main themes emerging from the interviewees tended to corroborate the teachers' opinions on linking physics concepts with societal issues. The emerging themes were 'lack of capacity to innovate', 'curriculum specifications', 'limited opportunities to share experiences' and 'administrative barriers'. These aspects were deemed to be hindering teachers' efforts in linking physics concepts to everyday life. The potential impact of the presumed hindrances will be the focus of subsequent deliberations. The first port of call is the lack of capacity to innovate.

5.6.1 Lack of capacity to innovate

The responses from some of the interviewees indicated limited capacity to innovate. This is evidenced by the teachers' practices being restricted to the basics of linking physics concepts to everyday life. The sentiments below from some of the respondents serve to illustrate the lack of teachers' innovativeness in creating and facilitating opportunities for learners to engage in project work to solve societal problems.

> *"After teaching a concept we try to do it using examples, like the principle of moments, using spanners to tighten nuts"* (Teacher A).

> *"Take things they use every day, discuss how it functions, like transformers. Use models to relate to concepts, though we do this rarely"* (Teacher D).

> *"It is always referring to the basics they know already, ask them to observe phenomenon and ask students to point out real life experiences"* (Teacher E).

Synthesis of the teachers' responses revealed that the majority of teachers relied heavily on drawing from provided examples of daily contexts and citing examples of the applications of the concepts learnt to familiar daily phenomena. This finding is consistent with the Level 1 operational level as propounded by Rogan and Grayson (2003:1183) and Rogan and Aldous (2005:315).These authorities suggest that teachers relying mainly on previously learnt and provided examples and applications from everyday life to illustrate scientific concepts are operating at Level 1. This implies the physics teachers are operating at low levels with respect to linking physics concepts to everyday life. The practice of linking physics concepts to everyday life where concepts are explained first and then linked to real-life scenarios is detrimental to good mastery of concepts by learners since it reflects transmission methodology. There is need for an intervention to raise the teachers' operational levels to higher levels that foster effective mastery of concepts. From the prevailing situation it appears that teacher-centred approaches are being used at the expense of learner-centred approaches, which are being advocated for in the physics curriculum document. Hence, the teaching practice is contravening the prescription of the physics curriculum, which advocates learner-centred teaching approaches.

5.6.2 Curriculum specifications

The physics teachers lamented the lack of detail in the Advanced Physics curriculum document with respect to the linking of physics concepts covered to everyday life scenarios. Some of the respondents gave the sentiments indicating frustration with the physics curriculum.

> *"The curriculum should guide teachers in linking physics concepts to everyday life"* (Teacher J).

> *"The curriculum lacks detailed information in directing teachers in this area"* (Teacher A).

> *"I am not sure as to how far I should go with regards to linking physics concepts to everyday life"* (Teacher D).

These statements serve as an indication that some of the physics teachers are not quite conversant with the scope and breadth required in relating specific physics concepts covered to daily life situations. The syllabus is limiting since it does not spell out what is expected to be undertaken for the attainment of physics standards. This may require the physics curriculum document designers to include detailed guidelines and possibly practical activities on particular physics concepts in the content. Inclusion of guideline notes could assist the physics teachers in linking the physics concepts covered to everyday life.

5.6.3 Limited opportunities to share experiences

The majority of the physics teachers bemoaned the lack of financial support to share with colleagues' experiences and ideas on how to effectively link physics concepts to everyday life situations. Some of the respondents lamented the dearth of seminars in their educational province.

“There is a dire need to revive cluster workshops or seminars so that physics teachers can share experiences on how to effectively link physics concepts to everyday life” (Teacher E).

“There used to be in-service workshops to take us through such problematic areas” (Teacher A).

Considering that most of the Zimbabwean high schools have one physics teacher per school, this teacher has no one in the school to call for assistance. This raises an urgent need to revisit the idea of provincial seminars and mobilising resources to ensure the venture is a success. This finding is consistent with Fullan (2007:97) who notes that new competencies are enhanced through teachers sharing ideas and exchanging positive experiences regarding their work. From another perspective, teachers' narrow conception of linking physics concepts to daily life may also be an indication that there was no effective curriculum dissemination before the full scale implementation of the revised Advanced Level Physics curriculum. This perspective is consistent with Carl (2012:12) who posits that effective dissemination is a critical requirement for effective curriculum implementation. The physics curriculum merely states that the learners should link physics concepts to everyday life without detailing how teachers are expected to go about it. This leaves the linking of physics concepts to everyday life subject to the individual teacher’s interpretation. Hence, the learners are subjected to different variations of learning experiences depending on the teachers’ backgrounds and experiences.

5.6.4 Administrative barriers

Most of the participants strongly felt bureaucracy and red tape were frustrating them with respect to procedures to be followed to obtain permission to undertake school educational trips with the learners. Administrative support is an essential ingredient for motivating both the teachers and the learners. However, if the provision of outside support requires permission to be sought from head office, it may end up being an impediment to learning physics. The following sentiments captured from some of the respondents serve to illustrate this stance.

> *"We have a big challenge in organising field trips to industries due to financial constraints and red tape. For example just trying to visit the local hospital for a session with the radiographer on use of X-rays may take several months"* (Teacher J).

> *"Lack of field trips to relevant areas…visiting and talking to professional people motivates learners"* (Teacher E).

> *"Sometimes it is difficult to have real life applications to all concepts, for example, banking of aeroplanes or race cars. It is difficult because we need a real situation for them to see and appreciate"* (Teacher G).

From these sentiments it is quite apparent that seeking permission to embark on educational trips with learners is a cumbersome process. The limited support with respect to timeous facilitation of field trips and other enrichment excursions is a serious impediment to meaningful physics teaching and learning. This finding is inconsistent with Rogan and Aldous' (2005:320) operational Level 3 pertaining to direct support to the learners, which posits that learners' academic requirements in the form of field trips should be well catered for to ensure an enriching learning environment. One can conclude that the schools are not doing much to cater for learners' needs with respect to enriching their learning activities. This a clear case in which the construct of OI is not adequately complimenting the construct of PoI. The government needs to be more proactive to facilitate the reduction of bureaucratic procedures to enable learners to embark on industrial visits and other learning excursions as scheduled by the respective schools.

Although teachers value linking physics concepts to everyday life, the prevailing environment does not seem to promote adequate deep learning opportunities for context-based learning scenarios. This is quite a setback to physics teachers since real-life scenarios promote innovative teaching practices and facilitate active acquisition of knowledge. Consequently there is a need for the creation of an enabling environment and capacitating teachers to promote learning of physics in real-life situations. Real-life contexts facilitate better understanding of physics concepts by learners.

The survey findings indicate that the teachers value linking physics concepts to everyday life. The interview results reflect that the linking of physics concepts to everyday life is influenced by lack of capacity to innovate, lack of detailed curriculum specifications, restricted opportunities to share experiences and administrative barriers. The next section explores the physics teachers' perceived competences and practices in integrating ICT technologies in the teaching of physics.

5.7 INFORMATION COMMUNICATION TECHNOLOGY INTEGRATION IN PHYSICS TEACHING

This section focuses on the physics teachers' use of ICT tools in the teaching of physics. The research question to be addressed is: "How are ICTs applied in the learning and teaching of the Advanced Level Physics curriculum." This is premised on the idea that the integration of ICT tools in the learning of science has the potential to make it more meaningful and relevant to learners. The quantitative data was solicited through 11 self-reported statements on the survey questionnaire and qualitative data from interviews and document analysis. Issues of interest were the extent to which ICT is used as a pedagogical tool, barriers to ICT integration and possible intervention measures. The document analysis targeted the frequency of the use of ICT tools in the lesson plans, using 10 schemes of work for one school term. The teachers' self-reported responses on the questionnaire were ranked as Strongly Disagree (1) to Strongly Agree (5) with respect to the given statements. The quantitative data was organised employing descriptive statistics to facilitate the analysis and discussion. Table 5.6 shows the frequencies, percentages, means, mode and standard deviations for the respective statements.

Table 5.8: Frequencies, percentages and descriptive statistics of the perceived skills of teachers of using ICT tools to teach physics

	Percentages, frequencies and descriptive statistics							
Statement	**1**	**2**	**3**	**4**	**5**	**Mode**	**Mean**	**Std Dev**
I can create visual presentations, graphics, charts, drawings and type assignments for learners using ICT	1 (1.8)	5 (8.9)	10 (17.9)	22 (39.3)	18 (32.1)	4	3.91	1.01
I can download teaching materials regarding my subject	0	3 (5.4)	3 (5.4)	20 (35.7)	30 (53.6)	5	4.45	0.83
I can use computer-based programs in developing the scheme of work and lesson plan	1 (1.8)	5 (8.9)	8 (14.3)	20 (35.7)	22 (39.3)	5	4.02	1.04
I use email to ask and send assignments to my learners if possible	7 (12.5)	10 (17.9)	17 (30.4)	10 (17.9)	12 (21.4)	3	3.18	1.31
I am able to search for files on the computer system and organise them into folders	0	3 (5.4)	4 (7.1)	17 (30.4)	32 (57.1)	5	4.39	0.85
I am able to use a learning management system (example, Web CT) to support teaching	4 (7.1)	8 (14.3)	22 (39.3)	14 (25.0)	8 (14.3)	3	3.25	1.10
I can connect the computer to its peripherals	0	5 (8.9)	6 (10.7)	19 (33.9)	26 (46.4)	5	4.18	0.96
I can access and share information on CD/DVD/flash disc	0	2 (3.6)	6 (10.7)	19 (33.9)	29 (51.8)	5	4.34	0.82
I can create a basic presentation package and print to various networked printers	1 (1.8)	7 (12.5)	13 (23.2)	16 (28.6)	19 (33.9)	5	3.80	1.10
I can set up and use LCD or multimedia projector for classroom delivery	0	8 (14.3)	8 (14.3)	18 (32.1)	22 (39.3)	5	3.96	1.06
Average mean score							3.95	0.75

The overall mean scores of M=3.95; SD=0.75 in Table 5.8 indicates sound teacher competencies with regard to the use of ICT tools in the teaching of physics. The item: "I can download teaching materials regarding my subject" (M=4.45; SD=0.83) and item: "I am able to search for files on the computer system and organise into folders" (M=4.39; SD=0.85), were very highly rated. This is an indication that the majority of the teachers possess basic ICT skills. This finding resonates well with Ndibalema (2014:11), who established that teacher training focused on provision of elementary ICT skills to the detriment of pedagogical competencies. This is an unfortunate development since imparting ICT pedagogical skills to teachers would enrich physics learning contexts. The item: “I use e-mail to ask and send assignments to my learners if possible” (M=3.18; SD= 1.31) and item: “I am able to use a learning management system (example, Web CT) to support teaching” (M=3.23; SD=1.31), were the least rated. This may be an indication that the teachers rarely use e-mail in communication with the learners and learning management systems to support their teaching. This may be attributed to limited internet access by the learners. This coincides with the research of Ndibalema (2014:10), who found that teachers rarely used digital learning exercises to expedite their teaching and enhance their instructional practices. This is an unfortunate development since the use of these technologies would help teachers to teach learners and keep in touch with them outside the classroom.

The results from the interviews and document analysis indicate that there is very limited integration of ICT in the teaching of physics in the classrooms. This was mainly attributed to ‘limited ICT infrastructure and tools’, ‘financial constraints’ and ‘a lack of a clear policy on ICT equipment uptake in schools’. The next discussion elaborates on inadequate ICT equipment in the high schools.

5.7.1 Lack of ICT equipment

Most of the respondents lamented the inadequacy or lack of ICT infrastructure and equipment in the schools. In the majority of the schools, access to internet by both teachers and learners was a serious challenge. In some of the schools computers were only accessible to computing teachers and learners who were undertaking computing studies. Worse still, in the majority of high schools, the learners were not allowed to bring their own smart-phones or laptops for fear of misuse of the gadgets by the learners during lessons. There was very little effort in the majority of the schools to equip science teachers with modern ICT tools to enhance their lesson delivery in the classrooms and enrich learning contexts. Some of the sentiments of some of the interviewees shed light on the existing scenarios in most of the schools.

> *“I use ICT to a limited extent in my lessons, because the school has only one LCD for the six of us in the science department”* (Teacher A).

> *“I do not use ICT in my physics teaching. Our school does not have basic infrastructure for internet and ICT tools”* (Teacher B).

> *"The computer laboratory at our school is restricted to computer studieslearners only. Physics students use their smart-phones for research"* (Teacher J).

These sentiments serve as apparent evidence of an acute shortage of ICT infrastructure and equipment in the schools. This finding is consistent with Mlambo (2007:97) who established that Zimbabwean high schools had a critical shortage of ICT equipment. The situation in the schools is disturbing in this day and age. One would expect that basic ICT equipment is in place to enhance effective communication and open other avenues for information sharing between teachers and learners. It is also evident that the limited resources in the schools are not being fully utilised to benefit all learners. A few schools are however allowing learners to bring smart-phones. More school authorities need to be encouraged to allow learners to bring own smart-phones or laptops to alleviate the shortage of ICT equipment.

5.7.2 Limited financial support for ICT equipment acquisition

The majority of the respondents raised concerns about the limited financial support available to provide ICT infrastructure and equipment to the schools. It appeared that very little was being channelled towards the procurement of ICT equipment and services. If we are not to miss out on the integration of advanced technologies and their intended benefits in the teaching of physics, measures need to be put in place to improve funding for provision of ICTs. Some of the misgivings of the interviewees give an insight into the prevailing environment in the high schools.

> *"Due to financial constraints our bandwidth capacity has been downgraded. The school used to pay a thousand dollars per month and the school can only afford to pay two hundred and eighty. It is now very difficult to access the internet during the day"* (Teacher A).

> *"Schools need to convince parents on the benefits of ICT to the learners"* (Teacher G).

"Schools may hire computers having software from companies and pay a nominal fee. This may increase the teachers and learners access to computers" (Teacher E).

From these views it is quite apparent that the majority of the schools are finding it difficult to provide adequate infrastructure and ICT equipment for both teachers and learners. This finding is consistent with Rogan and Aldous' (2005:320) construct of OI with respect to sub-construct 'physical resources' operation Level 1. This sub-construct suggests that availed resources are just adequate to supplement existing, but inadequate to sustain the expected changes. This is an indication that the financial support for ICT integration in physics teaching is grossly inadequate to sustain meaningful teaching learning that may maximise benefits for the learners.

5.7.3 Lack of ICT school policy

The majority of the respondents lamented the lack of clear policy guidelines to facilitate the easy uptake of some modern ICT equipment in the schools. The government has left it to the discretion of individual schools to allow or deny the use of smart-phones. As mentioned earlier, the majority of the schools have resisted the move to allow learners to bring their own smart-phones or laptops to school. The majority of the interviewees were of the opinion that the school heads needed to open up space and move with global trends by allowing learners to bring these personal resources to school. The sentiments below are the viewpoints of some of the respondents who seem dissatisfied with the current situation in the schools.

"The school head needs to relook at the policy that bars learners from bringing smart-phones to school" (Teacher A).

"Learners should be allowed to bring smart-phones or cell phones or laptops to school" (Teacher D).

"Already learners know a lot about this technology. So why should we bar them from bringing them to school? Rather we should direct them towards the correct use of smart-phones" (Teacher I).

Lack of school policies on the uptake of some modern ICT tools in the school is a recipe for disaster and sadly most of the schools do not have a clear ICT implementation policy. Conservative school authorities stifle the uptake of new digital technologies such as the use of smart-phones to the detriment of enhanced teaching and learning experiences.

5.7.4 Advanced Physics curriculum analysisfor use of ICTs

The Advanced Level Physics curriculum document is silent on the integration of ICT tools into the teaching of physics in the classroom. This is quite absurd considering that modern digital technologies are the backbone of effective classroom instruction. ICT integration in physics teaching and learning is desirable for enriching the teaching and learning physics environment. ICT skills foster global competitiveness and it is imperative that the issue of embedding ICT in the physics curriculum receives urgent attention. The integration of ICT tools in the teaching and learning of physics should be an aspect of teacher professional development.

5.7.5 Analysis of schemes of work for use of ICT

Analysing the sample schemes of work depicted a gloomy picture of the use of ICT in the Advanced Level Physics teaching. All 10 schemes of work were hand-written. Rarely would one encounter a situation where ICTs were mentioned in the lesson plans. What featured rarely was the use of the LCD projector in lesson delivery. This is a basic for lesson presentation. It is imperative that the use of ICT for planning, research, communicating with the learners and creating instructional and learning resources be taken more seriously.

On the whole, guided by Rogan and Grayson's (2003:1188) construct of CtI with respect to teachers' factors, the teachers' practices were rated at operating Level 2. This is evidenced by the fact that the physics teachers have basic essential ICT skills to do their work. For the construct ofOI, the level of operation was again rated at Level 2, where change is instigated by top-down initiatives and encouragement (Rogan & Grayson, 2003:1193). This indicates that teachers operate at low levels of ICT integration in the physics classrooms, which do not contribute meaningfully to teaching and learning. The majority of the teachers are inadequately resourced to use modern ICT tools in the classroom. Adequate resources and basic infrastructure are needed to facilitate easy integration of modern ICT equipment in the physics classroom.

The survey findings suggest that teachers have the requisite competencies for integrating ICT in teaching physics. However, interview and document analysis results reflect low level use of ICT tools in the teaching and learning of physics. This may be attributed to external forces such as lack of ICT equipment, limited financial support and lack of a school ICT policy. By addressing these impediments there should be an upsurge in ICT integration in the physics classroom. The next section explores how the school climate promotes or hinders the physics curriculum implementation.

5.8 SCHOOL CLIMATE

This section explores the teachers' perceptions of the school climate and how it promotes or hinders the effective teaching of physics. The question to be answered is: "How does the school climate influence the implementation of the Advanced Level Physics curriculum?" The question was premised on the idea that the school context has considerable bearing on physics classroom undertakings. The data was solicited through eight closed statements from the survey questionnaire and 10 interviews focusing on the prevailing school climate and how it can be improved. Descriptive statistics was utilised to analyse quantitative data to facilitate discussions. Table 5.9 reflects the frequencies and means for the teachers' self-reported perceptions of the prevailing school climate.

From Table 5.9 the overall mean scores (M=3.66; SD=0.99) indicate that the teachers are very positive about the climate of their respective schools. This suggests that the schools' environments are conducive to effective teaching and learning of physics. The item: "Science teachers respect other teachers who take the lead in school improvement efforts" (M=4.14; SD =0.75) and the item: "It is okay in this school to discuss feelings, worries, and frustrations with other science teachers" (M =3.93; SD=0.91) were very highly rated. This indicates that the science teachers in the schools are working harmoniously with colleagues from other departments and within the science department itself. Based on the sub-construct 'school ecology' of CtI, the teachers were rated to be operating at Level 3, as signified by their commitment to their work (Rogan & Grayson 2003:1189). This finding resonates well with those of Fullan (2007:97) and Thijs and Van den Akker (2009:29), who argue that when teachers share ideas and experiences it relieves them of their frustrations and enhances their teaching competencies. This is highly commendable since the prevailing school climate fosters team spirit and common shared values, which promote effective teaching and learning in the classrooms.

Table 5.9: Frequencies, percentages and descriptive statistics with respect to the school climate

	Frequencies, percentages and descriptive statistics (N = 56)							
Statement	**1**	**1**	**3**	**4**	**5**	**Mode**	**Mean**	**Std Dev**
I am supported by colleagues to try out new ideas	0	5 (8.9)	9 (16.1)	31 (55.4)	11 (19.6)	4	3.86	0.84
I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning	9 (16.1)	9 (16.1)	14 (25.0)	14 (25.0)	10 (17.9)	3	3.12	1.34
Science teachers in this school regularly observe each other teaching classes	3 (5.4)	10 (17.9)	16 (25.0)	26 (44.6)	3 (5.4)	4	3.29	1.00
Science teachers in this school trust each other	0	2 (3.6)	18 (32.1	24 (42.9)	12 (21.4)	4	3.82	0.81
It is okay in this school to discuss feelings, worries, and frustrations with other science teachers	1 (1.8)	2 (3.6)	13 (23.2)	24 (42.9)	16 (28.6)	4	3.93	0.91
Science teachers respect other teachers who take the lead in school improvement efforts	0	2 (3.6)	6 (10.7)	30 (53.6)	18 (32.1)	4	4.14	0.75
It is okay in this school to discuss feelings, worries, and frustrations with the headmaster	5 (8.9)	9 (16.1)	13 (23.1)	19 (33.9)	10 (17.9)	4	3.36	1.21
My headmaster takes personal interest in the professional development of the teachers	2 (3.6)	3 (5.4)	15 (26.8)	21 (37.5)	15 (26.8)	4	3.79	1.02
Averagemean scores							3.66	0.99

The item: "I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning" (M=3.12; SD=1.34) received the lowest rating. This may be an indication that the teachers' professional decisions about teaching and learning in the schools are in sync with the school authorities' expectations. However, the high standard deviation of 1.34 indicates a lack of consistency in their responses. Nearly 43% of the respondents agreed with the statement. What is evident is that there is no conflict in approaches to teaching and learning between most teachers and school authorities. The item: “Science teachers in this school regularly observe each other teaching classes” (M=3.29; SD=1.00) was also lowly rated. This is an indication that science teachers do not regularly observe colleagues teach classes. This finding is inconsistent with Ronfeldt et al. (2015:512) who posit that close collaboration between teachers is instrumental to high chances of learners’ success. Observing colleagues teach provides the observer with an opportunity to see methods in action with real learners. Sharing the observations would improve classroom practices and facilitate trying of new ideas in one’s own classroom. Ultimately the sharing of instructional techniques improves teaching practices and learner performance.

The rating of the item: “It is okay in this school to discuss feelings, worries, and frustrations with the headmaster” (M=3.36; SD=1.21) implies that the teachers share their problems with school authorities. The high standard deviation of 1.21 reflects inconsistency in their responses. About 51.7% of the respondents agreed with the statement. This may be an indication that there is little room for teachers to share their concerns and worries with their respective school heads. This is a worrisome development since teachers need to be heard and their concerns addressed for them to be focused on their key business of teaching. Failure to address teachers’ concerns timeously could, in some situations, lead to disillusionment and lack of commitment to their work. The school’s climate was rated at operational Level 2, based on the idea that the responsibility for making the school function is shared by the school authorities and the teachers to a limited extent (Rogan & Grayson, 2003:1189).

The interview responses substantiated the teachers’ appreciation of the good ambience that prevailed in the schools, the collegiality that existed, and indicated areas they felt needed more support for the effective teaching of physics.The school authorities were highly commended for their moral support and relentless efforts in sourcing equipment, especially for public examinations in view of the harsh economic environment prevailing in the country. Three themes emerged from the interviews conducted with respect to creating a more conducive working environment in the high schools. The three themes were ‘creating synergies’, ‘capability of the learner’ and ‘limited consultation’. The discussion below elaborates on some of the respondents’ views with respect to the school climate and areas where they were of the opinion that the school management could still improve on enriching the existing teaching and learning environment.

5.8.1 Creating synergies

Despite the huge appreciation of an environment conducive to teaching and learning, the teachers strongly believed that the schools' authorities needed to go an extra mile in making their work more enjoyable. One possibility highlighted was that authorities may create relationships with universities to enable their learners to access some of the modern equipment. The schools may also consider the option of sharing equipment and instructional materials among themselves. This could be attained by creating good relations for resource-sharing such as between advantaged and disadvantaged schools. The teachers were convinced that schools needed to do more interms of creating avenues for cooperation to enhance access to modern equipment. Some of the views of the respondents related to this issue are given below:

> *"Schools should get into some partnerships with some institutions of higher learning like universities, so that the learners can access some modern equipment in their laboratories"* (Teacher G).

> *"I am aware there are some companies that are lending schools computers at a nominal fee. Schools need to engage them as this could go a long way in empowering teachers and learners"* (Teacher E).

> *"Disadvantaged schools need to liaise with privileged schools in their locality to share science equipment"* (Teacher I).

The matter of creating relations with institutions of higher learning and other well-resourced schools may go a long way in alleviating the shortage of equipment through sharing resources. Given the harsh economic situation in the country it is more likely to be a realistic option, since universities are the direct beneficiaries of graduates being churned out by the high schools. It is a worthwhile cause that institutions of higher learning become part of the solution of the critical shortage of equipment in some of the schools. An "education ecosystem" should be created to enhance resource adequacy.

5.8.2 Capability of learners

The capability of the learner enrolling for Physics at Advanced Level is quite pertinent for effective teaching and learning. Hence, it becomes critical to enrol learners with a good grounding in physics so that their chances of doing well are maximised. The respondents raised reservations about the ability of some of the learners currently enrolled for Advanced Level Physics. Some of the sentiments raised by the respondents are evidence to this:

> *"There is need to separate science from other subjects right from Form 1. Subject specialists should teach the learners right from the onset"* (Teacher C).

> *"The gap between the Ordinary Level and the Advanced Level is wide. Learners who have done pure physics do well at Advanced Level"* (Teacher F).

A synthesis of the teachers' views suggests that physics as a discipline should start at Form 1 and be taught by subject specialists.Such a situation may give the learners a good grounding for studying Physics at the Advanced Level with better chances of success. The current situation,where some of the learners do General Science at Junior Secondary and Physical Science at Ordinary Level, is not very helpful in building a solid foundation of physics concepts in learners. The respondents opined that school authorities should make efforts to have physics taught as a discipline by specialists from as early as junior secondary level. This finding resonates well with Buabeng (2015:16) who argues that learners at the junior secondary levels are subjected to unequal access to physics teaching based on their teachers' backgrounds. The teaching of Physical Science at Ordinary Level as a preparatory subject for either Chemistry or Physics studies at Advanced Level was highly criticised as a futile exercise by the respondents. The respondents were also of the view that if Physical Science was being taught by a chemistry specialist there was a tendency to focus more on the chemistry section at the expense of the physics section. The chemistry teacher may not have adequate physics CK, which may be detrimental to the learners hence the need to give learners a strong physics foundation starting from junior secondary level and this may reduce misconceptions.

5.8.3 Limited teacher consultation

The majority of the interviewees bemoaned the restricted consultations during departmental budget deliberations with respect to their subject requirements. Teachers were adamant that they needed good support with their teaching requirements, to be motivated to teach effectively. Some of the opinions of the respondents with respect to limited consultation are given below:

> *"The physics teacher needs to be consulted by school heads when coming up with the science departmental budget"* (Teacher J).

> *"We used to have some virtual laboratory and a cyber-class, currently it is down. We used to have a projector and it is also down. Maybe it is just due to a minor fault"* (Teacher C).

The need to be consulted with respect to resources for use in the physics classroom is very critical. Failure to address the teacher needs demotivates the teacher, leading to learners not benefiting from the learning and teaching environment. The prevailing school climate shows that the sub-construct OI is not supporting the sub-construct PoI. The prevailing environment does not promote the effective teaching and learning of physics.

The survey findings suggest that teachers rate the prevailing school environment highly. Similarly, the interview findings depict that the school environment could further be enhanced through creating synergies with universities, enrolling more capable learners and improved teacher consultation. The next section is going to deliberate the professional development opportunities available to the physics teachers in the schools.

5.9 STAFF DEVELOPMENT OPPORTUNITIES

The quality of professional development opportunities availed to teachers in their respective schools, as perceived by the teachers, was explored. The question to be answered was: "What is the nature of professional development opportunities availed to teachers in the schools"? This was premised on the idea that teachers need to be empowered in the process of improving their own practices and pedagogy. The data was solicited through 13 survey questionnaire statements and two interviews questions. Descriptive statistics was enlisted to show the pattern of the quantitative data, whereas emerging themes from the interviews were collated, and concretised the discussion. Table 5.10 shows the frequencies and means of the teachers' self-reported responses.

From the Table 5.10 the average mean scores (M=2.91; SD=0.88) indicate a high degree of satisfaction with the quality of professional development opportunities availed to the teachers. This is highly commendable as evidence of the prevalence of a culture of enhancing teachers' continuous professional development in the schools. Creating opportunities for teachers to engage as students themselves fosters growth and enhances practice (Fullan, 2007:97). This scenario is a recipe of cross-pollination of ideas which will benefit teaching and learning in the schools. All the items had an average mean score of above 2.5 which is reminiscent of good professional development culture existence in the schools.

The item: "I reviewed learner work or scored assessment" (M=3.25; SD=0.82) and the item: "I led group discussions" (M=3.09; SD=0.82) were highly rated. The practice of reviewing learner work is evidence that the teachers are in constant touch with the learners' progress. The teachers are bound to understand the learners better and develop appropriate instructional strategies to assist the learners. This is an indication of reflective practice and the learners are likely to benefit much from it.Taking part in group discussions fosters collaboration and team spirit. This also develops a professional learning culture in the schools and ensures job satisfaction. The learners are likely to benefit from school-wide good practice and that enhances learners' chances of doing well.

Table 5.10: Frequencies, percentages and descriptive statistics on the quality of professional development available to teachers in the schools

	Frequencies, percentages and descriptive statistics(N= 56)						
Statement	**1**	**2**	**3**	**4**	**Mode**	**Mean**	**Std Dev**
I observed demonstrations of teaching techniques	4 (7.1)	8 (14.3)	31 (55.4)	13 (23.2)	3	2.95	0.82
I led group discussions	2 (3.6)	10 (17.9)	25 (44.6)	19 (33.9)	3	3.09	0.82
I developed curricula or lesson plans which other participants or the activity leader reviewed	7 (12.5)	15 (26.8)	23 (41.1)	11 (19.6)	3	2.68	0.94
I reviewed learner work or scored assessments	3 (5.4)	4 (7.1)	25 (44.6)	24 (42.9)4	3	3.25	0.82
I developed assessments or tasks used by other teachers	6 (10.7)	10 (17.9)	24 (42.9)	16 (28.6)	3	2.89	0.95
I practised what I learned and received feedback	4 (7.1)	7 (12.5)	26 (46.4)	19 (33.9)	3	3.07	0.87
I received coaching or mentoring in the classroom	8 (14.3	12 (21.4)	27 (48.2)	9 (16.1)	3	2.66	0.92
I gave a lecture or presentation to colleagues	10 (17.9)	15 (26.8)	20 (35.7)	11 (19.6)	3	2.57	1.01
My school’s professional development activities are designed to support the school-wide improvement plan adopted by my school	2 (3.6)	14 (25.0)	27 (48.2)	13 (23.2)	3	2.91	0.79
My school’s professional development activities are consistent with my science department or form level plan to improve teaching	2 (3.6)	13 (23.2)	21 (37.5)	20 (35.2)	3	3.05	0.86
My school’s professional development activities are consistent with my own goals for professional development	3 (5.4)	11 (19.6)	25 (44.6)	17 (30.4)	3	3.00	0.85
My school’s professional development activities are based explicitly on what I learnt in earlier professional development activities	3 (5.4)	20 (35.7)	18 (32.1)	15 (26.8)	2	2.80	0.90
I followed up the school professional development activities with related activities that built upon what I had learnt as part of the activity	3 (5.4)	14 (25.0)	20 (35.7)	19 (33.9)	3	2.89	0.90
Averagemean scores						2.91	0.88

The item: “I gave a lecture or presentation to colleagues” (M=2.57; SD=0.1.01) was rated the lowest. This may be an indication that the practice of giving teachers opportunities to present to colleagues on issues of professional development is not very prevalent in the schools. This finding coincides with those of Gulamhussein (2013:4) and Bellibas and Gumus (2016:13), who recommend that the traditional strategy of professional development needs to be phased out and replaced by contemporary methods that foster teamwork and interaction. The item: “I received coaching or mentoring in the classroom” (M=2.66; SD=0.92) was also low-ranked. This suggests that mentoring is not prioritised in the schools. Mentoring promotes teacher growth and enhances effectiveness. The restricted mentoring in the schools may be attributed to the lack of vast experience in science teachers.

The statement: “My school’s professional development activities are based explicitly on what I learnt in earlier professional development activities” had the lowest mode (2). This is an indication that professional development activities in the schools lacked continuity. This situation is not desirable since continuity promotes growth and enhances practice. One-shot professional development workshops have been largely deemed ineffective (Fullan, 2007:285; Gulamhussein 2013:9). Sustained and longer professional development activities are likely to promote prolonged discussions on misconceptions of concepts and instructional strategies. This may in turn create better opportunities for teachers to experiment with new practices and receive feedback. Based on the limitation that the professional development opportunities given to the physics teachers were predominantly one-shot workshops, the practice was rated at operational Level 1 as per Rogan and Grayson (2003:1193).

A chi-square test exploring the relationship between the level of teacher professional development opportunities offered to the teachers and the teachers’ characteristics was conducted. The results obtained indicated no significant association with respect to gender, age, school location, teachers’ highest qualification, class size and teaching experience. For the relationship between the area of specialisation and the level of professional development activities, chi-square value (χ) of 56.00 was obtained with 22 (df) at 0.05 level of Confidence; a (p) of 0.00 was attained. Therefore, one can conclude that there is a significant association between the area of specialisation and the level of professional development activities. This may be attributed to the idea that the teachers in a particular subject discipline are very clear on their needs and interests with respect to professional development activities.

Despite the teachers’ reported favourable dispositions regarding the availability of professional development opportunities in the schools, a lot more needs to be done. The qualitative data validated and corroborated survey findings. The majority of the interview participants expressed the view that school professional opportunities tended to zero in on teaching approaches. Among the issues raised by the participants the following themes emerged: ‘lack of physics-related workshops’, ‘lack of experimental design and hands-on activities seminars’, ‘limited use of instructional technology’ and the need for sustainable conduct of ‘meaningful professional development activities’.

5.9.1 Lack of physics-related workshops

The majority of the interviewees had reservations about the dearth of physics-related workshops in the schools. Some of the participants had reservations about effective teaching of electronics and some aspects of modern physics and needed assistance to deepen their CK. This finding is consistent with Buabeng (2015:4) and Kind in Venkat et al. (2014:23) who suggested that teachers require sound CK for them to be effective in lesson delivery. If some of the teachers have misgivings about their subject matter mastery, they may lack confidence and learners may not benefit much from the conducted learning activities. Some of the interview respondents raised the following sentiments to illustrate the predicament.

> *“For modern physics there may be need to exchange insights and teaching experiences with knowledgeable colleagues in workshops”* (Teacher F).

> *“I need in-servicing in current trends in technology applications like electronics. This should go hand-in-hand with changing the current syllabus”* (Teacher I).

From the above sentiments it is apparent that some of the teachers need assistance in expanding their CK. The teachers need to deepen their CK to develop their capabilities and practices. Hence capacitating physics teachers in CK should be a viable and appropriate option for professional development.

5.9.2 Experimental design and hands-on activities

The majority of the interview respondents expressed reservations about their capabilities to design and deliver practical work, particularly experimental design and interactive class activities. Hands-on activities and interactive activities enhance conceptual understanding of physics concepts. It is prudent that practical work and interactive activities are well-planned and structured so that learners derive maximum benefit. The teachers expressed their dissatisfaction with their perceived inadequacy in these competencies.

> *"I am not comfortable with planning practical work activities for the learners"* (Teacher C).

> *"I have challenges in dealing with the design practical question"* (Teacher F).

The preceding sentiments are an indication that some of the physics teachers need to be assisted in the planning and execution of practical work activities. This finding agrees with Kim and Tan (2010:484); Munikwa et al. (2011:42) and Ramnarain (2011:92), who reported that learners are subjected to practical work activities dominated by teacher demonstrations and teacher-directed confirmatory experiments. This approach to learner hands-on activities undermines learner creativity and autonomy, rendering it inappropriate for effective physics learning. The teachers need to be capacitated with skills to facilitate learners designing and conducting their own experiments.

5.9.3 Limited use of instructional technology

The majority of the respondents expressed the need for assistance in the use of instructional technology in the teaching of physics. The teachers were concerned about the limited use of modern technology in their teaching. This finding coincides with that of Buabeng (2015:16) who posits that physics teachers rarely used modern technologies in their physics teaching. The current physics teacher practices that are devoid of modern technology integration are of critical concern and desire urgent redress in the form of professional development. Some of the participants' opinions on the perceived limited use of modern instructional technologies in physics teaching are:

> *"Maybe to have practice on using the e-learning platform"* (Teacher J).

> *"I am currently undertaking a post graduate diploma in science education, which is quite enriching in the use of Instructional technologies in teaching and learning. I wish my colleagues could be afforded the chance to do it, to have a paradigm shift"* (Teacher I).

These statements suggest that teachers' limited use of instructional technologies could be an impediment to the effective execution of their responsibilities. Every teacher needs to be conversant with the integration of instructional technologies to facilitate effective teaching and learning. Instructional technology tools are the bedrock of the 21st century effective teaching strategies. Hence, being found stuck in traditional teaching approaches makes teachers vulnerable, and the learners under their guidance could be disadvantaged. Consequently, professional learning with respect to instructional technologies' use and practices in physics teaching and learning becomes paramount.

5.9.4 Conduct of sustainable professional development activities

The majority of the interview respondents suggested that staff development seminars had to be conducted in the schools by experienced teachers. They were adamant that the workshops should be more beneficial if conducted in the school contexts and facilitated by experts within the teaching fraternity. The teachers maintained that such scenarios would make the in-service courses address their needs and more relevant to their responsibilities. This finding is consistent with Ferreira (2014:11), Gokmenoglu et al. (2016:120), Qablan et al. (2015:629) and Zakaria and David (2009:230), who reported that teachers are interested in professional development activities that articulate their needs and experiences. This is quite pertinent as the perceived needs and context may motivate the teachers to participate in the professional development activities. Addressing teacher needs and interests may also provide a platform for physics teachers to try out what they may have learnt from the professional development activities. Ultimately such interactive professional development activities' learning outcomes are likely to promote growth, enhance practices and meaningful learning. Some of the interview respondents made the following comments with respect to conduct of professional development activities, facilitators and the timing.

> *"In-service workshops should be conducted in the schools in the province. The facilitators should be experienced physics teachers or experts from universities"* (Teacher C).

> *"The in-service would be better at the school level, with experts in that area. Preferably physics teachers in the province converge at one school for the exercise"* (Teacher A).

> *"I am comfortable with the teachers who have classroom experience facilitating in seminars rather than university lecturers"* (Teacher F).

These statements serve to substantiate that the teachers are keen to undertake professional development workshops conducted in the schools. They are also keen to have the workshops facilitated by knowledgeable colleagues who are well versed in their work environment and resources at their disposal. Such workshops may have the potential and the capacity to address teachers' needs, weaknesses and concerns. This finding is consistent with that of Bellibas and Gumus (2016:13), who posit that staff development activities conducted in the schools and facilitated by seasoned teachers address real classroom problems.

The survey findings reflect that teachers are satisfied with the professional development opportunities availed to them in the schools. The interview results seem to suggest the narrow scope or scarcity of staff development opportunities being offered to the physics teachers in the schools. The areas of inadequacy indicated by the teachers should form the basis of the ZFI. The teachers' shortcomings and needs should direct the course of professional development activities based on individual teacher needs and school capacities. Sustainable contextualised and appropriate staff development seminars facilitated by seasoned teachers or experts need to be instituted in the schools as a matter of urgency.

5.10 CHAPTER SUMMARY

Data from the closed survey questionnaire, structured interview guide and document analysis guide was analysed to synthesise physics teachers' interpretation of the physics curriculum and current classroom practices. The physics teachers were found to be adequately trained and narrowly interpreted the physics curriculum with respect to science inquiry-based instruction, linking physics concepts to everyday life and ICT tools' integration in physics teaching. The context in which the physics teachers were operating was supportive to the teacher classroom practices. The quality of staff development opportunities available to the teachers was highly appreciated, but there is room for improvement with regard to scope, depth and sustainability. The next chapter presents the conclusions and recommendations of this study.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The aimof this investigation was to examine the Zimbabwean physics teachers' interpretation of the Advanced Level Physics curriculum. The motivation of teachers to adopt new practices and the match between their understanding and the practice envisaged by developers, do not always tally (Fullan, 2007:39; Ndawi&Maravanyika, 2011:68). Zimbabwean Advanced Level Physics teachers are not an exception to this predicament, as evidenced by the low numbers of undergraduate students and the misconceptions displayed by physics learners enrolling for first year university work in physics-related disciplines (Kazembe &Musarandega, 2012:4). Having an idea of physics teachers' perceptions, experiences and current practices with regard to the revised Advanced Level Physics curriculum would be fertile ground for possible intervention measures and policy decisions. It is anticipated that the findings will provide important implications for teaching, learning, resource mobilisation, support and curriculum design in Zimbabwe or other nations engulfed in similar situations to enhance effective curriculum enactment.

To obtain a more holistic picture of the physics teachers' perceptions, experiences and practices, a mixed methods research approach was adopted.The convergent parallel design gives room for both quantitative and qualitative data to be collected at roughly the same time (Creswell, 2014:220;Fischler, 2014:22).Collection of both quantitative and qualitative data ensures that the researcher maximises on the strengths of both the quantitative and qualitative methods to obtain a full picture of the research question. A closed survey questionnaire was used to solicit for information from 56 physics teachers in four educational provinces of Zimbabwe namely Harare, Mashonaland East, Mashonaland Central and Mashonaland West. Multistage sampling was employed to select the participants. First cluster sampling was used to place schools into two groups, namely rural and urban. Random sampling was then used to select the participating schools from which respondents would be drawn. Of these participants, 10were purposively selected for face-to-face in-depth structured interviews based on their availability and accessibility. Ten schemes of work, one from each teacher for one school term, and six past examination practical paper 4 question papers were collected and analysed using a document analysis guide. This assisted in collectively constructing a holistic understanding of the physics teachers' perceptions and current practices and how those perceptions and practices may be changed for the better. Quantitative data was analysed using descriptive statistics and chi-square, whereas qualitative data was collated into themes for discussion purposes.

Rogan and Grayson's (2003) theory of curriculum implementation particularly for developing countries was employed to guide data-gathering, analysis and interpretation. The theory was instrumental in framing the findings. Rogan and Grayson's (2003) sub-constructs of PoI, OIs and CtI were utilised to rank teachers practices, national physics curriculum intentions, public examinations questions skills demands and micro-curriculum intentions as depicted in teachers' schemes of work against model operational levels. The PoI indicates the extent to which curriculum intentions are being enacted through practical work activities, linking physics concepts to daily life and types of assessment being conducted. The CtI gives insight into factors that promote or hinder the implementation of the Advanced Level Physics curriculum through the availability of material and physical resources, teacher competencies and school culture. The OIs foster insights on how outside bodies such as NGOs and SDCs support the implementation of the Advanced Level Physics curriculum. This may be attained through the use of physical resources, material resources and possibly teacher professional development. The four operational levels of the sub-constructs served as guidelines for ranking the established teacher practices compared to prescribed practices. The majority of the teacher practices were predominantly of lower operational practices, with only a few bordering on high levels. For instance, the teachers' practice of regularly affording learners opportunities to conduct guided practical work activities for learners within the sub-construct 'science practical work' served as evidence of high operational level practice. Consequently, the current physics teacher practices, resources availability and school contexts may be considered to be trailing behind with regard to the anticipated high level of operations of Rogan and Grayson's (2003) sub-constructs alluded to earlier. The official Advanced Level Physics curriculum was found to be successfully articulating with the high levels of Rogan and Grayson's (2003) operational levels, such as providing opportunities for learners to design and conduct their own experiments.

The idea of ZFI as postulated by Rogan and Grayson (2003) was used to identify the training needs of physics teachers, the specific interventions required for growth and schools' potential teacher support. The ZFI may refer to new teaching approaches adapted by the physics teachers that are within their school capacities as they construct and execute the micro-curriculum (Rogan, 2007:451). The current physics teacher practices, as compared with the prescribed official curriculum intentions and teaching approaches, would give the gap in practice that should be addressed. In this case, the gap between the official curriculum intentions and the teachers' construed micro-curriculum also gives a measure of the ZFI. It was evident that identifying individual teacher needs and interests was instrumental in devising intervention measures for particular teachers and schools. The areas of inadequacy indicated by the teachers should form the basis of the ZFI. To that end, the teachers' shortcomings and needs should direct the course of professional development activities based on individual teacher needs and school capacities.

First the summary of the main findings with respect to research questions is presented. Next, the conclusions are elaborated upon, followed by the limitations of the study underpinned by the research design and the quality of the findings. Then the implications of the study and the recommendations based on study findings will be presented. In conclusion, the study proposes areas for further research within this field.

The main thrust of this research was to examine how teachers interpret and implement the Zimbabwean high school physics curriculum. Consistent with the main aim, the key research question was:

How do Zimbabwean physics teachers translate the Advanced Level Physics curriculum into practice?

Seven sub-questions supported the major research question. The first sub-question explored the Zimbabwean physics teachers' perceptions of the Advanced Level Physics curriculum and the factors influencing these perceptions. The second sub-question probed the level of preparedness of teachers to implement innovative teaching strategies in the physics classroom and contributing factors. The next question centred on how Zimbabwean teachers teach inquiry skills and to what level in Advanced Level Physics lessons, and on the anticipated impediments. The fourth sub-question explored how the teaching and learning of physics concepts were related to Zimbabwean everyday life and the challenges faced. The following question focused on how ICTs are applied in the learning and teaching of the Advanced

Level Physics curriculum and the challenges faced. The sixth sub-question delved into how the school climate influences the implementation of the Advanced Level Physics curriculum in the selected schools. The final sub-question examined the nature of professional development opportunities availableto teachers in the schools and how these development opportunities influenced classroom practice. The study findings are summarised in the next paragraphs.

6.2 KEY FINDINGS

The key findings are discussed with respect to the main study question as declared previously, namely: How do Zimbabwean physics teachers translate the Advanced Level Physics curriculum into practice?

6.2.1 Insights on literature review

The PoI was found to be quite pertinent with respect to the high schools having limited infrastructure in terms of the physics laboratories, which are ranked at high operational levels. The concept ofZFI was utilised in conjunction with the sub-constructs to single out the disparities existing in the high schools, specifically with regard to the interventions needed by individual teachers and respective high schools. For instance,OI was instrumental in establishing the limited support given to schools in complementing their efforts to implement the physics curriculum. The scarcity of modern physics and ICT equipment in the schools served as an indicator of areas of low operational levels of OI.

The literature review had a double-barrelled motivation. First, the literature proffered insights on international and regional trends in the developments and understanding of teachers' perceptions, experiencesof teaching, and learning practices in science subject classrooms. Insights acquired from these international and regional developments provided ingrained knowledge on the question being studied. Secondly, literature captured other studies, giving their findings, limitations and strengths that enabled the researcher to glean critical suggestions. For instance, the purported discrepancies between curriculum intentions and examinations demands (Buabeng,2015:235; Chabalengula& Mumba, 2012:325) guided the researcher in determining the relationship between the national Advanced Level Physics curriculum intentions, the teachers' classroom inquiry-based physics practices and the public examinations demands. In the same spirit, connecting physics to real-life situations promotes deep learning, but school contexts may not be supportive of such teaching approaches(Ng & Nguyen,2006:40; Yerdelen-Damar&Elby, 2016:13). This guided the study in establishing how Zimbabwean physics teachers were linking physics concepts with real-life situations and the challenges they could be encountering in the process. The literature review guided and validated the research approach, thereby giving reliability to the findings. Having clarified the place of the literature review in this study, the next subsection focuses on the study findings, starting with the teachers' perceptions of the Advanced Level Physics curriculum.

6.2.2 Teachers' perceptions of the Advanced Level Physics Curriculum

In this section, the insights generated from the study and the main findings that may contribute to the existing knowledge are underscored. The sub-question to be first addressed in this section is:

What are Zimbabwean physics teachers' perceptions of the Advanced Level Physics curriculum?

The physics teachers were found to have positive perceptions about the relevance of the subject content of the Advanced Level Physics curriculum as evidenced by 84.0% indicating that the physic curriculum promotes problem-solving and critical thinking skills and 76.8% who found that the suggested teaching approach is compatible with the final assessment. However, the participants identified some areas of the Advanced Level Physics curriculum that needed to be reviewed, among which are: limited suggested practical activities, limited equipment for learners to undertake hands-on activities, and the perceived broadness of the physics curriculum.

6.2.3 Teachers' preparedness to teach Advanced Level Physics

The sub-question to be answered in this section follows:

What is the level of preparedness of teachers to implement innovative teaching strategies in the physics classroom?

The majority of the physics teachers indicated that they were adequately prepared to teach Advanced Level Physics as evidenced by 94.7% of the participants indicating that they were well prepared to manage a class undertaking hands-on activities, and about 84% of the participants indicating that they had no problems in providing effective instruction to the physics learners. Participants in the study also suggested some areas of improvement in teacher education as a possible means of further enriching the current teacher training programmes through: Standardised physics content knowledge offered in universities, having basic minimum body of knowledge for pedagogical courses, and synchronising how student teachers are taught in universities and how they are expected to teach in the high schools. The student teachers are taught mainly through teacher-centred methodologies but are expected to teach using learner-centred approaches. The participants also pointed out that there was need to institute a teaching practicum period that is more than one school term to facilitate better understanding of the learners and the work environment by the student teachers.

6.2.4 Inquiry-based physics teaching

The sub-question to be addressed in this section is stated below:

How do Zimbabwean teachers teach inquiry skills in Advanced Level Physics lessons?

The Zimbabwean physics teachers are conversant with the theoretical underpinnings of inquiry-based instructional practices. This was confirmed by 96.4% of the participants who indicated that they encouraged learners to work in collaborative groups on investigations and 87.5% of the participants who suggested that they encouraged learners to design their own investigations to solve scientific phenomena. Despite holding inquiry-based physics teaching in high esteem, the main instructional methodologies for imparting inquiry skills to the learners employed by the physics teachers are: the traditional lecture method (39.16%), solving mathematical problems (24.47%) and group discussions (20.98%). The participants claimed the main factors contributing to resorting to transmission teaching methods were the in-adequate supply of relevant equipment such as cathode ray oscilloscopes and digital timers, teachers' prior conceptions of their learners, limited time to complete the physics syllabus and teaching physics for examinations.

6.2.5 Linking physics concepts with everyday life

The sub-question to be addressed in this section is stated below:

How is the teaching and learning of physics concepts being related to Zimbabwean everyday life?

The physics teachers value the linking of physics concepts to everyday life highly. The vast majority (92.8%) of respondents affirmed the importance of linking physics concepts with real life, for the purpose of encouraging uptake of physics for further study (92.8%), facilitating improved conceptual understanding (96.5%) and for meaningful learning of physics (94.6%). A similar majority of respondents were of the opinion that contextualised teaching of physics serves the ability to apply physics to everyday life (94.6%) and to stimulate creativity (94.6%). These sentiments are consistent with Ng and Nguya (2006) and Yerdelen-Damar and Elby (2016:13) who claim that physics teaching should be related to real-life situations capitalising on the learners' personal experiences.

Despite the high regard for linking physics concepts with everyday life, the current physics classroom practices show that Zimbabwean physics teachers are operating at low operational levels of linking physics concepts to everyday life. This is confirmed by the fact that theyresort to giving explanations and citing given examples in the majority of their classroom deliberations. The low level operational practices of linking physics concepts to everyday life were attributed to the teachers' lack of capacity to be innovative, lack of detailed curriculum specifications, lack of opportunities to share experiences with seasoned colleagues, and administrative barriers. The participants suggested that intervention measures to enhance the effective linking could be promoted by giving teachers opportunities to share experiences, detailing the link between physics concepts and everyday life in the curriculum, and reducing bureaucratic procedures stipulated by the education system before learners could undertake educational tours.

6.2.6 Integration of Information Communication Technology in teaching physics

The sub-question to be answered in this section is as stated below:

How are ICTs applied in the learning and teaching of the Advanced Level Physics curriculum?

The majority of the Zimbabwean physics teachers have basic ICT competencies as evidenced by 89.3% of participants being able to search for files on the internet and organise them into folders; 87.5% being able to download teaching material pertaining to physics and 80.3% being able to access and share information on CD/DVD/flash disc. The physics teachers indicated that they rarely utilised ICT in the teaching and learning of physics in the classrooms. The analysis of the teachers' schemes of work confirmed the limited use of ICT tools as evidenced by occasional use of LCD projectors in lesson delivery. The participants attributed the low or non-use of ICT tools in their physics teaching to the lack of basic ICT infrastructure and tools, schools' financial constraints and the lack of a clear ICT policy in the high schools, with only a few schools allowing the learners to use their smart-phones for learning. The teachers suggested that there was an urgent need for schools to develop basic ICT infrastructure, source modern ICT equipment, and to establish a clear ICT school policy and to implement it for the benefit of the learners.

6.2.7 School climate

The sub-question to be addressed to in this section is stated below:

How does the school climate influence the implementation of the Advanced Level Physics curriculum?

The prevailing climate in the schools promotes teaching and learning of physics as evidenced through enabling physics teachers to share their concerns and frustrations with other science teachers (71.5%) and respecting colleagues who initiate school improvement efforts (85.7%). Despite the teachers' appreciation of a conducive environment for teaching physics, the participants were of the view that the school climate could be enhanced by creating synergies with universities to enable learners to access modern equipment, enrolling better quality learners for physics who are well grounded in physics concepts at the junior levels, and improved consultation of physics teachers with school authorities on issues such as departmental budget allocation and procurement of physics equipment.

6.2.8 Teacher professional development opportunities

The sub-question to be addressed in this section is as stated below:

What is the nature of professional development opportunities availed to physics teachers in the schools*?*

The physics teachers are subjected to one-shot traditional staff development workshop offered to them in the schools. This is evidenced through the majority of the participants (78.6%) having participated in demonstrations of teaching techniques,78.5%leading staff development group discussions, and 55.3% of the participants having presented a lecture to fellow teachers. The staff development opportunities prevalent in the schools are more focused on teaching methods at the expense of physics content. The participants suggested the following areas as potentially viable for staff development: physics content-related seminars, experimental design and hands-on activities skills, and use of instructional technology delivery in the physics classrooms. The physics teachers were also of the view that the staff development opportunities should be provided for physics teachers in a familiar context, facilitated by seasoned teachers, and conducted it in an interactive fashion to enhance chances of adoption of skills gained.

6.3 CONCLUSIONS

The findings from the study culminated in several conclusions about Zimbabwean high school physics teachers' interpretations and implementation of the physics curriculum. First, the teachers provided insights into their perceived positive perceptions of the physics curriculum, while indicating the need to infuse modern communication technologies into this curriculum. The Advanced Level Physics curriculum could be enriched through suggesting more hands-on activities and reducing its breadth to make it compatible with the apportioned time.

The study revealed that the physics teachers were inadequately prepared to teach Advanced Level Physics and suggested that more could be done in restructuring teacher training programmes with respect to standardising physics content and pedagogical content offered in universities and synchronising how student teachers are taught in universities and how they are expected to teach in the high schools.

The study findings demonstrated teachers' awareness of high level inquiry-based physics classroom practices, while indicating that teachers are operating at low level in these practices. The low inquiry-based physics practices are attributed to an examination-driven curriculum and as such, the teachers tended to focus on specific areas, especially practical activities which were thought to be examination targets. The physics teachers also pointed out that time constraints, learners' prior knowledge and inadequate modern equipment forced the teachers to rush through the physics curriculum, resulting in learners' surface learning which is detrimental to proper understanding of physics concepts.

The study findings provided insight into teachers' classroom practices in linking physics concepts with everyday life. The findings suggest that physics teachers operate at low levels of linking physics concepts with everyday life. The physics teachers pointed out that they need more guidance in facilitating the linking of physics concepts to everyday life and that the curriculum designers should provide explicit physics curriculum guidelines about how to do this.

The findings offered insights regarding the physics teachers' skills in integrating ICT into the teaching and learning of physics. The teachers are not highly competent with respect to ICT skills and there is limited use of ICT tools in the Zimbabwean high schools physics classrooms. The limited use of ICT, lack of modern ICT equipment, and lack of a clear school ICT policy all act as obstacles to creating more space to promote ICT integration in physics teaching and learning.

The study findings provided insight into how the school climate influences teaching, and demonstrated that the prevailing school environment is conducive to the teaching of physics. Physics teachers suggested that creating synergies with universities, enrolling learners who are well grounded in Ordinary Level Physics and increasing teacher consultation on sourcing of physics equipment would enhance teaching of physics.

The study findings revealed a prevalence of traditional one-shot workshops on teaching approaches and a dearth of physics-related seminars in the schools. The physics teachers pointed out that physics seminars should be resuscitated to enrich their knowledge through sharing experiences with seasoned colleagues in experimental design skills, hands-on activities and instructional delivery. This would ultimately enhance their effectiveness in the teaching and learning physics practices and the learners were bound to benefit from these enhancements.

6.4 IMPLICATIONS OF THE STUDY

The study has implications for a physics curriculum review, teacher curriculum interpretation, teacher practices, and resource mobilisation and teacher professional development. Zimbabwean physics teachers are currently employing both teacher-centred and learner-centred teaching approaches for instruction delivery. The physics curriculum advocates the use of learner-centred teaching approaches. The use of teacher-centred teaching approaches is therefore inconsistent with the official curriculum intentions. It appears that physics teachers are misinterpreting the physics curriculum in this respect. The physics teachers need to critically reflect on their professional responsibilities and construct suitable learning experiences that promote interiorised learning utilising learner-centred classroom activities to facilitate internalisation of concepts by the learners.

The curriculum designers need to review the physics content and arrange it in a manner that is comprehensible and attainable by the physics teachers to facilitate easy interpretation and implementation of appropriate and relevant learning experiences for the learners. The official physics curriculum could benefit from the incorporation of cell phone technologies, Medical Physics and Environmental Physics as sub-disciplines, and from instituting explicit guidelines for teachers in constructing suitable learning experiences to link physics concepts with everyday life.

Physics teachers generally operate at low levels with respect to linking physics concepts with everyday life, ICT integration into the physics classroom discourse, and higher order ideals of inquiry-based physics teaching in terms of Rogan and Grayson’s (2003) operational levels. The physics teachers are subjecting learners to low order skills, which is not consistent with the requirements of the current Advanced Level Physics curriculum, science education global trends or21st century skills acquisition ideals. The mismatch between the official curriculum prescriptions and the physics teachers' constructed micro-curriculum should be recognised and given due attention by the Zimbabwean government and curriculum designers for quality Advanced Level Physics implementation to occur.

The Zimbabwean physics teachers are operating at high levels of Rogan and Grayson's (2003) sub-construct 'practical work' as evidenced by the teachers regularly encouraging learners to undertake guided practical work activities, and occasionally affording learners opportunities to design and carry out their own experiments. These efforts need to be supported and encouraged by school authorities so that the practices are maximised for the benefit of the learners through enhancing better understanding of physics concepts.

The government, school authorities, SDCs and local communities should provide pertinent teaching and learning resources to facilitate the teachers in enacting the curriculum. Prudent financial allocations should expedite curriculum implementation and learner's learning. SDCs need to be proactive in mobilising resources with fundraising efforts to facilitate acquisition of basic internet infrastructure, modern ICT tools, and modern equipment for effective curriculum implementation for the benefit of the learners.

The current Zimbabwean Advanced Level Physics teachers have basic ICT skills and competencies and a few possess their own laptops or smart-phones. The majority of Zimbabwean high schools have basic internet infrastructure. However, there is little integration of ICT tools in the teaching of physics in the physics classrooms. The current physics teachers are not being innovative to take advantage of the existence of basic infrastructure in the schools to network and share experiences with colleagues using ICTs at their disposal. Teachers creating such platforms could breed a community of practice that would greatly enhance their teaching practices and benefit learners' outcomes. This could be facilitated through sharing experiences, collaboration and peer coaching, irrespective of school geographical location, and ultimately deepens the physics teachers' knowledge and practices. The government and school authorities need to take advantage of the physics teachers' basic ICT competencies and should mobilise resources to motivate teachers so that these skills are used in productive classroom activities that enrich teaching and learning.

The physics teachers need to be capacitated in deepening their knowledge of design experiments, hands-on activities and instructional technology delivery through investment in continuous staff development programmes. The staff development seminars could be orchestrated by engaging physics teachers in interactive seminars addressing their individual needs and interests, taking cognisance of the schools' capabilities and taking advantage of the ZFI. Conducting staff development seminars in school contexts, facilitated by seasoned teachers in the schools, would ensure sustainability, reflective practice and better chances of trying out newly acquired experiences.

6.5 RECOMMENDATIONS

From the study findings, the following recommendations are proffered:

The curriculum designers need to revisit the Advanced Level Physics curriculum and infuse modern cutting-edge technologies consistent with the 21st century global trends to benefit learners with modern technology competencies and enhance its relevance to physics teaching.

Policymakers should re-structure and standardise teacher training programmes offered by Zimbabwean universities to ensure that student teachers studying at different institutions are subjected to the same basic minimum body of knowledge, so that when the qualified teachers start teaching, their curriculum interpretations are similar so that all learners benefit to the same extent.

The teacher educators are encouraged to use learner-centred teaching approaches and to focus on how best to prepare the prospective teachers to face aspects of the school environment that affect their instructional practices. This approach would enable prospective teachers to easily adjust to the envisaged learner-centred teaching approaches in the high schools.

The curriculum designers need to reduce the physics curriculum breadth and revisit the assessment criteria to align it with high order inquiry-based physics skills demands. Such a move would ensure that assessment practices, the curriculum and pedagogy augment each other for effective curriculum implementation.

Physics teachers should provide more opportunities for learners to design their own experiments; carry them out and evaluate their undertakings. Such undertakings may enhance learners' understanding of physics concepts through construction of own meanings and internalisation of concepts.

Curriculum designers should provide detailed guidelines and learning activities for linking physics concepts with everyday life to facilitate easy interpretation by the teachers and ensure learners benefit more from the available learning experiences.

The government and curriculum designers need to restructure the Junior Level Science curriculum so that the different science disciplines are taught separately and by subject specialists from Form one level. This will facilitate learner grounding in specific science subjects and adequately prepare the learners for learning Advanced Level Science.

School authorities should source modern ICT equipment and formulate and implement school ICT policies that are consistent with current technological trends to facilitate the increased integration of ICT tools in the physics classroom discourse.

The school authorities should create synergies with universities to facilitate learners getting access to modern equipment in institutions of higher learning and enhance better understanding of physics concepts by the learners.

School authorities should make efforts to consult physics teachers when making departmental budget allocations. This will provide teachers with opportunities and room for decision-making when their concerns and expertise are acknowledged. Recognition is the factor most likely to evoke trust, cooperation and commitment, which are critical requirements for effective curriculum implementation.

School authorities need to revive physics-related professional development seminars to deepen physics teachers' skills in experimental design, hands-on skills and instructional technology delivery to ensure the learners benefit more from teaching and learning of physics.

School authorities need to establish and develop online support systems to sustain physics teachers' staff development initiatives that could be facilitated and accessed through ICTs.

6.6 LIMITATIONS OF THE STUDY

The mixed methods approach was advantageous to the study. The qualitative and quantitative paradigms corroborated each other to holistically answer the research question. For instance, the qualitative approach facilitated better understanding of issues raised in the survey with regard to teacher perceptions and teaching practices through interviews, which could not have been accessed through the survey (Flick, 2014:370). However, since the two approaches are hinged on different assumptions, each has its own weaknesses. Efforts toquantitise qualitative data in some aspects of the research may result in it losing its flexibility and depth. Depth.Effects of quantification of qualitative data on findings was minimised through verbatim presentation of respondents' ideas. In the same vein the researcher's bias may have been an impediment to the qualitative methodology, and possible effects of the findings were minimised through focusing on points of interest and guiding respondents to stick to issues pertinent to the study (Gray,2009:370).

The survey limitation could be based on whether the physics teachers were able to accurately assess themselves with respect to their perceptions and teaching practices and whether they accurately reported on their actual perceptions and practices. There was no assurance that the participants in the survey precisely appraised themselves regarding their teaching practices and that they flawlessly reported on these practices. However, several questions were employed to authenticate their responses to enhance validity and reliability of the findings. In the same spirit the trustworthiness of the study has been enhanced by the use of data triangulation, whereby more than one method of data collection was employed to gather data.

The restricting of the study to four educational provinces in a country with 10 educational provinces was a potential limitation to the generalisation of findings. However, the education system in Zimbabwe is standardised through use of the same syllabuses, examinations and a regulated teacher training system which made this limitation insignificant. The standardisation in the education system also meant that the sampling of the participating schools was representative of schools in the country.

6.7 SUGGESTIONS FOR FURTHER RESEARCH

In light of the findings of this study, some areas of concern are singled out in the following paragraphs, as possible fertile ground for further probing.

A majority of the study participants hold the perception that the physics curriculum content lacks modern technology aspects. Further studies may be necessary to ascertain how to bring modern technologies into the Advanced Level Physics curriculum, to make it more relevant and appealing to learners.

There is a knowledge gap regarding the correlation between how student teachers are taught in university faculties of education, and how the teachers are expected to teach learners in high schools. There is a need to approach current university lecturers who teach teacher education, to establish their perceptions, experiences and teaching practices with a view to informing and engaging them on the merits of employing learner-centred approaches for the benefit of prospective teachers.

The participants in this study bemoaned the examination-driven physics curriculum impacting negatively on the effective teaching and learning of inquiry-based physics. This raises the question of whether the prevailing physics teaching practices benefit the learners as per expectations of the physics curriculum. Further research is needed to determine the effects of assessment on teachers' practices and learners' learning.

The examination-driven physics curriculum is an issue of concern for the learners' good mastery of physics concepts. A further study is envisaged where key stakeholders' views are solicited pertaining to the feasibility of introducing continuous assessment in the teaching and learning of physics.

There is need to ascertain the relationship between professional development and use of innovative teaching methods in Advanced Level Physics classrooms. This could also be extended by determining the physics teachers' views on innovative teaching methods to guide the development of a relevant professional development programme for the physics teachers.

6.8 CHAPTER SUMMARY

The study investigated the Zimbabwean physics teachers' interpretation of the revised Advanced Level Physics curriculum, which was introduced by the government in 2002.The study specifically explored the perceptions, views, experiences and practices of 56 physics teachers from 28 urban and 28 rural high schools in four educational provinces of Zimbabwe. Using the mixed methods approach, the convergent parallel research design generated data through survey questionnaires, interviews and document analysis. The findings of the study reveal that the physics teachers have embraced the ideals of the physics curriculum and have adapted the curriculum to their operating context through reiterative interpretation process to construct personal meaning. The teachers are mainly utilising teacher-centred approaches to impart knowledge to the learners, which is not consistent with the physics curriculum anticipations of using learner-centred approaches. The teaching of physics has been described by this study as surface learning and mainly a product of micro-curriculum implementation. Informed by the research findings, several recommendations were suggested and the need for further research was proffered.

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APPENDIX A

RESEARCH ETHICS CLEARANCE CERTIFICIATE

APPENDIX A

UNISA university of south africa

COLLEGE OF EDUCATION RESEARCH ETHICS REVIEW COMMITTEE

15 July 2015

Ref #: **2015/07/15/49917315/17/MC**
Student#: Mr S Munikwa
Student Number #: 49917315

Dear Mr Munikwa

Decision: Ethics Approval

Researcher
Mr S Munikwa
Tel: 00263 67 25341
semunikwa@gmail.com

Supervisor
Prof JG Ferreira
College of Education
Department of Curriculum and Instructional Studies
Tel: +2712 429 4540
Ferrejg@unisa.ac.za

Proposal: Analysis of Zimbabwean teacher's interpretation of the advanced level Physics curriculum: Implications for practice

Qualification: D Ed in Curriculum Studies

Thank you for the application for research ethics clearance by the College of Education Research Ethics Review Committee for the above mentioned research. Final approval is granted for 2 years.

For full approval: *The application/ resubmitted documentation was reviewed in compliance with the Unisa Policy on Research Ethics by the College of Education Research Ethics Review Committee on 15 July 2015.*

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the College of Education Ethics Review Committee.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa

An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.

3) The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

Note:

The reference number **2015/07/15/49917315/17/MC** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the College of Education RERC.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof VI McKay
ACTING EXECUTIVE DEAN

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150

APPEDIX B

PERMISSION LETTER TO CARRY OUT RESERACH

APPENDIX B

All communications should be addressed to "The Secretary for Primary and Secondary Education"
Telephone: 799914 and 705153
Telegraphic address : "EDUCATION"
Fax: 791923

ZIMBABWE

Reference: C/426/3
Ministry of Primary and Secondary Education
P.O Box CY 121
Causeway
ZIMBABWE

24 August 2015

Simbarashe Munikwa
Chinhoyi University of Technology
Department of Quality Assurance
Private Bag 7724
Chinhoyi
Zimbabwe

RE: PERMISSION TO CARRY OUT RESEARCH IN HARARE METROPOLITAN; MASHONALAND CENTRAL; EAST AND WEST PROVINCES

Reference is made to your application to carry out a research in the above mentioned provinces on the research title:

"AN ANALYSIS OF ZIMBABWEAN TEACHERS' INTERPRETATION OF THE ADVANCED LEVEL PHYSICS CURRICULUM; IMPLICATION FOR PRACTICE"

Permission is hereby granted. However, you are required to liaise with the Provincial Education Directors Harare Metropolitan, Mashonaland Central, East and West, who are responsible for the provinces which you want to involve in your research.

You are required to provide a copy of your final report to the Secretary for Primary and Secondary Education by December 2016.

E. Chinyowa
Acting Director: Policy Planning, Research and Development
For: **SECRETARY FOR PRIMARY AND SECONDARY EDUCATION**
cc: PED – Mashonaland East province

r/asmunikwa/mkwala15

APPENDIX C

REGIONAL PERMISSION LETTER TO CARRY OUT RESEARCH

APPENDIX C

All communications should be addressed to "THE PROVINCIAL EDUCATION DIRECTOR"

Telephone : 792671-9
Fax : 796125/792548
E-mail : moeschre@yahoo.com

ZIMBABWE

REF: G/42/1
Ministry of Education, Sport and Culture
Harare Provincial Education Office
P. O. Box CY 1343
Causeway
Zimbabwe

15 October 2015

Simbarashe Munikwa
Chinhoyi University of Technology
Department of Quality Assuarance

RE: PERMISSION TO CARRY OUT RESEARCH IN SOME SELECTED SCHOOLS

HARARE PROVINCE SCHOOLS TOPIC: AN ANALYSIS OF ZIMBABWEAN TEACHERS' INTERPRETATION OF THE ADVANCED LEVEL PHYSICS CURRICULUM; IMPLICATION FOR PRACTICE

Reference is made to your letter dated 24 August 2015.

Please be advised that the Provincial Education Director grants you authority to carry out your research on the above topic. You are required to supply Provincial Office with a copy of your research findings.

Mayengwa

For: Provincial Education Director
Harare Metropolitan Province

MINISTRY OF EDUCATION HARARE REGION 15 OCT 2015 BOX CY 1343, CAUSEWAY ZIMBABWE

5

APPENDIX D

LETTER TO SEEK PERMISSION TO CARRY OUT RESEARCH

Chinhoyi University of Technology
Department of Quality Assurance
Private bag 7724
Chinhoyi
17 June 2015

The Permanent Secretary
Ministry of Primary and Secondary Education
Union Avenue
P.O. Box CY 121
Causeway
Harare
Zimbabwe

Dear Sir/Madam

REF: SEEKING PERMISSION TO CONDUCT A RESEARCH IN ZIMBABWE

I write to seek your approval for my research project in Zimbabwe. I am a DED student from Unisia under the supervision Professor JG Ferreira (ferrejg@unisa.ac.za; Tel: +27124294540). I have chosen 40 high schools (20 urban and 20 rural) in Harare, Mashonaland Central, Mashonaland East and Mashonaland West as the context for conducting the field study.

The letter is seeking your consent to carry out the field study that is estimated to take six months and is scheduled to take place between July and December, 2015. My proposed research topic is: *An Analysis of Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum: Implications for practice*.

The aim of the research is to investigate how teachers are interpreting the Advanced Level Physics curriculum and the factors that are influencing their interpretation and the planning and delivery of learner-experienced curriculum in contemporary high schools. The study also seeks to investigate how and what learners are learning. The study will focus on perceptions and experiences of classroom teachers during the implementation. The research will also provide an opportunity for teachers to voice their views, opinions and experiences in the implementation of the Advanced Level Physics curriculum. Two research assistants will be involved in the study.

My contact details are: cell 00263 773 460 916 and email: semunikwa@gmail.com. I wish to acknowledge that I am familiar with the Unisa research policy and the Unisa ethics policy. Attached to this application please find my research plan, CV and a copy of the ethical clearance.

I would be grateful if you grant me permission to conduct my research in the four Provinces.

Thank you for your anticipated cooperation.

Yours Sincerely

MunikwaSimbarashe

APPENDIX E: INFORMED CONSENT FORM

Dear prospective research participant,

1. Introduction

I am SimbarasheMunikwa, a DEd student registered at the University of South Africa and currently teaching at Chinhoyi University of Technology. My supervisor is Prof JG Ferreira (Department of Curriculum and Instructional Studies; UNISA. ferrejg@unisa.ac.za Tel +27124294540). You are kindly invited to participate in a research study that I will undertake that will, if successfully completed, lead to the award of a DEd degree. The title of the research is: *An Analysis of Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum: Implications for practice*. This form is to assist you decide whether you would like to participate in the research. It is important for you to fully understand what is entailed in the research to enable you to make an informed decision whether to participate or not. If you have any queries regarding the research study after reading this form please do not hesitate to consult me or my supervisor on the contact details given in paragraph 8. You are at liberty not to agree to take part in the study if you are not happy about any part or procedures to be followed.

2. The nature and purpose of this study

The aim of this study is to investigate how teachers interpret the Zimbabwean high Advanced Level Physics curriculum. It is hoped that the study will enable me to come up with effective teaching strategies and learning environments that will enhance the teaching of Physics. It is envisaged that this will consequently lead to improve teaching and learning of Physics in Zimbabwean high schools. You have purposely been selected to take part in this investigation because of your experience as a Physics teacher.

3. Procedures for selecting participants

Purposive sampling will be employed to select 40 Advanced Level Physics, from 40 randomly selected High schools from two clusters (20 urban & 20 rural), from four Educational Provinces of Zimbabwe who have experience in teaching Physics.

4. Procedures to be followed

You are being requested to accept to participate in completing a questionnaire and one-on-one interview that will be based on your perceptions, experiences and practices in the teaching of Physics. I shall be personally conducting the interview and I hope it will take about 45 minutes and with your permission, it will be audio-recorded. Audio-recording will enable me to capture every bit of information that you will have volunteered for purposes of analysis and verification. Please be advised that this exercise is voluntary and you will be free to withdraw from the interview at any stage.

5. Risk and discomfort involved

You may feel uncomfortable being interviewed or recorded or talking about some of the questions during the interview, but I will make every effort to accommodate your needs. The interview will be in an agreed upon location at a time convenient to you. I want to assure you of complete confidentiality and anonymity. The collected information and tapes will not be used for any other purpose but for this research. The tapes will not be used by any unauthorized persons and will be kept under lock and key before they are destroyed at an appropriate time.

6. Possible benefits of the research

As a participant in this research project, you will have assisted in highlighting teacher perceptions, beliefs, experiences and practices in Zimbabwean high schools and therefore contribute to the envisaged strategies for effective teaching and learning. Findings will be provided to you in follow-up feedback sessions. You will be welcome to request the summary of the findings. The findings will also be readily available in articles that will be published in education journals and in the thesis that will easily be accessible from the Unisa library or the research as a soft copy.

7. Ethical clearance processes

Please note that for purposes of the integrity of this research, Unisa as an institution and I as the researcher have ensured that good research practices and conduct are observed. In this regard I sought a full ethical clearance from the ethical committee (CEDU REC) to ensure that, among several other things, your rights as a participant are guaranteed; and that you maximise the possible benefits and minimise possible risks (if any) associated with this research. After a rigorous examination of the application that indicated how all ethical issues will be handled, permission to conduct the research was granted by the ethical committee.

8. Information

For any questions and clarity concerning this study, do not hesitate to contact the researcher or the supervisor on the contacts below:

Supervisor: Prof. JG Ferreira

Contact details: +27 12 – 429 454 or + 27 78 120 5798

E-mail: ferrejg@unisa.ac.za

Researcher: Mr. SimbarasheMunikwa

Contact details: 00263 773 460 916

E-mail:semunikwa@gmail.com

9. Consent to participate in this study

I have read and understood the information above before signing this consent form. I have been given the opportunity to ask questions and I understand that there is no risk to me or my position should I decline to participate in the study.

I hereby volunteer to take part in this study.

Participant's name (Please print) Researcher's name (Please Print)

Participant signatureResearcher's signature

……………………………………… ……………………………….

Date………………………………… Date……………………………

APPENDIX F

LETTER REQUESTING AN ADULT TO PARTICIPATE IN AN INTERVIEW

Dear Prospective Participant

This letter is an invitation to participate in a study I, MunikwaSimbarashe, am conducting as part of my research as a student entitled:*An analysis of Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum: Implications for practice*at the University of South Africa. My supervisor is Prof JG Ferreira (ferrejg@unisa.ac.za Tel +27124294540). Permission for the study has been given by Ministry of Primary and Secondary Education and the Ethics Committee of the College of Education, UNISA. I have purposefully identified you as a possible participant because of your valuable experience and expertise related to my research topic.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. The importance of research in education is substantial and well documented. Curriculum interpretation and implementation is critical for effective teaching and learning. In this interview I would like to have your views and opinions on this topic. This information can be used to improve the teaching and learning of Physics. Two research assistants will be involved in this study.

Your participation in this study is voluntary. It will involve an interview of approximately 45minutes in length to take place in a mutually agreed upon location at a time convenient to you. You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences.
With your kind permission, the interview will be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or to clarify any points. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. However, with your permission, anonymous quotations may be used. Data collected during this study will be retained on a password protected computer for 5 years in my locked office. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at 0773 460 916 or by e-mail at semunikwa@gmail.com.

I look forward to speaking with you very much and thank you in advance for your assistance in this project. If you accept my invitation to participate, I will kindly request you to sign the consent form which follows on the same page.

Yours sincerely

MunikwaSimbarashe

CONSENT FORM

I have read the information presented in the information letter about the study entitled: An analysis of Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum: Implications for practice. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and add any additional details I wanted. I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I was informed that I may withdraw my consent at any time without penalty by advising the researcher. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participants Name (Pleaseprint):

Participant Signature: ……………………….Date………………..

Researcher Name: (Please print) MunikwaSimbarashe

Researcher Signature: Date:

APPENDIX G
COVERING LETTER FOR A QUESTIONNAIRE

Title of questionnaire: Teacher opinion of Advanced Level Physics Curriculum

Dear Respondent

This questionnaire forms part of my doctoral research entitled: *An analysis of Zimbabwean teachers' interpretation of the Advanced Level Physics curriculum: Implications for practice,* for the degree ofDEdat the University of South Africa. You have been selected by a purposive sampling strategy from the population of 150. Hence, I invite you to take part in this survey.

The aim of this study is to investigate how teachers interpret the Zimbabwean high school Physics curriculum. The findings of the study will benefit policy makers, curriculum developers, teachers and learners. You are kindly requested to complete this survey questionnaire, comprising seven sections as honestly and frankly as possible and according to your personal views and experience. No foreseeable risks are associated with the completion of the questionnaire which is for research purposes only. The questionnaire will take approximately 45 minutes to complete.

You are not required to indicate your name or school and your anonymity will be ensured; however, indication of your age, gender, qualification and teaching experience, will contribute to a more comprehensive analysis. All information obtained from this questionnaire will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if so desired, or to withdraw from answering this survey without penalty at any stage. After the completion of the study, an electronic summary of the findings of the research will be made available to you on request.

Permission to undertake this survey has been granted by the Ministry of Primary and Secondary Education and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor. My contact details are: 0773 460 916e-mail: semunikwa@gmail.com and my supervisor, Prof

JG Ferreira, can be reached at 012 429 4540 , Department of Curriculum and Instruction Studies, College of Education, UNISA, e-mail: ferrejg@unisa.ac.za.

By completing the questionnaire, you imply that you have agreed to participate in this research.

Please return the completed questionnaire to the researcher as soon as you go through it.

APPENDIX H

TEACHER QUESTIONNAIRE

Section A: Teacher background

Indicate your response by putting an X in the appropriate box.

1. Indicate your sex. Male ☐ Female ☐
2. Indicate the category that depicts your age group.

   21 – 30 ☐ 31 – 40 ☐ 41 – 50 ☐ 51 – 60 ☐ 61+ ☐
3. Indicate the location of your school. Urban ☐ Rural ☐
4. Indicate your highest qualification. Bachelor of Education ☐

   Bachelor's degree (non–Education) ☐ Bachelor's degree (with Education) ☐

   Master's degree (non-education) ☐ Master of Education ☐
5. Indicate your subject specialty Physics ☐ Chemistry ☐ Biology ☐
6. Indicateyour Advanced level Physics teaching experience in years.

   0 – 5 ☐ 6 – 10 ☐ 11 – 15 ☐ 16 – 20 ☐ 21+ ☐
7. What is the average Physics class (es) sizes that you commonly teach?

   1 –5 ☐ 6 – 10 ☐ 11 – 15 ☐ 16 – 20 ☐ 21+ ☐

Section B. Perceptions towards the Physics curriculum

The statements below seek your opinion on the value of the Physics curriculum. Place an X in the applicable box to indicate the extent to which you agree or disagree with the given statement,using the scale, Strongly Disagree(SD)=1, Disagree (D)=2, Neutral (N) =3; Agree(A)=4 and Strongly Agree (SA)=5.

Statement	**SD 1**	**D 2**	**N 3**	**A 4**	**SA 5**
8.The curriculum content fosters cutting-edge technology	1	2	3	4	5
9.My learners find the curriculum content interesting	1	2	3	4	5
10.The content fosters problem –solving and critical thinking skills	1	2	3	4	5
11.The curriculum content helps learners in career pioneering	1	2	3	4	5

12. The curriculum content has concepts which are difficult for me to understand	1	2	3	4	5
13.My content knowledge of topics in Physics curriculum is sound	1	2	3	4	5
14.The content is excessive compared to the allotted time	1	2	3	4	5
15.I have difficulties in providing effective instruction	1	2	3	4	5
16.The teaching approach is compatible with the final assessment	1	2	3	4	5

Section C: Sense of Preparedness to teach Physics

The following statements seek your opinion on your level of preparedness to teach using Innovative teaching strategies with respect to your pre-service training. Indicate the level of preparedness you attach to the given statements using the scale; Not well prepared (NP) = 1; somewhat prepared (SP) = 2; well prepared (WP) = 3 and very well prepared (VWP) = 4 by placing an X in the applicable box.

Statement	NWP 1	SP 2	WP 3	VWP 4
17.Indicate the extent to which you are prepared to teach Physics at Advanced level	1	2	3	4
18.Indicate the extent to which you are prepared to integrate Physics with other subjects	1	2	3	4
19.Indicate the extent to which you are prepared to provide Physics instruction that meets Physics content standards at national level	1	2	3	4
20.Indicate the extent to which you are prepared to use a variety of assessment strategies (including objective and open-ended formats)	1	2	3	4
21.Indicate the extent to which you are prepared to manage a class of learners who are using hands-on or laboratory activities	1	2	3	4
22.Indicate the extent to which you are prepared to take into account learners' prior conceptions about natural phenomenon when planning	1	2	3	4

Section D. Inquiry based science teaching instruction

The following statements seek your opinion on inquiry based Physics classroom instruction.Indicatethe level of importance you attach to the given statements using the scale; Not Important (NI)=1;Somewhat Important(SI)=2; Important(I)=3 and Very Important(VI)=4 by placing an X in the applicable box.

Statement	**NI** **1**	**SI** **2**	**I** **2**	**VI** **4**
23. I afford learners the opportunities to construct meaning from inquiry experiences such as engaging in open-ended questions and group discussions.	1	2	3	4
24. I involve learners with Physics experiments with known outcomes.	1	2	3	4
25. I prepare daily lesson plans guided by textbooks.	1	2	3	4
26.I encourage learners to design their own investigations to solve a scientific question	1	2	3	4
27. I teach learners guided by national examinations	1	2	3	4
28.I use inquiry method in Physics instruction	1	2	3	4
29. I teach facts as the primary goal of Physics instruction.	1	2	3	4
30.I teach the processes of Physics as the primary goal of physics instruction	1	2	3	4
31. I use multiple-choice questions as the main strategy to evaluate learner learning.	1	2	3	4
32. I use of open-ended (essay, problems) questions as the main strategy to evaluate learner learning.	1	2	3	4
33.I encourage learners to work in collaborative groups on investigations	1	2	3	4

Section E. Linking Physics concepts to everyday life

The statements below link Physics concepts to everyday life. Based on your opinion on how Physics concepts maybe linked to everydaylife, indicate whether you agree or disagree with the statements using; Strongly Disagree (SD) =1; Disagree (D) =2; Neutral (N) =3; Agree =4 and Strongly Agree =5; by placing an X in the applicable box.

Statement	**SD 1**	**D 2**	**N 3**	**A 4**	**SA 5**
34. It is important to link Physics concepts to real world contexts and global issues such as energy consumption and climate change.	1	2	3	4	5
35. Linking physics to real world contexts will encourage more learners to study Physics.	1	2	3	4	5
36.Linking Physics to everyday life helps learners understand concepts better	1	2	3	4	5
37.Linking Physics concepts to everyday life assist learners to see the practical life of Physics theories in everyday life	1	2	3	4	5
38.Linking Physics concepts to everyday life will help learners learn physics in a meaningful way	1	2	3	4	5
39.Linking Physics concepts to everyday life will help learners to be more creative	1	2	3	4	5
40. The resources provided by the school make it easier for me to link my teaching to real world issues.	1	2	3	4	5
41. The resources provided by the school will make Physics more interesting to learners.	1	2	3	4	5
42.The contexts and issues presented in the resources are relevant to my learners	1	2	3	4	5
43.I am likely to make substantial changes to the way I teach Physics based on the resources at my disposal	1	2	3	4	5
44.Linking Physics to real world contexts need diverse resources (internet, websites, problem sets)	1	2	3	4	5

Section F.Use of ICT as a pedagogical tool in teaching physics

The following statements solicit information on your capacity on use of ICT as a pedagogical tool in the teaching of Physics. Use Strongly disagree (SD) = 1;Disagree (D)=2,Neutral (N) = 3; Agree(A)=4; and Strongly Agree(SA) =5, by placing an X in the applicable box.

Statement	**SD 1**	**D 2**	**N 3**	**A 4**	**SA 5**

45.I can create visual presentations, graphics, charts, drawings and type assignments for learners using ICT	1	2	3	4	5
46. I can download teaching materials regarding my subject.	1	2	3	4	5
47. I can use computer based programs in developing the scheme of work and lesson plan.	1	2	3	4	5
48. I use email to ask and send assignments to my learners if possible.	1	2	3	4	5
49. I am able to search for files on the computer system and organize them into folders.	1	2	3	4	5
50.I am able to use a learning management system (example, WebCT) to support teaching	1	2	3	4	5
51. I can connect the computer to its peripherals.	1	2	3	4	5
52. I can access and share information on CD/DVD/flash disc.	1	2	3	4	5
53. I can create a basic presentation package and print to various networked printers.	1	2	3	4	5
54. I can set up and use Liquid Crystal Display (LCD) or Multimedia Projector for classroom delivery.	1	2	3	4	5

Section G. school organisational climate and culture

The following statements seek your perceptions on your school's organisational culture and climate. Using Strongly Disagree=1; Disagree=2; Neutral (N) =3; Agree=4; and Strongly Agree =5, by placing an X in the applicable box.

Statement	**SD 1**	**D 2**	**N 3**	**A 4**	**SA 5**
55.I am supported by colleagues to try out new ideas	1	2	3	4	5
56.I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning	1	2	3	4	5
57.Science teachers in this school regularly observe each other teaching classes	1	2	3	4	5
58.Science teachers in this school trust each other	1	2	3	4	5
59.It is okay in this school to discuss feelings, worries, and frustrations with other Science teachers	1	2	3	4	5

60.Science teachers respect other teachers who take the lead in school improvement efforts	1	2	3	4	5
61.It is okay in this school to discuss feelings, worries, and frustrations with the headmaster	1	2	3	4	5
62.My headmaster takes personal interest in the professional development of the teachers	1	2	3	4	5

Section H: Quality of professional development opportunities available

The following statements solicit for your opinion on the quality of professional development opportunities available to teachers at your school. Using the scale, Never (N)=1;Rarely(R)=2;Sometimes(S)=3 and Often(O)=4,indicate your opinion with respect to each statement by placing an X in the applicable box.

Statement	**N 1**	**R 2**	**S 3**	**O 4**
63.Iobserved demonstrations of teaching techniques	1	2	3	4
64. Iled group Discussions	1	2	3	4
65.I developed curricula or lesson plans which other participants or the activity leader reviewed	1	2	3	4
66.Ireviewed learner work or scored assessments	1	2	3	4
67.Ideveloped assessments or tasks used by other teachers	1	2	3	4
68.I practiced what I learned and received feedback	1	2	3	4
69.Ireceived coaching or mentoring in the classroom	1	2	3	4
70.I gave a lecture or presentation to colleagues	1	2	3	4
71.Myschool’s professional development activities are designed to support the school-wide improvement plan adopted by my school	1	2	3	4
72.Myschool’sprofessional development activities are consistent with my science department or form level plan to improve teaching	1	2	3	4
73.My school’s professional development activities are consistent with my own goals for your professional development	1	2	3	4
74.Myschool’s professional development activities are based explicitly on what I learnt in earlier professional development activities	1	2	3	4
75.Ifollowed up the school professional development activities with related activities that built upon what I had learned as part of the	1	2	3	4

activity				

76. Indicate if you are in a position to avail yourself for an interview. Yes ☐ No ☐

If yes give your contact number

…………………………………………………………………………

Thank you for sparing your precious time

APPENDIX I
INTERVIEW SCHEDULE GUIDE

INTERVIEW SCHEDULE

1. Which areas in the Advanced level Physics curriculum need to be improved? Why do you say so?

2. What are the factors that inhibit the implementation of the Physics curriculum in your school? Why do you say so?

3. To what extent did your pre-service training course prepare you for teaching Advanced level Physics? Why do you say so?

4. What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

5. What instructional strategies do you use in your classroom to impart inquiry skills?

6. What form of support would you need to promote inquiry based Physic teaching?

7. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

8. What challenges are you facing in linking physics concepts to everyday life?

9. Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

10. To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

11. What are the barriers to ICT integration in the teaching of Physics?

12. Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

13. In what ways does your school support the teaching of Physics?

14. What can your school do to improve the teaching of Physics?

15. In which aspects of your teaching would you like further in-servicing training?

16. How would you expect this in-service training to be conducted and where?

17. Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum

APPENDIX J

INTERVIEW REVIEW GUIDE

Document review guide

1 Physics Curriculum 9188

Content

Check intentions of curriculum developers

Prescribed teaching approaches

2. Teachers' Schemes of Work

Check for teachers expectations

ICT pedagogical tools used and frequency of use in the Physics classroom

Strategies used to teach inquiry Physics and frequency of use

Resources used for teaching and their frequency of use

Evaluations (analysis of learning activities, opportunities, challenges & intervention measures)

3. Past Examination Papers

Frequency of aspects being examined

Discrepancies between intentions and examined concepts

APPENDIX K: INTERVIEW TRANSCRIPT A

Respondent A

Date: 08/10/15.

Which areas in the Advanced level Physics curriculum need to be improved?

A: Inclusion of latest technology like the cell phone. The syllabus is too long.

Why do you say so?

A lot of theory to be covered in a short time.

What are the factors that inhibit the implementation of the Physics curriculum in your school?
A: availability of resources, since 2010 we have not managed to buy a c.r.o
Why do you say so?
A: Topics like diffraction grating are difficult to teach without the necessary equipment.
Raton what extent did your pre-service training course prepare you for teaching Advanced level Physics?
A: to a large extent in terms of educational foundations.
R: Why do you say so?
A: Teaching methods helped me in handling mixed abilities classes.

What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?
A: apprenticeship type of training, spent more time with learners and senior teachers.
R. What instructional strategies do you use in your classroom to impart inquiry skills?
A: A.AA maybe not sure of inquiry; I use presentations, group discussions
What form of support would you need to promote inquiry based Physic teaching?
A: increased access to the internet. The school used to pat $1 000-00 for internet per month, parents complained and they are now paying $80-00. The internet is now very slow.
R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

A. That is where we have a problem in our curriculum. Yes we try to do it using examples like on moments, turning of screws, taps. The curriculum should guide us in this area.

R. What challenges are you facing in linking physics concepts to everyday life?
A: Time is the main constraint. Involving learners in projects would be the best, but time is not available.
R: Suggest what could be done to improve teachers’ capabilities in linking physics concepts with everyday life?
A; Teachers should undertake projects in physics during their training.
R. To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?
A: to a limited extent. We have one LCD to six science teachers, so we have resolved that the HOD should use it.
R. What are the barriers to ICT integration in the teaching of Physics?
A: limited resources; baring use of cell phones in schools.
Suggest measures schools may undertake in integrating ICT in the teaching of Physics.
A: Schools to introduce tablets in schools; allow use of cell phones in schools.
R.In what ways does your school support the teaching of Physics?
A: To a great extent, buying latest equipment like digital meters.
What can your school do to improve the teaching of Physics? A: schools to buy tablets for learners
A: schools to convince parents to buy tablets for learners, learners to use cell own phones.
R: In which aspects of your teaching would you like further in-servicing training?
A: the practical aspect.
R. How would you expect this in-service training to be conducted and where?
A: done at school level by experts in that area, cluster seminars at a particular school.
R: Before, I end our discussion what else would you have like to share with me about the teaching of Advanced Level Physics curriculum.
A: teaching of physics to be given a priority, incentives physics teachers; introduce physics as a subject at form one level
R: Thank you very much. I really appreciate your contribution.

APPENDIX L: INTERVIEW TRANSCRIPT B

Respondent B

Date: 12/10/15.

Which areas in the Advanced level Physics curriculum need to be improved?

B: Okay, radioactivity.

Why do you say so?

B: There is too much theory; there is need for practical activities, no equipment like the Geiger Muller tube.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

B: lack of motivation; teachers not being valued; lack of support for seminars, no internet access

Why do you say so?

B; poor treatment of teachers by school authorities

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

B: To a small extent.

R: Why do you say so?

B: What we did is not linked to what are teaching currently.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

A: training to focus on areas in Advanced Level physics in detail.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

A: okay, assignments, traditional methods, lecture

R: What form of support would you need to promote inquiry based physics teaching?

B: fully equipped laboratory, so that learners can be assigned to design own friends.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

Everyday life examples, discuss how it functions, like transformers, use of practical based models, but rarely.

R. What challenges are you facing in linking physics concepts to everyday life?

B: lack of competencies.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

B; in-service courses on best ways to link physics concepts to everyday life through workshops.

R. To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

B: Have never used it.

R. What are the barriers to ICT integration in the teaching of Physics?

B: lack of competencies

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

B: send teachers for ICT training.

R.In what ways does your school support the teaching of Physics?

B: Buying equipment particularly for exams.

What can your school do to improve the teaching of Physics?

B: schools to buy tablets for learners

B: incentivise physics teachers, adequately equipping laboratories,

R: In which aspects of your teaching would you like further in-servicing training?

B: Computer knowledge.

R. How would you expect this in-service training to be conducted and where?

B: In the schools by professionals.

R: Before, I end our discussion what else would you have like to share with me about the teaching of Advanced Level Physics curriculum.

B: nothing

R: Thank you very much for your time and contributions.

APPENDIX M: INTERVIEW TRANSCRIPT C

Respondent C

Date: 12/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

C: Hmm, maybe I would take of some current applications, use of cell phones being inco-operated and also need to improve on electronic. This should go hand in hand with the syllabus change.

R; Whydo you say so?

C: There are a lot of changes taking place in electronics and communication technology.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

C: I am thinking of limitations in practical activities. Need to have more practical activities linked to what happens in society.

R: Why do you say so?

C: Imagine an Advanced Level student not able to repair a simple gadget like an electric iron. (Laughs).

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

C: To much great extent, a lot of staff we covered is not being utilised.

R; Why do you say so?

C: We did work which is far beyond the Advanced Level physics syllabus requirements.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

C: There is need to need to have more time for teaching practice, starting from the first year to give student teachers more time with the learners.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

C: I normally use discussions, presentations, group work, demonstrations and here and there, the lecture method in some areas.

R: What form of support would you need to promote inquiry based physics teaching?

C: we need more laboratory equipment.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

C: In most cases we refer to what they experience in their day to day life throughout the topics. Today I was teaching Polarisation (electromagnetic waves). I asked them why the aerials are put in certain positions. Learners to realise light is polarised, certain plane.

R.What challenges are you facing in linking physics concepts to everyday life?

C: No challenges

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

C: We need to have some workshops to share experiences as teachers.

R.To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

C: To a small extent.

R: How do you use it?

C.We used to have some virtual labs; we used to have a cyber class. Currently it is down.

R.What are the barriers to ICT integration in the teaching of Physics?

C: lack of ICT tools and maybe the school to hire a technician, some equipment failure could be due to a minor fault, who knows.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

C: source for modern ICT equipment

R.In what ways does your school support the teaching of Physics?

C: They are in the process of refurbishing the laboratories, quite supportive when we need equipment particularly for exams,

R: What can your school do to improve the teaching of Physics?

C: We also need equipment for day to day practical activities

R: In which aspects of your teaching would you like further in-servicing training?

C: use of ICTs in the classroom

R. How would you expect this in-service training to be conducted and where?

C: In universities by professionals

R: Before, I end our discussion what else would you have like to share with me about the teaching of Advanced Level Physics curriculum.

C: There is need the sciences right from form one. Specialists for each subject to teach the learners.

R: Thank you very much for your contributions and time spared

APPENDIX N: INTERVIEW TRANSCRIPT D

Respondent D

Date: 14/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

D: The first issue is on assessment of the practical component, as it is right now there is no difference between a theory paper and a practical paper. Secondly there is a gap between recent technology and our syllabus. The issue of cell how cell phones are manufacture should be included in the syllabus.

R; Whydo you say so?

D: For the practical paper there is need to assess the actual carrying out rather than giving marks for the report.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

D: Lack of resources, equipment. Learners do practical activities in groups due to lack of equipment. We also have limited access to the internet and inadequate textbooks.

R: Why do you say so?

D: learners have very few computers at their disposal

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

D: I think very well, because we had teaching practice and subject content.

R; Why do you say so?

D: Content coverage was adequate

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

D: I think maybe to increase the duration of the teaching practice. I also think teacher training should include ICT in their course outlines

R. What instructional strategies do you use in your classroom to impart inquiry skills?

D: Mostly, I use the lecture method, group discussions and research.

R: What form of support would you need to promote inquiry based physics teaching?

D: The school should acquire the resources we need; parents should pay the fees in time and consultation days.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

D: Use of ICT in the teaching and sometimes we have field trips.

R.What challenges are you facing in linking physics concepts to everyday life?

D: Maybe lack of resources

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

D; I think the teacher should research more

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

D: To some extent.

R: How do you use it?

D. We focus more on the exams. So our teaching is mainly lecture method, revising past exam papers. I sometimes use power point to present lessons.

R. Whatare the barriers to ICT integration in the teaching of Physics?

D: lack of ICT equipment.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

C: source for modern ICT equipment

R.In what ways does your school support the teaching of Physics?

D: schools should acquire resources such as projectors and LCDs

R: What can your school do to improve the teaching of Physics?

D: They are doing a lot with the limited funds they have.

R: In which aspects of your teaching would you like further in-servicing training?

D: At the moment, I am comfortable

R. How would you expect this in-service training to be conducted and where?

D:

R: Before, I end our discussion what else would you have like to share with me about the teaching of Advanced Level Physics curriculum.

D: Just to say, enrolments in physics are increasing in the schools. The pass rate in physics is also increasing.

R: Thank you very much for your cooperation

APPENDIX O: INTERVIEW TRANSCRIPT E

Respondent E

Date: 14/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

E: The last chapters, modern physics, radioactivity and photo-electricity, we go through these chapters without carrying out experiments.

R; Whydo you say so?

E: Because of the nature of the topics or infrastructure. It is difficult for the learners to understand the concepts involved.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

E: Ability of the learners,

R: Why do you say so?

E: if the learners are not good in mathematics, it becomes very difficult since most physics concepts involve mathematics.

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

E: To a great extent.

R; Why do you say so?

E: The programme was quite intense. It really capacitated me in both theory and practical work at this level.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

E: I think they need to do more with respect to teaching practice.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

E: giving learners work to research on in groups, make presentations and evaluate them as a class.

R: What form of support would you need to promote inquiry based physics teaching?

E: In terms of resources, textbooks, equipment such as c.r.o

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

E: It is always pointing to the basics they know already, observe phenomenon, and asking the learners to pint out real life experiences.

R.What challenges are you facing in linking physics concepts to everyday life?

E: In some areas like quantum physics experiences of real life situations are rare.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

E; In some regions we used to have some periodic group meeting to share experiences. Now there are very few chances of teachers meeting in seminars to share experiences.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

E: Currently we are doing very little in terms of ICT because of lack of resources.

R: How do you use it?

E. Making presentations using the projector at times.

R.What are the barriers to ICT integration in the teaching of Physics?

E: lack of ICT equipment.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

E: I understand there are companies lending computers at a nominal fee. Borrow computers from some companies for use by the teachers.

R.In what ways does your school support the teaching of Physics?

E: Making efforts to source for equipment

R: What can your school do to improve the teaching of Physics?

D: Introduce science levy to buy science equipment

R: In which aspects of your teaching would you like further in-servicing training?

E: To further my studies through attaining a master's degree

R. How would you expect this in-service training to be conducted and where?

D: At one of the local universities

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

D: If there could be a way to encourage more girls to take up physics

R: Thank you very much for your time and contributions.

APPENDIX P: INTERVIEW TRANSCRIPT F

Respondent F

Date: 15/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

F: Haaa, so far I do not think there is need to change.

R: Why do you say so?

F: It is okay as it is.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

F: Lack of equipment in the laboratories.

R: Why do you say so?

F: If we had equipment like the c.r.o, it would make learners easier to attempt some questions, if they had used it.

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

F: In terms of teaching methods no, but in terms of physics content it was okay.

R; Why do you say so?

F: They did not emphasise the teaching methods.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

F: They need to emphasise more on teaching methods.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

F: We mainly use the lecture method

R: What form of support would you need to promote inquiry based physics teaching?

F: We need equipment.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

F: Haa, just explaining.

R.What challenges are you facing in linking physics concepts to everyday life?

F: Lack of field trips to relevant areas.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

F: Visiting and talking to professional people motivates the learners.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

F: I have not started using it.

R.What are the barriers to ICT integration in the teaching of Physics?

F: lack of resources

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

F: Having a resource centre with tablets, where learners can access information, it will be good.

R.In what ways does your school support the teaching of Physics?

F: Having well equipped laboratories and learners accessing the internet.

R: What can your school do to improve the teaching of Physics?

F The talk is there, but implementation is lacking. It is not really prioritised.

R: In which aspects of your teaching would you like further in-servicing training?

F: I would like to be assisted in the practical paper. The last question I am not very confident. At times learners come up with something new that I am not sure of.

R. How would you expect this in-service training to be conducted and where?

F: I am more comfortable with teachers not lectures. Those who have classroom experience.

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

F: the gap between the Ordinary Level and the Advanced Level is too wide. Learners who have done pure sciences do better at Advanced level than those who would have done physical science.

R: Thank you very much for your time and contributions. When I go through my studies I will avail you with a soft copy of the document.

APPENDIX Q: INTERVIEW TRANSCRIPT G

Respondent G

Date: 20/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

G: The practical activities aspect

R: Why do you say so?

G: There are many books for theory but the practical activities are not matching. And also practical work is mainly in two sections, electricity and oscillations.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

G: Lack of apparatus and time.

R: Why do you say so?

G: There is very little that we can do in terms of practical work with the learners.

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

G: It was okay in terms of content, but not methodology.

R: Why do you say so?

G: They did not emphasise the teaching methods.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

G: Technology has changed; they need to improve on the computer skills they offer.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

G: We use many, practical work activities so that they can discover on their own, project work, question and answer, presentations and research activities.

R: What form of support would you need to promote inquiry based physics teaching?

G: If we can have more equipment so the learners are exposed to more hands on practical activities.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

G: We do problem solving. Solving some real problems that the learners solve using concepts learnt in physics.

R.What challenges are you facing in linking physics concepts to everyday life?

F: It is difficult to have real applications for some concepts. For example in banking of aeroplanes and race cars. We need the real situation for the learners to appreciate it.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

G: If teachers can have a way of interacting. Teachers coming together and come up with lesson plans on how best to handle some topics. This can generate a lot of ides.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

G: We use it so much. We usually download videos from you tube, which we can project using projectors. We can also download past examinations papers from other international examination bodies.

R.What are the barriers to ICT integration in the teaching of Physics?

G: The problem is that learners are not allowed to bring own smart phones or lap tops. This is a serious setback. If learners are allowed, it can improve ways we use ICT. The majority of school heads have minimum knowledge about ICTs, they do not appreciate ICT.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

G: There should be a policy in all schools to allow certain ICT equipment. Teachers must be staff developed to use ICTs.

R.In what ways does your school support the teaching of Physics?

G: The built a physics laboratory.

R: What can your school do to improve the teaching of Physics?

G: If we can have partnerships with institutions like CUT. If there is great interaction it will help to access some of the materials they have.

R: In which aspects of your teaching would you like further in-servicing training?

G: I feel it is good to do a masters degree and come back to teach Advanced Level physics.

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

G: Guys teaching at the lower levels do not have the right qualifications. Some of the things which we think the learners know, they will have misconceptions. Recently I was in Kenya for a science seminar as a provincial representative. I brought some materials which I still have to share with colleagues.

R: Thank you very much for your time and contributions. When I go through my studies I will avail you with a soft copy of the document.

APPENDIX R: INTERVIEW TRANSCRIPT H

Respondent H

Date: 20/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

H: Yea, there is need for some depth to be increase with reference to what is required in industry, it is too theoretical.For instance, equipment found in industry.
R: Why do you say so?
G: In most cases the syllabus is too theoretical.
R: What are the factors that inhibit the implementation of the Physics curriculum in your school?
H: Lack of equipment. For instance is you want to measure g, it would be accurate using logic gates. Use of stop watches is erroneous. I
R: Why do you say so?
H: Industry has up to date equipment.
R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?
H: To a large extent
R: Why do you say so?
H: At least we were taught how to handle a class with mixed abilities and having learners working in groups fruitfully.
R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?
H: They need to improve on computer skills.
R. What instructional strategies do you use in your classroom to impart inquiry skills?
H: I usually give them questions to research on, especially the design question, they present to the class using a diagram and focus on things that are workable in the laboratory.
R: What form of support would you need to promote inquiry based physics teaching?
HI think there is need for parents to assist by paying science levies to buy equipment, rather than to wait to but equipment for practical examinations.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

H: Usually I expect learners to give practical examples. For example when we learn about generators, how we use them. How can we improve the efficiency say of a lawn mower. Learners should be able to apply the theory to real situations.

R.What challenges are you facing in linking physics concepts to everyday life?

H: There is a very big challenge in terms of pairing physics to industry.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

H: If we could have opportunities to visit industry where physics is applicable. For instance visiting places where hydraulics is used to see advantages and disadvantages. Taking a class to farming area to see sprinklers in action.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

H: Usually I use a computer and a projector where there is need. For instance polarisation, it is easy if the boys see the way polarisation function on a screen. Easy to recall later.

R.What are the barriers to ICT integration in the teaching of Physics?

H:There are no funds set aside for the department to purchase ICT equipment.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

G: The government should provide subsidies to assist parents in the procurement of ICT equipment.

R.In what ways does your school support the teaching of Physics?

G: They arrange seminars for the learners to share experiences with those from other schools.

R: What can your school do to improve the teaching of Physics?

G: Have seminars with other schools regularly, not just for examination classes only.

R: In which aspects of your teaching would you like further in-servicing training?

G: Maybe to have practice on e-learning processes.

R: How would you expect this in-service training to be conducted and where?

G: Very happy if it is done at my school, by people who are currently linked to the current syllabus. People who are on the ground, not education officers.

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

G: If we could have a system, where, slow learners, get the time to do Advanced Level in three years, so that they mature and learn more concepts.

R: Thank you very much for your time and contributions. When I go through my studies I will avail you with a soft copy of the document.

APPENDIX S: INTERVIEW TRANSCRIPT I

Respondent I

Date: 22/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

I: The core physics is fine. There is need to bring back options remove such as Environmental physics, Telecommunications and Medical physics

R: Why do you say so?

I: These options areas are still relevant to our current situation.

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

I: In some cases large numbers of learners are being enrolled for lower sixth. Enrolling learners who have done integrated science who usually struggle.

R: Why do you say so?

I: large numbers are difficult to deal with during practical work activities.

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

I: The training was adequate, it was mainly the subject content and a little bit of pedagogy looking at teaching of Advanced Level physics.

R: Why do you say so?

I: It catered for both subject content and teaching methods.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

I: We need to train specialists in the subject, to be able to communicate and facilitate. You need to know how to deal with advanced Level students.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

I: We normally have the participatory approach where they do experiments individually, starting from lower sixth to build their confidence. I believe in group learning. Giving them topics, they go and research.

R: What form of support would you need to promote inquiry based physics teaching?

I: Laboratories need to be improved to accommodate the large number. Allowing students to bring own smart phones or laptops.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

I: We have done quite a lot in terms of interconnectivity.Encourage learners to participate in science exhibitions

R.What challenges are you facing in linking physics concepts to everyday life?

I: The problem is that at the Ordinary level learners do not do practical work activities.

R: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

I: We need shop-floor experience, where learners are attached to industry to see physics in action and having educational tours.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

I: It is the main tool in the science department, we use it daily, learners in groups of four are assigned a laptop to do research and share. We use the projector for delivery lessons.

.R.What are the barriers to ICT integration in the teaching of Physics?

I:Convince parents and school administrators on the benefits of using ICTs for teaching.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

I: The school authorities should facilitate ICT training for all teachers.

R.In what ways does your school support the teaching of Physics?

I: Prioritising access of learners to the internet. Emphasising use of internet rather that textbooks.

R: What can your school do to improve the teaching of Physics?

I:They should allow learners to. Bring smart phones to school

R: In which aspects of your teaching would you like further in-service training.

I:More exposure to ICTs.

R: How would you expect this in-service training to be conducted and where?

I: Very happy if it is done at my school, by people who are currently linked to the current syllabus. People who are on the ground, not education officers.

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

I: We need to take on board pure sciences from form one. These should be taught in such a way that they become easy to everyone.

R: Thank you very much for your time and contributions. When I go through my studies I will avail you with a soft copy of the document.

APPENDIX T: INTERVIEW TRANSCRIPT J

Respondent J

Date: 23/10/15.

R: Which areas in the Advanced level Physics curriculum need to be improved?

J: Inco-operation of ICTs in the curriculum

R: What are the factors that inhibit the implementation of the Physics curriculum in your school?

J: Lesson delivery is a problem due unavailability of software.

R.To what extent did your pre-service training course prepare you for teaching Advanced level Physics?

J: The teacher training aspect did a great deal in preparing for physics teaching.

R: Why do you say so?

J: It catered for both subject content and teaching methods.

R: What suggestions would you make to improve the quality of learning experiences in the pre-service teacher training course?

J: They need to improve on areas that deal with the computer system like programming.

R. What instructional strategies do you use in your classroom to impart inquiry skills?

J: Giving assignments, learners prepare and present on specified topics, and make learners design projects.

R: What form of support would you need to promote inquiry based physics teaching?

J: Schools to source for software.

R. What instructional strategies do you use for linking Physics concepts with everyday life in the classroom?

J: Visiting the hospital- X-rays; for structures visiting local bridges.

R.What challenges are you facing in linking physics concepts to everyday life?

J: Administrative barriers in requesting for field trips, you need to apply for permission from ministry head office. It takes too long.

J: Suggest what could be done to improve teachers' capabilities in linking physics concepts with everyday life?

I: Science department to be allocated its own budget. Decisions for field trips to be done at school level.

R: To what extent do you use ICT as pedagogical tool in your Physics classroom? How do you use it?

J: To a limited extent. We use the projector for delivery lessons.

R: What are the barriers to ICT integration in the teaching of physics?

J.In-accessible computer laboratories. Computer labs are restricted to computer studies learners only.

R: Suggest measures schools may undertake in integrating ICT in the teaching of Physics.

J: Schools to allow learners to bring own laptops.

R.In what ways does your school support the teaching of Physics?

J: They are doing very little. I am the only physics teacher at this school. Material supply for the department is very limited.

R: What can your school do to improve the teaching of Physics?

J:Liaising with privileged schools to share resources.

R: In which aspects of your teaching would you like further in-service training.

J: I would like to believe the need is in the ICT area.

R: How would you expect this in-service training to be conducted and where?

J: To be done at district level. Each district to establish an in-service training centre.

R: Before, I end our discussion what else would you have liked to share with me about the teaching of Advanced Level Physics curriculum.

J: I wish we could revive doing electronics practical work with learners at Saganotronics.

R: Thank you very much for your time and contributions. When I go through my studies I will avail you with a soft copy of the document.