AN ANALYSIS OF O-LEVEL PHYSICS CURRICULUM DESIGN AND TEACHER PEDAGOGICAL CONTENT KNOWLEDGE IN SELECTED SECONDARY SCHOOLS IN LUSAKA DISTRICT, ZAMBIA

BY

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A dissertation submitted to the University of Zambia, school of education, in partial fulfilment of the requirements for the award of the degree of Master of Education in Curriculum Studies

THE UNIVERSITY OF ZAMBIA

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AUTHOR'S DECLARATION

I, **Jacqueline Zulu,** do hereby solemnly declare that this dissertation represents my own work, except where otherwise acknowledged and that it has never been previously submitted for a degree at the University of Zambia or any other university.

Signature…… Date ……..

APPROVAL

This dissertation of **Jacqueline Zulu** is approved as fulfilling the partial requirements for the award of the degree of Master of Education in Curriculum Studies of the University of Zambia.

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ABSTRACT

The rationale behind the 2013 Zambian revised curriculum is to prepare learners who can face challenges in a rapidly changing world. The world has become a technological space and as such its citizens are supposed to be scientifically oriented. However, the situation in secondary schools in Zambia is that science subjects are becoming less popular among secondary school learners and the most affected is physics. Physics forms a base for science and technology (Zhaoyao, 2002). There has been a general decrease in the knowledge of physics in Zambia exhibited by the decline in the candidature of physics learners during the school leaving examinations for grade 12 as well as the high failure rate in O-level physical science which is a combination of physics and chemistry. The aim of this study was to analyse the effect of the physics curriculum design and pedagogical content knowledge of the teacher on the continued poor performance of learners of O-level physics.

The embedded research design of the mixed method approach was used. 158 secondary school learners where sampled using the stratified random sampling. Quantitative data was obtained from the learners through the use of questionnaires. Teachers of physics and subject specialists from CDC and ECZ where selected using purposive sampling and semi-structured interview guides where used to obtain qualitative data from six of them. Data collected from questionnaires was analysed using descriptive statistics while data from semi-structured interviews and lesson observation was analysed using themes so as to easily interpret and understand the essence of the data. The findings of the study clearly suggested that truly physics was difficult to the learners as confirmed by the learners themselves, teachers as well as the specialists. The findings of this study helped the researcher to conclude that lack of appropriate pedagogical content knowledge by the teachers had contributed to the subject being difficult to the learners. Curriculum designing was also another factor that was found to be a contributor to poor learner performance in physics but this view only came from the learners and the teachers but as far as the specialists were concerned the physics curriculum was well designed. Based on the findings of this study there is a need for teachers of physics to undergo continuous professional development in order to perfect their art of teaching and thus improve learner's comprehension of physics which can lead to better performance.

Keywords: *curriculum designing, pedagogical content knowledge, comprehension,*

DEDICATION

This work is dedicated to my beloved husband Brian; you have been my pillar and source of strength throughout this study. The support I received from you was simply amazing and there is no way I could have achieved this without the financial and moral support which I received from you. May God bless you in all your endeavours.

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ACRONYMS AND ABBREVIATIONS

CDC	Curriculum Development Centre
ECZ	Examination Council of Zambia
MoE	Ministry of Education
MoESVTE	Ministry of Education Science, Vocational and Technical Education
UNESCO	United Nation Education Scientific and cultural Organisation
UK	The United Kingdom
IT	Information Technologist
IUPAP	International Union of Pure and Applied Physicists
PCK	Pedagogical Content Knowledge
ZASE	Zambia Association of Science Education
TIE	Tanzania Institute of Education
CPD	Continuous Professional Development12
O-Level	Ordinary Level
KNEC	Kenya National Examination Council
NASAC	Network of African Science Academic
TEVETA	Technical Education, Vocational and Entrepreneurship Training Authority
CRDD	Curriculum research and Development Division
DEBS	District Education Board Secretary
ZESCO	Zambia Electricity Supply corporation

CHAPTER ONE: INTRODUCTION

1.1 Overview

This chapter presents the background of the study, statement of the problem, aim of the study, research objectives and research questions. It further describes a theoretical framework, conceptual framework of the study, delimitations, limitations and operational definition of key terms.

1.2 Background of the Study

The rationale behind the 2013 Zambian revised curriculum was that learners should be prepared for the challenges they were to face in a rapidly changing world (MoESTVE, 2013). The changing of the world is biased towards technological innovations and to respond to this challenge, the education system is supposed to be tailored in such a way that it provides solutions to the challenges that society encounters. The goals of education as stated in the 1996 policy document for education imply that science and technology has a radical impact on Zambia's economy and on the way of life of almost every one of her people (MoE, 1996). It is also clear in the document that there was need to increase the ability of the people to think scientifically and to understand that scientific process was becoming a condition for survival. Science subjects in secondary schools offer a base on which future technological advancements can be built and physics is such a subject. Zhaoyao (2002) postulated that physics is an important base in science and technology since it explains the essence of natural phenomena and helps people understand the increasingly technological changing society.

There is an indication that the base subject in science, which is physics, is facing the challenge of disappearing from the secondary school curriculum because in recent years there has been a reduction in the candidature in physics. ECZ (2016) confirmed this assertion in the examination performance review report that the candidature in the pure sciences, physics and chemistry, declined while the rest of the subjects recorded an increase. The reduction in candidature showed that the pure sciences were becoming unpopular among secondary school pupils. The case for physical science is made worse by the poor performance especially in physics. For many years now Zambia has recorded an increase in the failure rate in national examinations at secondary school level and the pass rate in physics is the lowest

(MoE, 2015). According to the Zambia Association of Science Education (ZASE, 2015) from the samples of marked scripts of grade 12 science paper II (physics) which were analysed, the majority of the candidates obtained about 29% of the total mark.

In the revised curriculum (MoESTVE, 2013) physical science is compulsory in both the academic and career pathways because it forms a basis for increasing advancement in science and technology which aims at improving the overall quality of life. Physical science is a combination of physics and chemistry and is taken by the majority of the learners. However, there has been a general decrease in the quality of science results obtained at grade twelve (12) with the majority of the candidates obtaining satisfactory results or unsatisfactory. Quality results in science are attributed to candidates who sit for pure physics and pure chemistry but there has been a general decrease in the number of candidates taking pure physics since it was offered as an option. The low marks in science are mostly attributed to physics as it is perceived to be a difficult subject by most learners in secondary school. Pure physics and chemistry are offered to learners as an option while science which is a combination of physics and chemistry are offered to the majority of the learners as a compulsory subject (ECZ, 2015). The performance in physical sciences by subject is summarised in Table 1.1

Table 1.1**: Comparison of performance by subject in 2014 and 2015**

Subject	Mean Raw Score (%)		% Change	Direction of Change
	2014	**2015**	**2013-2014**	
Physics	48.33	48.83	+0.05	Up
Chemistry	49.33	49.82	+0.70	Up
Science	17.76	17.65	-0.11	Down

Source: ECZ (2016) examination performance review report

While physics and chemistry recorded a decline in candidature, the performance changed in the positive but physical science which is compulsory and a combination of physics and chemistry recorded a decrease in performance. The poor performance in science may be attributed to physics and this can be demonstrated by physics having a lower percentage than chemistry. There may be a perception among learners

of science that physics is a difficult subject as can be seen from the lower mark for pure physics (Haambokoma et al, 2002). This study focused on physics which is a component of science (combination of physics and chemistry) as it is the one that is offered as a compulsory subject and taken by the majority of the learners. Table 1.2 shows the provincial ranking of four (4) selected subjects according to performance in order to further highlight the effect of physics on the position of science.

Table 1.2**: Provincial ranking according to performance of four selected subjects 2015 and 2014.**

Province	Mean Score in Percentage (%)					
	ENGLISH	MATHS	BIOLOGY	SCIENCE	AV(2014)	AV(2015)
Southern	38.7	19.41	23.75	18.31	25.12	24.19
Lusaka	38.83	18.25	22.99	18.76	24.71	24.64
Eastern	34.75	21.16	22.6	19.61	24.53	23.41
Central	35.95	17.49	21.73	18.41	23.39	23.11
Muchinga	32.47	18.67	21.99	18.5	22.91	22.36
Northern	33.46	18.89	21.68	17	22.75	21.82
Luapula	32.02	16.51	20.34	16.98	21.46	22.77
Copperbelt	33.52	15.62	20.22	16.18	21.38	21.37
Western	31.93	15.61	20.32	15.92	20.95	20.47
North	30.68	14.78	19.97	17.11	20.64	21.58
National	35.16	17.42	21.59	17.66	22.96	22.78

Source: Mean Scores of the 2015 examination results statistics. ECZ, 2015.

As can be seen from the statistics shown in table 1.2, learners have not been performing well in science country wide and there is need to establish what has led to this poor performance. There was an indication from the statistics that the performance of pupils in physics was lower than that of chemistry and therefore the combination of the two in science gives a very low performance outlook (ECZ, 2016).

Physics in Zambian secondary schools is taught in two ways, as an option to pupils who were purported to have a strong background in science and the code for this subject is 5054 which is pure physics. It is this type of physics whose candidature has been declining over the years. Pupils who sit for this examination are very few and

perform well and this is indicated in table 1.1 which is showing an upward trend in performance. The other type of physics has a code 5124. It is taught separately and examined separately but the results are combined with chemistry and it comes out as science on the result transcript. Physics (5124) is compulsory and characterised by poor performance of learners in secondary schools. Despite physics being one of the most important subjects in the Zambian education system as well as one of the oldest fields of study in the history of mankind, the performance of learners has been unsatisfactory for years (ECZ, 2016). This prompted the researcher to ask questions such as: why did pupils find physics to be a difficult subject if content was arranged in a coherent manner? or was there a problem in the way physics was taught in secondary schools?

There are several studies that have been done at the University of Zambia pertaining to physics as a difficult subject in secondary school. Among them are studies done by Kabwita (2014), Maguswi (2012), Mafuleka (2012),Chishiko (2011) and Kaulu (2011) just to mention a few. These studies have indicated that learners in secondary schools in Zambia find physics difficult and each study has identified one aspect in trying to understand this problem. For example Kabwita (2014) explored the idea of using mathematical concepts by teachers when teaching physics to learners as a way of making it easily understood. Maguswi (2012) compared the performance of females and males in O-level physics examinations while Kaulu (2011) researched on effectiveness of the physics classroom computer software in the learning of kinematic. There seemed to be no specific study to relate to physics curriculum design and teacher pedagogical content knowledge and their contribution to physics being a difficult subject to secondary school pupils.

A curriculum can help in the social and economic development of both developed and developing countries. The way a curriculum is conceptualised in theory and then designed, organised and developed for practical implementation depends on a country's particular philosophy of education, national, social, cultural, economic and developmental aspirations where it considers the mainstream of emphasis should lie (TIE, 2010). Delgado (2012) described curriculum design as the structure or arrangement of the components or elements of the curriculum in a coherent manner. The grade twelve physics curriculum design in Zambian secondary school is arranged in such a way that it first introduces learners to international standards of

measurements known as SI units standing for system Internationale (Serway & Faughn, 1999). This knowledge enables learners to acquire the skill of measuring, accuracy and precision as well conversion of units. It contains other important topics which fall under mechanics, thermal physics, wave motion, static electricity, current electricity, basic electronics and nuclear physics. These topics provide learners with worthwhile knowledge and skills that can help them rise to the challenges that society is facing. Steinberg (2008) expressed that in order to have a skilful and knowledgeable learner, the physics curriculum and syllabus was loaded with content as a response to the demands of the international standards. This study endeavoured to analyse the secondary school physics curriculum design in Zambia so as to find out whether the content is aligned in a coherent manner and whether it is not burdensome to secondary school learners. The other area of interest for this study was the pedagogical content knowledge employed by the teacher in teaching secondary school physics. According to MoESTVE (2013), the 2013 revised curriculum has adopted an outcome based curriculum as one of its guiding principles. In the document outcome based education was described as an approach to learning that the Ministry of Education Science, Vocational Training and Early Education has adopted moving away from behavioural approach and learners were given practical experience during the teaching and learning process that helps them get life skills.

Consequently, outcome based education was to be achieved when learning was guided in the prescribed manner through the teacher's knowledge and skill about the subject matter. Every teacher needed to possess pedagogical content knowledge in order to manage the important task of achieving outcome based education. The pedagogical content knowledge (PCK) helps the teacher to guide learning in ways which are appropriate as prescribed by the curriculum in order to achieve the aspirations for education for a nation. Shulman (1987) described PCK as an important aspect of teaching that allows teachers to effectively relay and make the subject matter and curricula knowledge comprehensible to the learners. There is need for the teacher to possess more knowledge in order to have the capacity to clear learner's misconceptions and difficulties about a particular subject. Park and Oliver (2008) explained PCK as what the teacher understands and enactment of how to help a group of learners understand specific subject matter using multiple instructional strategic representations and assessments while working within the contextual,

cultural and social limitations in the learning environment. Redish (1994) explained that physics is a difficult subject because it employs different methods. However, pedagogical content knowledge helps the teacher to competently shuffle from one method to another without losing the learners in the maze of knowledge.

Mulenga (2015) contended that a teacher with PCK would know how to effectively sequence the teaching and learning materials and formulate very good questions that probe for alternative views. The teachers should be well ahead of the learners in terms of how to handle the content knowledge by showing understanding of what is to be taught and learnt taking into consideration the learner's misconceptions and their way of thinking. ECZ (2016) revealed that the poor performance in physics at grade twelve could be as a result of the usage of strategies that were not compatible with the demands of the subject. The speculations of the ECZ report need to be investigated and this study thus analysed the pedagogical content knowledge of the teachers of physics and the curriculum design for physics so as to establish the effects they had on the learners comprehension of the subject.

1.3 Statement of the Problem

The research problem which was addressed in this study was that despite physics being a base subject in science and technology, it had become unpopular among secondary school learners in Zambian secondary schools. This could be seen as learners continued to obtain poor results in O-level physics during the school leaving examinations. According to ECZ examination review report (2016), despite physics being one of the most important subjects in Zambia's education system as well as one of the oldest fields of study in the history of mankind, the performance of learners had been unsatisfactory for years. The poor results that the country had continued to record in O-level physics were indications that there was something wrong with physics education in secondary schools in Zambia. If the physics problem was not addressed, the knowledge base relevant for the advancement of science and technology will decline and that can lead to stagnation in technological and economic development of the country. Hence the study focused on the curriculum design and the pedagogical content knowledge of the teacher of O-level physics.

1.4 Aim of the Study.

The aim of this study was to analyse the effect of the physics curriculum design and pedagogical content knowledge of the teacher on the continued poor performance of learners of O-level physics.

1.5 Research Objectives

The objectives of this study were to;

1. establish why secondary school learners perceived physics to be a difficult subject.
2. assess whether the perception of physics as a difficult subject had any effect on the learner's performance during examinations.
3. investigate the effect of the physics curriculum designing on learners comprehension of the subject.
4. analyse the effect of teacher PCK on learners comprehension of physics

1.6 Research Questions

1. Why did secondary school learners perceive physics to be a difficult subject?
2. What effect did the learner's perception of physics have on their performance?
3. How does the physics curriculum design affect learner's comprehension of the subject?
4. How did teacher's PCK affect learner's comprehension in secondary school Physics?

1.7 Significance of the Study

It was hoped that the results of this study would bring out information that might contribute to the existing literature on efforts to improve learner performance in physics. Curriculum specialists may use the information to determine areas of difficulty in the curriculum if any and how they can be overcome. The research findings may also help teacher educators to package teacher PCK in order to help address learner difficulties with O-level physics. Standard Officers and the National Science Centre may use the information to identify areas of study for Continuous Professional Development (CPD.

1.8 Theoretical Framework.

The theory that guided this research was the schema theory. According to Hewson and Posner, (1984) a schema is a set of coherent knowledge that is brought up in a set of similar context or situation. The schema theory is attributed to Sir Frederic Charles Bartlett (1886-1069). He advanced this theory to provide a basis for a temporal alternative to traditional spatial storage theories of memory. Bartlett suggested that human beings possess generic knowledge in the form of unconscious mental structures. Human beings use schemata to organise, retrieve and encode chunks of important information. Schemas accumulate over time and through different experiences. If teachers use teaching strategies that conceptualise learners existing schema new information will be integrated. Mcgovern (2017) expressed that learners learn best when they can relate new knowledge to previous knowledge by the use of schema. This theory is very relevant to this study because it explains how new information is gained in the process of learning. The problem at hand was that it seemed like learners were unable to acquire new knowledge of physics which lead to them performing poorly in the subject. When a curriculum is well designed and the ideas are well aligned, there should be no problem with the learners integrating new information in the existing schema because leaners will understand the concepts easily and relate it to previous knowledge. The teachers PCK also plays an important role in ensuring that learning is guided appropriately and in a coherent manner to make understanding easy. The fact that physics is perceived to be difficult implies that the learners have failed to integrate knew knowledge of physics in their schema. The findings of this study endeavoured to establish the struggle that the learners have with physics in relation to integrating new physics knowledge in their schema.

1.9 Conceptual Framework

The conceptual framework in figure 1.1 shows the link between physics education of the learners and what may happen if this knowledge is represented by a well-designed curriculum and effective PCK of the teacher or not well designed curriculum and inadequate teacher's PCK in preparing learners and the impact on the technological and economic development of the country. The framework helped to explain the ideal situation for physics education as well as the resulting situation if necessary interventions are not put in place.

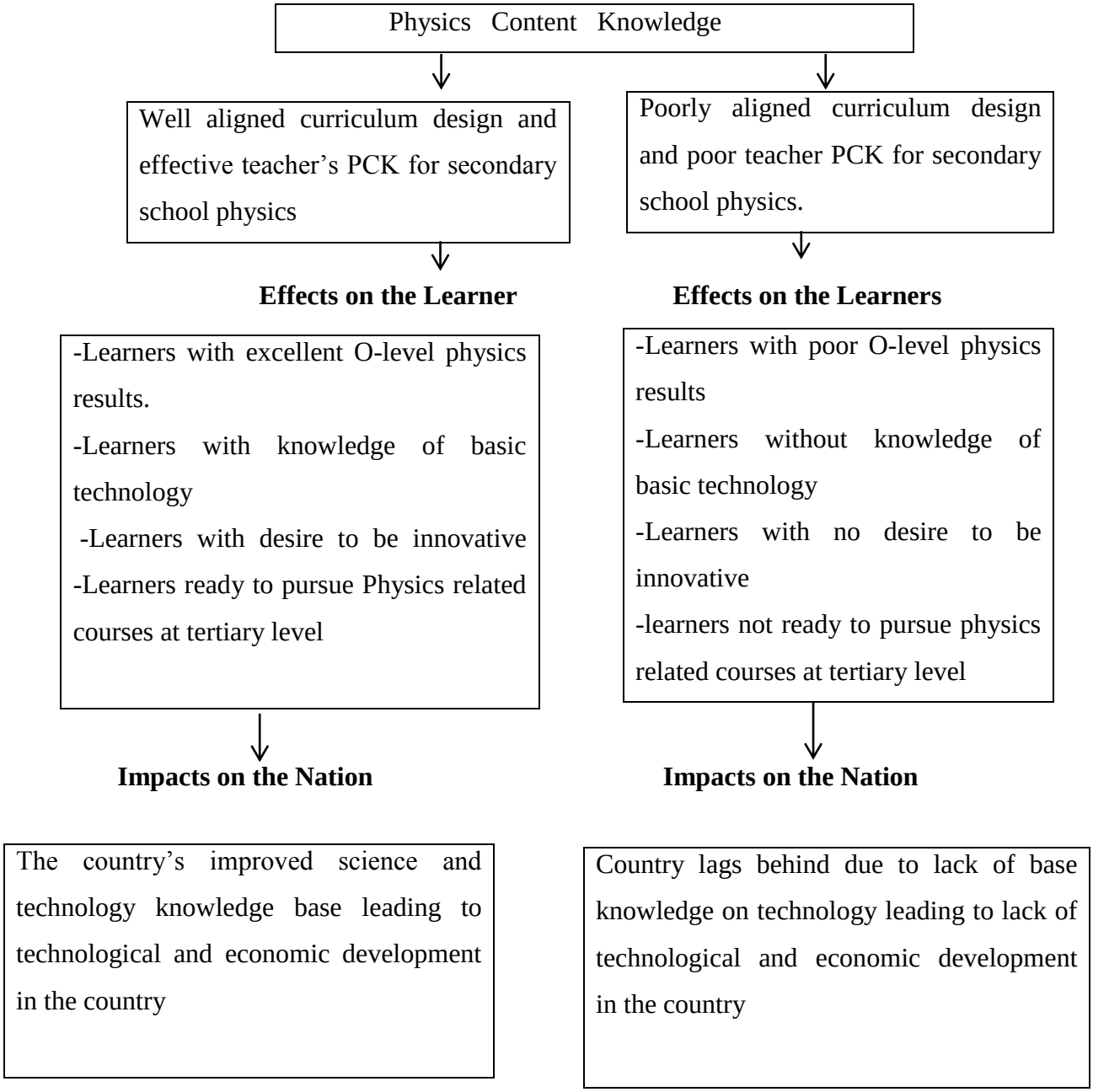

Figure1.1 Conceptual Framework

The term effectiveness has been used in the conceptual framework to refer to the degree of successfulness of the learners of physics. Ogula (2002) explained that effectiveness measures the degree of attainment of the predetermined objectives of the study. For this study, the desired result was the ability of learners in secondary

school to understand physics concepts and to attain desired values, skills and attitudes in basic technology through physics.

1.10 Delimitation of the Study

The study was limited to the analysis of the curriculum design and teacher's PCK for O-level physics in selected secondary schools in Lusaka district, Zambia. It was extended to subject specialists with a bias to physics from CDC and ECZ who are knowledgeable about physics curriculum and PCK. Furthermore, it was extended to the National Science Centre for more insight into this matter.

1.11 Limitations of the study

1. The study would have been enriched if it had included learners' monthly and termly assessment test. This could have shown that poor performance of learners in secondary schools is reflected even in monthly tests but it could not be so because the selected schools were not willing to allow their confidential information to be included in the study
2. The other limitation was that the study was more qualitative than quantitative thus the results could not be generalised to other schools but limited only to the selected secondary schools even though other schools in the country could be facing the same challenge with physics due to the national outlook of science results.

1.12 Operational Definition of terms

Curriculum-all planned learning experiences offered to learners under the guidance of the education institutions

Curriculum design- the structure or arrangement of the components of the curriculum in a coherent manner.

Effective- ability of the education programme to accomplish its designated purpose.

Perception-the way in which something is regarded or intepreted

Pedagogy-the skill that enables the teacher to teach effectively.

Pedagogical content knowledge- a skill that enables the teacher of physics to present the fundamental physics concepts and teaching methods to the learner in a comprehensible manner.

Schema- a cognitive framework that helps to organise and interpret information

1.13 Organisation of the study

The dissertation has been divided into six chapters. The first chapter explains the introduction and in it the main problem that this study sought to address was described, the significance of the study, the theoretical framework for the study, including the key words used in this study.

In chapter two, literature review was discussed and was aimed to analyse the effect of the physics curriculum design and pedagogical content knowledge of the teacher on the poor performance of learners of O-Level physics so as to establish the gap that this study was trying to fill. Literature was purposely searched and reviewed on the basis of its relevance on the main themes.

In chapter three, the methodology that was used to solicit data was explained and it comprised the following sub-sections; research paradigm, research design, study site, target population, sample size, demographic characteristics of respondents, sampling techniques, data collection instruments, procedure for data collection, validity, reliability, trustworthiness, data analysis and ethical considerations.

In chapter four, the findings of the research questions based on a number of themes that emerged from the data were presented. Qualitative data was analysed using thematic analysis while quantitative data was presented in descriptive statics and the findings were discussed in chapter five.

Chapter six comprised of the conclusion and recommendations of the study and all of which were based on the findings of the study. The proposed areas for future research in the same field of this study were presented.

1.14 Summary

In this chapter a number of important issues have been discussed as a way of putting the study into context. An overview of learner's struggle with physics as a subject in secondary school has been explained which had set the context of the study and justification of the study. The background led to the description of the statement of the problem. In this chapter the theoretical framework which supported this study has been explained and the conceptual framework which revealed the researchers

thinking and understanding of the problem at hand has been described as well. Other aspects included the significance of the study, delimitations and operational definition of terms. In the next chapter, the literature was a way of understanding aspects of the topic under discussion.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview

In this chapter, literature review has been presented according to the themes on how physics is perceived in different regions. The researcher did not only examine literature on studies done in Zambia which had provided a gap for this study, but also considered studies done outside Zambia in order to address the research objectives. Studies done in Zambia helped to identify the gap which the study tried to address as well as to provide a specific background. Studies done elsewhere provided a general background and helped the researcher to compare findings on how physics is perceived among learners in other places other than Zambia. The combination of studies done locally and abroad helped the researcher to have insights into what had already been studied. Literature was reviewed under the following themes; the importance of physics in society, physics; a global perspective, physics; a regional perspective, importance of physics knowledge in the Zambian, physics curriculum designing for Zambian secondary schools education system, the teacher pedagogical content knowledge used in Zambian secondary schools, the state of physics in Zambia and a summary by other scholars on the topic.

2.2 The Importance of Physics in Society

Science is recognised widely as being of great importance both for the economic well-being of nations and for having a scientifically literate citizenry (Frazer & Walberg, 1995). The knowledge of science and technology had been going through evolution since the industrial revotlution of the 17^{th} Century. Sir Isaac Newton, Galileo Galileo and Einstein have been called fathers of modern physics. Newton for his famous laws of motion and gravitation, Galileo for his role in scientific revolution and his contribution to observation astronomy and Einstein for his ground breaking theory of relativity (Serway & Faugn,1999). The demands for science innovation have since become greater due to the increase in population. The increase in population however, brings with it challenges that require technological innovation as part of the solution. Knowledge of science and technology is therefore a requirement in all countries and all the people globally due to the many challenges the world is facing. Challenges such as the emergence of new drug resistant diseases,

effects of genetically modified seeds on the environment, ecological impact of modern technology, dangers of nuclear and biological weapons, tsunamis, earth quakes and other natural calamities (Alsop & Hicks, 2001**).** These events have accelerated the changes taking place in communication technology, agriculture and medicine just to mention a few. Science as an instrument of development plays a dominant role in bringing about solutions to these changes by advancing technological development, promoting national wealth, improving health and industrialization (Republic of Kenya, 1999). At the heart of all sciences is physics which offers the basic knowledge that helps to lay a foundation for technological innovations. Taylor (1984) emphasised the importance of physics that it will remain a fundamental science. Taylor implied that other sciences depend upon the knowledge and skills obtained through the study of physics. For instance, globalisation has reduced the world into a global village through information technology which is achieved through the use of satellites and computers and the knowledge of physics is at the heart of this undertaking. The knowledge of physics explains natural phenomena and how it is applied in everyday life without taking anything for granted. Wide ranges of application of physics are used in industrial development for the improvement of materials useful to the well-being of humankind. Alsop and Hicks (2001) revealed that the study of physics involves the pursuit of truth hence inculcates intellectual honesty, diligence, perseverance and observation in the learners.

The recognition given to the knowledge of physics is supported by Zhaoyao (2002:19) who stated that,

> *Physics is an important base in science and technology since it studies the essence of natural phenomena and helps people understand the increasingly technological changing society. It is a branch of science that has a lot of applications and has been exploited by medical communities to come up with new technologies for diagnosis and treatment of various illnesses. It is the basis for all types of analytical and measuring systems.*

Physics touches every aspect of human life as it involves the study of matter, energy and their interactions. Johnson and Goettsch (2009) explained that it is a science that cuts across all subjects because other sciences are reliant on the concepts and techniques developed through physics. It is quite evident that other disciplines such

as chemistry, agriculture, environmental and biological sciences use the laws of physics to better understand the nature of their own studies. All measuring instruments used in the field of chemistry such as test tubes, volumetric flasks, pipettes just to mention a few and for biology the microscope are all made with the accuracy adapted from the knowledge of physics. The IUPAP conference of March 1999 came up with the following list of reasons why physics is important to society:

1. Physics is an exciting intellectual adventure that inspires young people and expands the frontiers of our knowledge about Nature.

2. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world.

3. Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.

4. Physics is an important element in the education of chemists, engineers and computer scientists, as well as practitioners of the other physical and biomedical sciences.

5. Physics extends and enhances the understanding of other disciplines, such as the earth, agricultural, chemical, biological, and environmental sciences, plus astrophysics and cosmology - subjects of substantial importance to all peoples of the world.

6. Physics improves the quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer technology, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery.

The other aspect of the benefits that society can get from physics is its wide variety of career options as compiled by UNESCO (2006) as some career prospects of students who are well grounded in Physics such as Accelerator Operator, Applications Operator, Data Analyst, Design Engineer, High School Physics Teacher, IT Consultant, Lab Technician, Laser Technician, Laser Engineer, Optical

Engineer, Research Associate, Systems Analyst, Technical Specialist, Web Developer and Software Designer just to mention a few.

Physics as described in the previous paragraph is supposed to be the most sought after subject by learners in learning institutions but however the situation is different. Johnson and Goettsch (2000) expressed that physics is one of the most difficult subjects taught in schools. This conclusion was obtained from a study in the United Kingdom (UK) from 1985 to 2006 where it was found that there was a forty-one percent decrease in the number of candidates sitting for the senior secondary physics examination. This decreasing trend in candidature for physics examination is similar in other countries as well. Despite this trend physics remains an integral part of the education system. It is through physics that new methodologies were developed that help improve the quality of life including things such as cars which have made human mobility easy as well as modern construction which make the earth a beautiful place to live in. For example we take for granted the smooth operations of a car without taking into consideration the mechanisms at work. Figure 2.1 explains most of the operations of a car which can be well explained through the knowledge of physics. Topics like thermodynamics explain the functions of the engine and how the coolant helps in cooling the engine, electromagnetism explains how the car battery works, starter and headlamps. Vibrations and mechanical waves are also part of the content knowledge in physics (Serway & Faughaun, 1999).

If the learners who pass through the physics class can be enthusiastic about this knowledge, society would have well informed citizens who would not take anything for granted. For instance through the understanding of the effect of force on acceleration of a body of mass, drivers would drive with caution. The seat belt which is seen as an inconvenience or as a traffic regulation would be strapped without any reinforcement, speed limits would be adhered to and the roads could be likely to be safer for everyone. Physics knowledge can help learners to be well informed about aspects of matter and energy and their interactions. Learners are supposed to have an appetite for linkages between different phenomena in the environment and physics content knowledge brings clarity about a lot of science issues. Still on the same example of a car physics knowledge can help users appreciate the knowledge about the care of the car which lead the learners to embark on mechanical works which

may help them to earn a living after school without even attending mechanical school. Figure 2.1 shows a picture of a car and how certain topics in physics directly explain its operations. Without the knowledge of physics making a car would have been impossible (Serway & Faughaun, 1999). This is just but one example of how physics is important in human daily life.

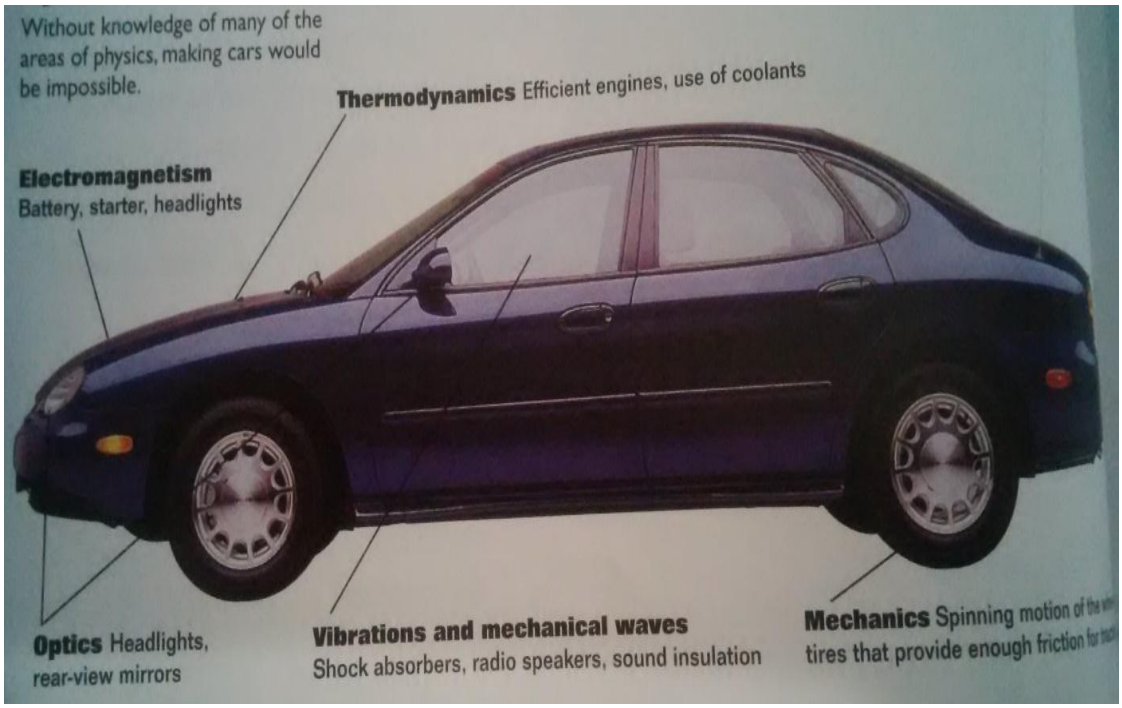

Figure 2.1: Physics and the operations of a car. source: Serway & Faughaun (1999).

2.3 Physics; a global perspective

Physics is considered a difficult subject that gives problems to learners all over the world. This has been supported by renowned institutions of learning like the Harvard University which rates it as the number one subject on the list of top ten most difficulty subjects (Kadzere, 2016). Owen, Dickson, Stanisstreet and Boyes (2008) revealed that there was a decline in the popularity of physics among secondary school learners and a low uptake at A-level and beyond continues to cause concern on education and economic grounds. The researchers at global level have already established the case for secondary school physics and it is that physics is a difficult subject among secondary school pupils. Research has revealed that physics is perceived as a difficult subject because it requires learners to employ a variety of methods of understanding from one form to another such as dealing with tables of

numbers, graphs, equations, diagrams and maps (Wambugu, 2007). Wambugu (2007) further explained that the different methods employed in the study of physics are a handful for most of the learners and it makes them lose interest in the subject in the long run. Wambugu's findings can be understood by presenting a table for the assessment objectives and structure of Zambian grade 12 physics as presented by ECZ (2016) examination review report.

Table 2.1 –Assessment objectives and structure of grade 12 physics.

Knowledge with Understanding	-scientific phenomena- facts, concepts, theories, laws. -scientific terminology- use of symbols, quantities and units. -scientific apparatus and instruments and their safe operation. -scientific and technological applications with social economic and environmental relevance.
Handling information and solving problems in order-	-locate, select, organise and present information from a variety of sources. -translate information from one form to another. -manipulate numerical data. -identify patterns and draw inferences from information. -give reasonable explanations for patterns and relationship. -make predictions and hypothesis.
Experimental skills(practical) including those involving how to-	-follow instructions -use techniques, apparatus and materials. -observe, measure, record -plan investigations. -interpret and evaluate observations and results. -evaluate methods and suggest possible improvements.

source: ECZ (2016)

The summary of the assessment shows how diverse physics is and it is on this basis that the subject may be perceived to be difficult. A learner is required to be competent in all the areas that are outlined in Table 2.1. This outline shows the relevance of physics in technology advancement as well as economic development of a country. The information in the Table 2.1 reveals how relevant physics is because

if a learner acquires what has been outlined society is likely to have a well enlightened citizenry with the skill to change the well-being of its communities.

If viewed from another perspective the vast knowledge and the variety of methods may seem to be negative but it is actually what makes physics to be the base science. Zhaoyao (2002) postulated that physics is an important base in science and technology since it studies the essence of natural phenomena and helps people understand the increasingly technological changing society. Physics as a branch of science has a lot of applications. According to Zhaoyao (2002) the most fundamental discoveries in physics have rapidly been exploited by medical communities to device new technologies for diagnosis and treatment of illness. However, despite knowing the importance of physics in technological development the knowledge of physics continues to decline because of it being regarded as a difficult subject. Holubava (2008) expressed that the decline in the number of physics students can also be seen at universities in the Czech Republic. Another research by Murphy and Whitelegg (2006) added by stating that learners avoid taking physics due to the fear for failure as physics has a high failure rate.

Additionally, Physics as a science subject has also been acknowledged as a prerequisite for the study of several courses in universities world over (Ogun eye, 2012). In view of the obvious importance of physics in scientific and technological advancement of any nation and its usefulness in nearly all fields of human endeavour, the poor performance of learners in the subject at secondary level has been a source of concern to various people and governments at various times (Onwioduoki, 2012). Ogun eye (2012) and (Onwioduoki, 2012) have added their view to the perception of physics as a difficult subject and what the situation is likely to be if nothing is done to uplift the standards of physics in secondary schools. The scholars cited so far have acknowledged that physics is perceived a difficult subject among secondary school pupils but there is no clear information about how this situation came about because this subject dates from ancient times and it has always been the reference to understand matter and energy. According to Brassel (1987) physics was introduced long before the twentieth century. The main reason for this was the industrialisation of societies and the development of science as a social activity.

Another study by Barmby and Defty (2012) analysed data collected by Durham University's Yellis project over the period 1999 to 2004. The study focussed on the degree to which pupils in England at the end of their secondary school liked or disliked different subjects and their expected examination grades in these subjects. The researcher's study focussed on the perception of pupils in the science subjects of biology, chemistry and physics. Using the available data, the study found that physics was perceived to be the most difficult subject and the expected results for physics where found to be the lowest. The study by Barmby and Defty (2012) showed a correlation between perception and performance and it was found to be positive. This can imply that the perception of physics as a difficult subject among secondary school pupils has the potential to influence learners to avoid the subject or perpetually perform poorly during examinations if no effort is made to correct the situation.

Research has gone further to examine teachers views on the factors that contribute to the declining interests in physics among secondary school learners in Singapore. Oon and Subramanian (2011) revealed that a total of 190 physics teachers from 91 secondary schools participated in this study. The findings of the study showed that teachers were uncertain about career prospects on physics graduates as physics seemed to be a difficult and abstract subject to learners. The poor perception of physics has not just been with the learners but it has affected the teachers as well. Teachers are supposed to be very knowledgeable about the career prospects of physics and be able to motivate the leaners in the course of study. Besides the many career opportunities that physics offers Rief (1985:148) added that;

> *Physics education in a school has several functions to perform. It must give the student a systematic training in careful observation, in experiment and in the estimation of relative value of results. It must provide for all pupils knowledge of the material world and nature, and the same time for the small proportions of pupils who would later become scientists or those who would become technicians, physics must lay a foundation for advanced work in the field of science and technology.*

Most scholars have stated that physics is difficult in secondary school but very few research findings are coming up with the reasons and scholars who have cited reasons have not made reference to the pedagogical content knowledge or the

curriculum design. It is for this reason that this study focused on the curriculum design and the teacher's PCK. There is need to investigate the case for physics further in order to come up with a conclusion that may change the perception of physics at the global level thereby increasing the knowledge base of physics. Murphy and Whitelegg (2006) reported that in the UK poor achievement and perception of the difficulty of physics are the determinants of student's decision about whether to continue to study physics at higher levels of education or not.

Physics has only very few participants as its enrolments have been decreasing steadily over the years among secondary school pupils since it is considered a difficult subject (Nielson & Thomson, 2007). Kingsbury (2004) lamented that "physics is a science that deals with matter and energy and their interactions is one of the most if not the most difficult science in existence". The message is clear that most learners in the world experience challenges with physics as a subject. It is therefore important to provide information for the gap identified as most of the studies consulted confirm but there is no clear solution to this challenge. The problem is that it is being tackled from different angles and for a solution to be found there is need to combine different research findings.

There is enough literature to bring to light the situation about physics in secondary schools world over. If the trend continues without being corrected what is likely to result will be the reduction of physicists on the world market and yet this is the time when the world is in need of them more than ever. Literature showed that the issue of physics as a difficult subject can be tackled from different angles but all them should contribute to finding a lasting solution. The methods used to teach physics should be an area of concern hence the need to analyse curriculum designing and teacher's PCK.

2.4 Physics; A Regional Perspective

The case of physics as a difficult subject in Africa is not different from the global perspective. UNESCO (2014) reported that for a long time physics had been mystified as a difficult subject hence some secondary schools had not offered it in the last years of secondary school education in some African secondary schools. Kenya National Examination Council (KNEC, 2013) revealed that it was alarming to see the declining levels of pupils who were interested in physics. The KNEC

further expressed concern that learner's performance in physics was poor and the subject was becoming less popular among secondary schools in Kenya compared to other science subjects. The same concern was echoed in Nigeria through research by different scholars and one such scholar is Onwioduoki (2012) who revealed that the poor performance of learners in physics in the state of Akwa Ibn, Nigeria where the research was conducted was due to poor attitude of the learners and poor understanding of difficult concepts. UNESCO (2015) revealed that despite the fact that physics is an important subject in economic, scientific and technological development, most schools in Africa have made physics an optional subject in senior secondary and the worst situation is that other secondary schools do not offer it at all. Onwioduoki (2012) also presented the Ugandan situation as not being different by stating that students find physics as one of the problematic areas within the field of science. It cannot be over emphasised that physics is key to technological development because all sciences basically depend on physics knowledge for interpretation of facts or use of equipment for that particular field of science. Physics knowledge equips the chemists and the biologists with the accuracy and precision that goes with the use of particular equipment. This knowledge is not only available to scientists but even political leaders are aware. It is in this light and awareness that members of the Network of African Science Academic, NASAC (2010) addressed the need for science and technology in the meeting of science and technology ministers in South Africa and said;

> *We are convinced that unless national scientific and technology capacities become a central component of all nations and continent wide effort to move Africa's economic development from a commodity of raw materials base to a knowledge base, the expected improvement in its economies or the equality of its people will be illusionary.*

The knowledge of physics is a unique facet and its understanding fosters human appreciation of nature and its characteristics. Michael (2011) observed that only science with physics as its foundation can solve many of the impending crises facing our society, such as global warming, overpopulation, energy and other mineral resources and poisoning of our planet. It is for this reason and many more that the knowledge of physics should have been growing at an accelerated rate and not the deceleration that is being experienced on the continent. The major problem with the declining knowledge of such an important subject seems to be the perception which

should be rooted out of the future generations. It is a well-known fact that physics is the base science and it is at the centre of any technological innovation as such much effort should be put in ensuring the growth in the knowledge of physics among learners.

Williams et al (2015) also postulated that learners find physics to be difficult because they consider it to be difficult and irrelevant. It is worry-some that such an important subject can be described as irrelevant. There are a lot of misconceptions and misrepresentation of physics from different aspects of life and this trickle down to the learners in secondary school who do not even give it a chance but just concede defeat. This subject is supposed to be held in esteem because of its application to everyday life and the way it can help humanity to understand phenomena. The subject offers simple explanations as to how clothes get dry when they are hanged on a line or when they are put in the dryer (Serway & Faughn, 1999). Learners of physics are given an opportunity to understand how objects seem to be moving while in actual sense it is the observer moving as well as understanding how the ventilation of a room works. Such valuable information is what comprises the content knowledge of secondary school physics. It is such knowledge that is declining steadily because learners seem to have lost interest in the subject or simply because they are afraid of failing during examinations. Holubova (2008) contended that physics is irreplaceable for the progress of society because modern technology involves physics as it is the basis for all types of analytical and measuring systems. For this reason physics knowledge should not be allowed to reduce by the reduction in candidature or failing. Africa needs to invest heavily in measures that bring about the revival of physics in secondary schools.

Wambugu (2007) revealed that Kenya needed to change the learner's poor perspective of physics because teaching physics provided learners with understanding skills and scientific research fostering technological and economic growth in the nation. There must be a very candid reason that has led to this situation and there is urgent need to find a solution to this problem that the education systems in many places in Africa are grappling with. The perception of physics as a difficult subject has very serious consequences for the development of Africa which has remained undeveloped for so many years. The knowledge that is relevant for development is declining and this is a sign that even development is declining and

the only technological advancement we will be interacting with will be coming from already advanced societies. The poor performance of pupils in physics can be attributed to a lot of factors and research has revealed that poor attitude by the learners is one of them (Onwioduoki, 2012). The concern is why should such an important subject draw a negative attitude from the learners?

Physics as a science subject has been acknowledged as a prerequisite for the study of several courses in the universities. Oguneye (2012) postulated that in view of the obvious importance of physics in scientific and technological advancement of any nation and its usefulness in nearly all fields of human endeavour, the poor performance of pupils in the subject at both secondary and post-secondary level in the country should be a source of concern to various people and governments at various times. As stated earlier some schools have stopped offering physics at secondary school level while those that are still offering it have made it an option thereby reducing the number of learners who are taking the subject. The implication of this reduction is that the knowledge of physics is likely to reduce and this means that the base on which technological development can be built may be weak. Every country in Africa seems to be in a hurry to develop and therefore their investment should be in initiatives that can be directly translated into development. The learning of physics helps to develop the producing ability of a society therefore the greater the numbers of pupils taking this subject the more skilled and productive workforce will the country have which in turn will contribute to an internationally more competitive nation (Kostyuk, 2004).

About Ghana, Murphy and WhiteLegg (2006) reported that the performance of Ghanaian students in physics has been generally and consistently poor over the years. The scenario presented was indeed cause for worry for the education system in the region and there was need for intervention and research that can provide the much needed information. Most cases reviewed have even attempted to provide the reason why physics is difficult but none has addressed the effect that a curriculum design and teacher PCK can have on the subject. It is for this reason that this research went on to find out if the curriculum designing for physics had anything to do with the subject being perceived as difficult hence resulting in poor performance of learners in secondary school in Zambia.

2.5 The Importance of the Knowledge of Physics in the Zambian Education System

Physics education in a school has several functions. It gives learners a systematic training in careful observation, in experimentation and in the estimation of the relative value of results. Rief (1985) postulated that physics provides for all learners knowledge of the material world. Zambia is endowed with abundant natural resources and it is important that learners who leave the education system at whatever level have the appreciation of the physical environment in order to use it for development in a sustainable manner. It should be appreciated that physics is an enterprise which plays a key role in the future progress of humankind. Michael (2011) repeated reasons why Physics education in Zambia should be supported with reference to the IUPAP conference of March 1999 as it has been explained earlier in this chapter.

IUPAP reasons on the importance of physics apply to Zambia as well but it is undisputable that Zambia which is a developing nation needs the knowledge of physics to increase more than ever. Like earlier alluded to, a nation cannot develop beyond the intellectual capacity of its own citizens and for that reason steps should be seen to invest in the knowledge that will bring a nation's technological advancement. Pampilion (2000) revealed that the trend of changes in our current information age in which scientific and information technology keep moving swiftly has inevitably compelled all countries of the world to find schemes for the development of their young through education.

In realising the importance of the young citizenry being the foundation of the development of the nation, many countries are signatories to the aspirations of the vision 2030. The Ministry of General Education in Zambia has revised the curriculum that would be in line with the aspirations of vision 2030. MoESVTE (2013) designed the revised curriculum through the Curriculum Development Centre and its aim was to produce a learner who;

1. is analytical, innovative, employable, entrepreneurial, productive and constructive.

2. appreciates the relationship between mathematical and scientific thought, action and technology on one hand and sustenance of the quality of life and the other hand.
3. is technically competent.
4. is scientifically, technologically and financially literate
5. is able to provide competent leadership and teamwork

These listed aims of education summarise Zambia's intentions in promoting knowledge which is worthwhile. In order to achieve this, subjects like physics should be promoted. How does physics help to achieve this, one may ask? Physics allows learners to interact with phenomena in different ways as they are exposed to a clear conceptual development followed by the practice of working with both fundamental physical concepts around them and the world of physics (Serway &Faughn, 1999). It is through the subject of physics that learners may be able to comprehend how water put in a plastic container which is wrapped in a muslin sack gets cooled or how a clinical thermometer is able to read body temperature. This knowledge that is taken for granted by many and yet the subject of physics explains how evaporation brings about coolness in the former and expansion of liquids in the later. According to the Kenya Institute of Education (2012) the teaching of physics provides learners with understanding, skills and scientific knowledge needed for scientific research fostering technological and economic growth in the society where they live thus improving the standard of living. Zambia is grappling with issues that are as a result of global warming, bad consumption methods, waste management which bring about problems such as drought , floods, emergence of army worms and disease just to mention a few and these problems require scientific research in order to come up with solutions. The subject of physics provides learners with a critical mind that will lead them to look for solutions about phenomena around them. Physics is a subject that provides the best way to ensure learning that lasts long after formal education. This is because physics uses practical applications and concrete examples that learners can relate to and appreciate.

Fonceca and Conboy (1999) reported that the development of technical training systems of high school physics creates the necessary prerequisites for raising the educational level of learners which is the formation of professional competence. Zambia requires a transformation of the minds of its work force to be professional in

order for the utilization of its natural resources to be sustainable. Secondary school physics provides an opportunity for the learners to gain skills that will help them have an enterprising mind in order to reduce on the dependency on the white collar jobs after graduation.

2.6 Physics Curriculum Designing for Zambian Secondary Schools

A curriculum is a vital tool in the social and economic development of both developed and developing countries (Tanzania Institute of Education, 2010). It is therefore imperative for developing counties like Zambia to design a curriculum which embraces quality education as a vital tool for accelerating the socio-economic development. Developed countries design curricula which can help the nation to move to greater heights of development as well as sustaining that development. For developing countries, development can only come if the curriculum of their education system contains aspects of development. Curriculum designing refers to the structure or the arrangement of the components or elements of the curriculum in a coherent manner (Delgado, 2012). The school curriculum is supposed to be arranged in such a way that the desired aspiration of the country is achieved through its education system. According to Meo (2008), many regular students struggle to succeed in a one-size-fits-all regular education curriculum. For this reason, there is need to design a curriculum that directly responds to the developmental needs of a country as well as being specific to particular needs of learners. It is therefore important to pay particular attention to the arrangement of the components of a particular subject. The starting points for all curriculum designing are clear defined learning experiences that learners are to achieve during the programmes. Therefore all instructional decisions should be made by tracing back from the desired end result and identifying the building blocks that will be required to achieve that end. This entails that there should be direct and explicit links between planning, teaching, assessment decisions and the outcome that learners should achieve (Print, 1993).

The education system in Zambia seeks to link education to real life experiences as it gives the learners skills to access, criticize, analyse and practically apply knowledge (MoESVTE, 2013). Learners should be given practical experiences during the teaching and learning process that help them to get life skills. The nature of physics is that it affords learners an opportunity to experience what has been outlined in the content. There seems to be a gap in the way physics has been aligned to the academic

pathway of the 2013 revised curriculum when it is practical in every sense and should have been assigned to the Vocational career pathway. The focus of the 2013 revised education curriculum is to incorporate current areas of social, economic and technological development and link the school's vocational curriculum to technical and vocational training curriculum (MoESVTE, 2013). Physics learning in secondary school helps to introduce learners to the fundamental ideas of the occurrence of phenomena in their natural environment and how learners can participate in sustainable ways of harnessing the natural resources to improve their lives. The purpose of this research is to identify the causes of the perceptions of learners about physics being a difficult subject by analysing the curriculum design and teacher PCK. It opens up room to find out why the researchers behind the revised curriculum did not assign physics to the vocational pathway as it does not only contain valuable content but can provide various life skills that help the learners to become an informed and innovative member of society.

Figure 2.2 shows the Senior Secondary School Curriculum giving the position which physics occupies in the senior secondary curriculum.

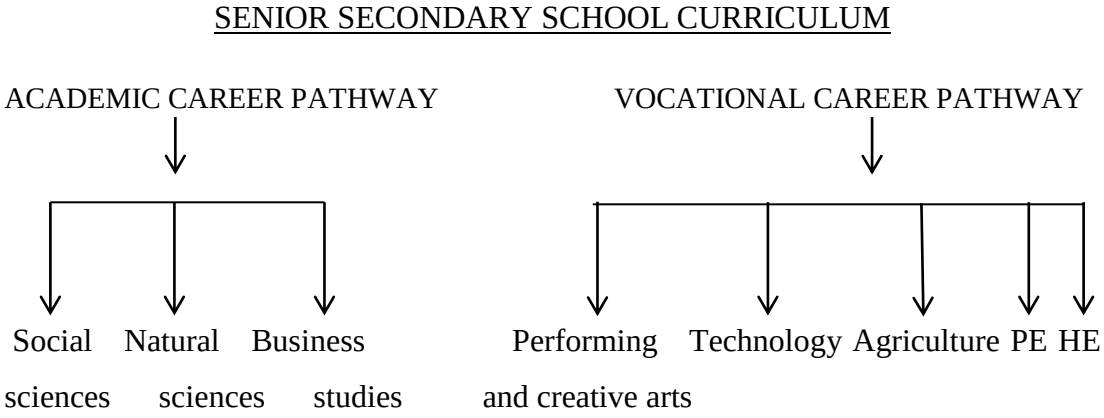

Figure 2.2. Senior secondary school two tier system. Source: MoESVTE (2013).

Learners who will study vocational subjects will be examined by TEVETA and given trade certificates. According to MoESVTE (2013), learners who will study vocational subjects up to grade 10 and pass, a level two trade certificate will be awarded by TEVETA. Grade elevens who successfully complete level one will be awarded a trade certificate. The gap in the curriculum designing is that physics has been assigned to the academic career pathway but physics has got almost all its topics practical in nature and can provide an opportunity for learners to acquire trade

certificates which can either make them employable at different levels of study or even to engage in entrepreneurship. In physics there are topics such as domestic wiring which provides content which the learners can use to apply in a real situation such as doing a simple wiring of a house with all precautions taken into consideration (Serway & Faughn, 1999). This can enable learners to get the qualification just as TEVETA has introduced subjects classified under the vocational career pathway. Physics is a technical subject and enables learners to gain lifelong skills but it's placement in the career pathway is an indication that there are misconceptions about physics in the Zambian education system. It is such misconceptions that may lead to learners encountering problems in the subject as the learners take most of the content which they learn in physics to be theoretical and only useful for acquiring a grade twelve certificate.

The grade twelve physics curriculum design is arranged in such a way that it introduces learners to international standards of measurements known as SI units standing for system Internationale (Serway & Faughn, 1999). This knowledge enables learners to acquire the skill of measuring, accuracy and precision as well conversion of units. It contains others important topics which fall under mechanics, thermal physics, wave motion, static electricity, current electricity, basic electronics and nuclear physics. These topics provide learners with worthwhile knowledge and skills that can help them rise to the challenges that society is facing. Steinberg (2008) expressed that in order to have a skilful and knowledgeable learner, the physics curriculum and syllabus is loaded with content as a response to the demands of the international standards. According to Rose and Meyer (2002), the design for learning is built on the premise that barriers to learning that occur in the interaction with the curriculum, they are not inherent solely in the capacity of the learner. When education fails, the curriculum, not the learner should take the responsibility for adaptation. The curriculum design should take into consideration the diversity of the learners and it should therefore be created in a flexible manner in order to support the progress of all learners in their individual capacity (Meo, 2008). Haambokoma et al (2002) in a study undertaken for the Ministry of Education to strengthen Mathematics and science education in Zambia revealed that the Zambian Physics curriculum was too long. Using such findings this study examined the curriculum

designing for secondary school physics in order to establish what effect it has on the learner's perception of physics as a difficult subject in Zambian secondary schools.

The physics syllabus embodies a wide range of activities such as projects, experiments, demonstrations and scientific enquiry skill (CRDD, 2008). The topics in the physics syllabus have been deliberately selected to enable learners acquire the relevant knowledge, skills and attitudes needed for tertiary level education, apprenticeship and for life. The study analysed the curriculum designing and teacher PCK so as to find out whether the problem of physics may be related to the subject matter or to its relation with society and perception by society. The poor perception of physics by learners if not corrected may diminish physics' importance to society and thus reduce the number of active participants in society with the valuable technological knowledge which physics brings with it. Physics is a central part of human culture and will continue to inspire many people as it reveals important universal truths not withstanding certain strands of post- modern thought (America Physics Society, 2008).

Zambia's struggle with physics is not the fact that the education system is not aware of its importance but it is the learners who seem not to be aware of its importance thus neglecting it. There is great need for the Zambian school system to prepare young Zambians to face the challenge and change the perceptions and attitudes to the teaching and learning of physics which is a prerequisite subject of science and technology. According to Till (1971:309)

> *Reliance on science and technology is immeasurable literacy in science is essentially for every man and woman who hopes to function efficiently in the twentieth century society. To function efficiently means that information from the base science which is physics provides a platform on which every citizen would become self- reliant and be accountable for their own life.*

Zambia, especially Lusaka has been struggling with the cholera epidemic which is an embarrassment in the twenty first century where a lot of information about waste management is readily available. Cholera is water borne disease which is spread through contact with contaminated water or food and as such containing it and eventual eradication depends on life style change of the citizens. The knowledge and skills physics offers provide the efficient ways of interacting with phenomena in our

environment without contaminating it or each other. It is the subject that gives birth to engineering which is a way of coming up with solutions to most of the problems mankind struggles with. Kostyuk (2004) confirmed that physics is the theoretical foundation of engineering and physicists are turning their talent to molecular biology, biochemistry, biology itself and medicine. The Zambian education system needs to come up with initiatives that can deal with this matter exhaustively such as research as well as other innovations that can push the knowledge of physics up. This research endeavoured to investigate the poor perception of physics by secondary school learners and what effect the teacher's PCK and physics curriculum design had on the poor performance of the learners in secondary schools in Zambia.

2.7 The Pedagogical Content Knowledge used in Zambian Secondary Schools for Teaching Physics.

Education is an integral part of the social system and responds to the requirements of society. This therefore means that for the curriculum to be progressive, relevant, dynamic and responsive, a number of considerations must be made (MoESVTE, 2013). Some of the considerations include the education guiding principles which require learners to employ a variety of methods of understanding. This involves moving from one form of dealing with tables of numbers, graphs and equations to diagrams and maps. Physics requires the teacher to be well vested with PCK in order to manage to competently shuffle the different types of methods without losing the learners in the maze of knowledge. The 2013 revised curriculum has adopted outcome based curriculum as one of its guiding principle. MoESTVE (2013:15) described outcome based education as;

> *an approach to learning that the Ministry of Education Science, Vocational Training and Early Education has adopted moving away from behavioural approach. The real life experience as it gives learners skills to access criticise, analyse and practically apply knowledge. Learners are given practical experience during the teaching and learning process that helps them get life skills.*

Pedagogical Content Knowledge (PCK) helps the teacher to guide learning in ways which are appropriate as prescribed by the curriculum in order to achieve the aspirations for education of a nation. Shulman (1987) described pedagogical content knowledge (PCK) as an important aspect of teaching that allows teachers to effectively relay and make the subject matter and curricula knowledge

comprehensible to the learners. There is need for the teacher to know more than what the textbook has in order to have the capacity to clear learner misconceptions and difficulties about a particular subject. Park and Oliver (2008) explained PCK as what the teacher understands and enactment of how to help a group of learners understand specific subject matter using multiple instructional strategic representations and assessments while working within the contextual, cultural and social limitations in the learning environment.

Mulenga (2015) in his doctoral study contended that a teacher with PCK would know how to effectively sequence the teaching and learning materials and formulate very good questions that probe for alternative views. A teacher needs to be well ahead of his/her learners in terms of how to handle the content knowledge by showing understanding of what is to be taught and learnt taking into consideration the learner's misconceptions and their way of thinking. ECZ (2016) revealed that the poor performance in physics at grade twelve could be as a result of usage of strategies that are not compatible with the demands of a subject. The speculation of the ECZ report was investigated and this study examined the pedagogical content knowledge of the teachers of physics to establish what effect it had on the learner's perception of physics.

It should be noted that knowing and understanding physics and having the skill of how to effectively teach it are two different things. Physics is a very technical subject as a result it is not enough to have understanding of the content only but the teacher should have the skill to bring to life the phenomena that is described in the content of physics in order to help learners grasp the concept and later on be able to apply it in real life situations. In order to help the teacher have the skill to teach the subject effectively Shulman (1987) came up with three aspects of pedagogical reasoning and he outlined them in three stages as follows;

a) the first stage is comprehension where the teacher first needs to understand the set of ideas to be taught and how they are related to other ideas within the subject and other subjects.

b) the second stage is to make sure that the comprehended ideas are transformed into a well arranged manner if they are to be taught and learnt.

c) the third stage involves reflection. This is where the teacher is expected to look back at the teaching and learning that has occurred and reconstructs.

From this analysis, the teacher's failure to adhere to the three stages implies the absence of PCK on the part of the teacher and it may lead to situations such as the one physics is facing today of decline in candidature and high failure rate. The teacher's inability to critically analyse the syllabi and effective sequencing of teaching and learning material can affect learner's performance in secondary schools. Is this the reason why learners find physics difficult and fail the subject? This study analysed the teacher's PCK and revealed the effect it had on the learner's response to physics.

Based on the 2015 school certificate examination results in Zambia, the Examination Council of Zambia (2016) reported that the performance of candidates in practical subjects was very good while mathematics and science had recorded the low performance. Here is a gap in the way physics is perceived, ECZ does not include it on the practical subjects and yet the examinations for physics include a practical component. Can this be the reason why the subject receives apathy from the learners as well? Does this mean that experiments done during physics lessons are not enough to qualify physics to be called a practical subject? These are some of the questions this study tried to answer in order to establish the real problem with physics as a subject in secondary schools in Zambia. From time in memorial, physics has been taught as a practical subject. Brussel (1987) revealed that practical work and laboratory as an integral part of physics were introduced in the early twentieth century. Wherever physics is taught, it is in form of practicals and projects however, it is surprising to have ECZ and CDC not to include physics among the practical subjects list. Darling Hammond (2000) expressed that active learning practices have significant impact on performance than any other variable. Effective teaching of physics is dependent on the economic status of a country. According to UNESCO (2015), in poorest countries the quality of teaching physics is dependent on the resources available for education, class size, pupil-teacher ratio or the years of schooling. But the method of teaching physics should be guided discovery instead of the traditional lecture method. Borich (2007) expressed that for physics learners to achieve their potential in schools, it would seem to be essential that teachers engage

in effective teaching because genuine and helpful interaction helps in the retention of knowledge and skills.

Although teaching is considered to be an art, preparing to teach effectively is one of the urgent problems encountering researchers who have the passion of improving teaching (Morris, Hierbert & Spitzer, 2009). There is so much research about improving learning because there is a growing urgency in developing nations to use education as a vehicle for economic and technological development. For example Zambia is in the process of diversifying its economic development from reliance on copper to agricultural production and to do this the revised curriculum has brought to life agricultural science as a compulsory subject in secondary school. It should be the concern of the educators to ensure that learning is actually taking place. Mulenga (2015) revealed that in every discussion that involves teacher preparation what should not be expected to miss out is the judgement about the content knowledge and skills teachers possess so that they are equipped to teach effectively. In addition well prepared teachers are likely to select valuable learning activities, ask productive questions, give good explanations and evaluate pupils learning.

Studies done by Kajander (2010) as well as Masaiti and Manchinshi (2011) have indicated that during teacher education programmes more time is spent on learning content courses than is spent on methodological courses. From the findings of their studies it is clear that what to teach is not more superior to how to teach the concept but they should be accorded the same respect. How the teacher presents the content to the learner determines how the learner is going to treat the knowledge and skills received and how long it will last in the learner's mind. It is the teacher's pedagogical skills that are going to convince the learners that the knowledge and skills received are actually usable in real life. Chamberlin (2007) emphasised that pedagogical strategies that support learners making sense of the materials are cardinal in the teaching and learning process. The same sentiments were echoed by Shulman (1987) who noted that what matters in the teaching and learning process is not necessarily the content but what the teacher does with that content he or she had acquired. There was need to establish how physics was taught in the Zambian secondary schools and to see whether it had any effect on the pupil's perception of the subject. There should be coherence in the aspirations of Ministry of General Education (MoGE) as expressed in the 2013 revised curriculum and the way teaching

of subjects is done in the classroom. Rose and Meyer (2002), supported the assertions of the MoGE by stating that the trend of changes in the current information age in which scientific and information technology keep moving swiftly has inevitably compelled all countries in the world to find schemes for the development of their young learners to develop in such a way as to be able to think analytically, synthetically and critically, to know how to solve problems, to be creative, to know how to search for knowledge from various sources, to be able to learn and construct new knowledge, to adapt ones' self to constant changes and to face challenges.

Zambia should not be among countries that have an education system that is designed in one way and implemented in another way. Holubova (2008) contended that today's education system is characterised by a gap between how students live and what they learn and how they learn. UNESCO (2007) also explained that recent international, regional and national assessments reveal that in many SADC countries children are emerging from school with the most basic skills only. Physics gives the learners the skill to interpret information technology as such efforts must be made that the skill is actually transferred during the process of teaching and learning so that learners are not just exposed to theories. According to the Intuitor (2002) physics is the most neglected subject because it has more misconceptions associated with its principles than any of the other sciences not to mention an underserved reputation for difficulty. More research into this area will bring to light the major problem and a solution may be found if findings from this study can provide information for the gap created by other researchers on topics similar to this one.

The aim of teaching and learning physics in secondary schools in Zambia and indeed anywhere else should be to help the learners become scientifically minded by emphasising experiments as a way of making discoveries. Chishiko (2011) in his study alluded to the fact that the secondary school physics teacher has a great responsibility to ascertain that the enthusiasm of the learner of physics is captured right at the beginning when the learner's curiosity about the environment is at its highest. Most secondary schools in Zambia lack the infrastructure to support the scientific method of teaching physics through practical ways and projects such that most physics teachers end up teaching the subject in the traditional method. Haambokoma et al (2002) expressed that African countries including Zambia have

not been spared by the same physics problems no matter how teachers teach the subject the pupil's perception of physics has remained the same way. Lawrence et al (1996) contended that visualising of physical phenomena through techniques such as experiments, demonstrations and models contribute much to learners understanding of physics concepts. Banda (2004) also argued that practical laboratory activities are better than the lecture method because they help pupils to see or visualise what is being taught. This study will endeavour to analyse the curriculum designing and teacher PCK in order to find out how physics is actually taught in Zambian secondary schools and how it contributes to the current situation.

The 2013 revised curriculum has made practical examinations in physics and chemistry to be compulsory and this implies that the way of teaching physics has shifted from the traditional way to the more scientific way of practical and observation. ECZ (2015) examination report revealed that pupils are required to perform practicals, observations and recording of results. There has been some effort by the Ministry of General Education in Zambia to ensure that sciences are taught in the right way to foster economic and technological development in the country. To support the revised curriculum of 2013 government with financial support from Japan and Ireland distributed over one thousand mobile science laboratories to more than two hundred secondary schools in an effort to improve the quality of science education (UKZambia media, 2013). There is an indication that facilities are being provided to help in the way of teaching science and physics in particular however the results for physics continue on their downward spiral and this is cause enough for more research into this matter. Providing mobile laboratories is one thing and using them is another thing and it is for this reason that this research analysed the curriculum designing and the Pedagogical Content Knowledge of the teacher of physics in selected secondary schools in Lusaka, Zambia in order to establish the problem behind the poor performance in physics by the learners.

Studies by Zambian scholars cited have raised serious concerns about physics being a difficult subject and the different angles which have been touched. Masaiti and Manchishi (2011), Banda (2004), Haambokoma, et al (2002) have given this study the gap to fill in terms of pedagogy and perception about physics as a science subject. The study by Kaulu (2011) focussed on the use of the physics classroom computer software as an effort to bring about effective teaching of physics. The

study revealed that the computer software could help in improving learner's comprehension of physics. Chishiko (2011) researched on the use of mathematical concepts in the teaching of physics to make it more easily comprehensible to secondary school learners. For this particular study the focus was on analysing the curriculum designing for physics and teacher PCK to see whether they have any effect on the poor perception of physics by the learners. The studies cited have formed a base on which this research was grounded because gaps were identified and hence the need to go out and look for information. One of the perennial problems of the education system in Zambia is high failure rate of learners at grade twelve in science and physics is the major contributor (Kafata & Mbetwa, 2016). There was a gap in the fact that the failing of learners can be described as a perennial problem. It is as if even when teachers teach the learners they already know that the outcome will be high failure rate and if this situation is left without finding a lasting solution the future of physics in Zambia will be very uncertain. It is therefore a matter of agency that more research is conducted to bring this matter to rest for the sake of technological and economic development in Zambia.

2.8 The state of Physics in Zambia

Physics in Zambia has been taught since independence in 1964. In the early 1980s Physics was taught to only form IV and form V pupils as the curriculum demanded. By mid 1980s the curriculum was changed from two years to three years. This allowed for more time for the learners to prepare for 'O' level examinations. In turn the number of pupils sitting for 'O' level physics gradually increased. However, the number of pupils sitting for 'O' level physics examinations has not continued to increase (E C Z, 2015). There has been a gradual decrease in the number of centres offering physics. According to Zhaoyao (2002) the number of students who take pure physics in secondary schools reduced from 23% in 1986 to about 16% in 1997 and it has continued to decrease to date. Meanwhile those that are still offering physics, grades obtained by learners at the end of high school are not encouraging. The grades boarder mostly in credits, satisfactory and unsatisfactory. Buabeng and Ntow (2010) explained that in Zambia ordinary level acceptable performance is a grade of six or better. The situation is that most physics candidates obtain grades lower than the 'O' level standard.

Zambia is a developing nation with a need for technology which is imported at a large scale. The importation of all sorts and kinds of technology has a negative effect on the foreign exchange of the country to the extent that the currency of the country is always behind major currencies. Chishiko (2011) expressed that the aspiration of a country cannot be achieved unless the vision is invested in the young. It is through education that leaders are focussed without any subject prejudice and subject which offer foundation for technological development should be encouraged. It is from this perspective that Ogunniyi (1996) observed that through the link between science and technology on one hand and economic progress on the other is rather subtle and complex, there is evidence to show that the two are inextrictly related and do influence each other in a significant way. The economy of the country is going to have its development measured by the amount of technological innovations that are coming up. From the time of the industrial revolution, man has always improved on the way of doing work. The mechanisation of tools reduces the amount of time spent on doing work thereby providing more opportunities for man to become more innovative and it also increases production turnover which increases the net turnover. Like earlier alluded to, a country cannot develop beyond the intellectual capacity of its own people. For development to take place the intellectual capacity of the citizens should be developed and this can be achieved through education of the citizens. Education can be achieved through schooling and every education system should put in place subjects that will help it achieve its objectives, for technological development physics offers opportunities for learners to have an appetite for new inventions. Development lies in the children who are the future leaders, scientists and technologists.

Kostyuk (2004:85) observed that;

> *for sustainable socio-economic development of Zambia its school system should produce more learners who are scientifically literate who could be successfully trained as scientists and technologists and physics is a theoretical foundation of engineering.*

The knowledge of physics is a unique facet and its understanding fosters man's appreciation of nature and its characteristics. Ndashye (2007) expressed that even though a person is not personally engaged in scientific or science related occupation, one needs some basic understanding of scientific ideas to be able to comprehend the

phenomena and the changes in the natural world in which he/she lives. Science and technology have a radical impact on Zambia's economy and on the way of life of almost every one. Increasing the way to think scientifically and to understand scientific processes is becoming a condition for human survival. The way physics is taught has a bearing on its survival as such efforts to ensure that learners take keen interest should be emphasised. The rationale behind the 2013 revised curriculum is that learners should be prepared for the challenges they will have to face in a rapidly changing world.

Kafata and Mbetwa (2016) contended that in Zambia learners perceive physics as being educational rather than its applicability to life. In Zambia, physics is taught in two ways. It is taught as an option and it comes in form of pure physics (5054) and it is taught as compulsory subjects were it is a part of the science component made up of physics and chemistry. This arrangement gives learners an opportunity to explore Physics at these two levels but there is not much difference in the content as there is just an additional of few topics to the one which is called Pure Physics (5054). The Pure Physics is offered to learners whose performance is deemed to be above average and usually schools only manage to come up with one class while the rest who are considered to be average performance are given the compulsory physics which is combined with chemistry during examinations but learnt separately. The outcome is that learners who perform well in chemistry have their science result reduced as a result of poor performance in physics. The learners who have problems with physics are the ones deemed to be average learners who take the subject as a compulsory subject but they do not get to see it appear on their result transcript. Could this be another deterrent to the progress of physics in secondary schools in Zambia?

ECZ (2016) in its 2015 performance review report had indicated that science pose serious challenges to most learners. In this report, ECZ revealed that the performance of candidates in science was not good with higher proportions of candidates failing the subject at 46.64% in 2014 examinations and 48.6% in 2015 examinations. MoE (1996) indicated that the overall unsatisfactory performance in school certificates is attributed in large measure to poor performance in mathematics and science especially physics.

There has not been much research to explain why physics is perceived as a difficult subject in relation to curriculum designing and teacher PCK. Some of the research on poor performance by learners in secondary school science is related to either girls performing poorly in science or the use of mathematics skills to teach physics. There seems to be no research that has addressed the issue of physics being a difficult subject and directly linked to curriculum designing and teacher PCK. Kaulu (2011) carried out a study that identified physics as a difficult subject but from the aspect of using computers as a means of making it easily understood by the leaners. The ECZ research team always reviews the performance of learners in all subjects and physics has not been left out but it has not provided information as to what the solution can be about the poor performance of the learners in science and physics in particular.

2.9 Summary

No research seems to have been conducted in Zambia to explain why physics is perceived as a difficult subject among secondary school learners. Additionally, there seems to be no study available to explain how the curriculum design for secondary school physics and the pedagogical content knowledge of the teacher contribute to physics being perceived as a difficult subject. This study analysed the curriculum designing for physics and teacher PCK in order to establish why leaners perceive physics poorly. Most of the literature reviewed had established that physics is a difficult subject not just for secondary school learners but also for higher education students. There was an indication in the literature reviewed that physics was difficult because of its diverse nature where various components of study are included in the content such as diagrams, graphs , maps , equations just to mention a few. The literature reviewed established the gap for this study. The next chapter that follows is on the methodology that was employed in this study.

CHAPTER THREE: METHODOLOGY

3.1 Overview

In this chapter, the researcher explains the research methodology that was used in this study. A methodology can be referred to as a research procedure (Kasonde-Ngandu, 2013). A methodology is important because it provides a sense of vision in terms of what the researcher wants to do in the research process (Strauss & Cobin, 1998). The methods employed in any research project help to provide the means of bringing out the vision which the researcher has. This study adopted a mixed method approach to analyse the curriculum design for secondary school physics and the pedagogical content knowledge of the teacher of physics in secondary schools. In this chapter, the researcher explained how a mixed method inquiry was selected as the research methodology in the research and how it guided the procedures of this research.

3.2 Research Paradigm

A research paradigm "is an assumption a researcher makes about reality, how knowledge is obtained and the methods of gaining knowledge" (Creswell & Plano Clark, 2011:21).This research adopted a mixed method approach. According to Creswell (2015:2) a mixed method approach "is an approach to research in the social, behavioural and health sciences in which the investigator gathers both quantitative and qualitative data, integrate the two and draws interpretations based on the combined strengths of both sets of data to understand the research problems". Mackenzie and Knife (2006) stated that without nominating a paradigm as the first step there is no basis for sub sequential choices regarding a research methodology, literature and research design. It is therefore important that a paradigm is identified first and thus for this study a mixed method was used. This was arrived at in order to maximise on the strengths of both the quantitative and qualitative paradigms and mitigate on the weaknesses of the two methods.

3.3 Research Design

A research design has two main functions. The first relates to the identification and development of procedures and logistical arrangements required to undertake a study and the other one emphasises the importance of quality in these procedures to ensure

their validity, objectivity and accuracy (Kumar, 1996). Through a research design one can conceptualise an operation plan to undertake the various procedures and tasks required to complete the study and ensure that these proceedings are adequate to obtain valid objectives and accurate answers to the research questions. The research design that was employed in this study is the embedded design. Figure 3.1 shows how the embedded design is illustrated.

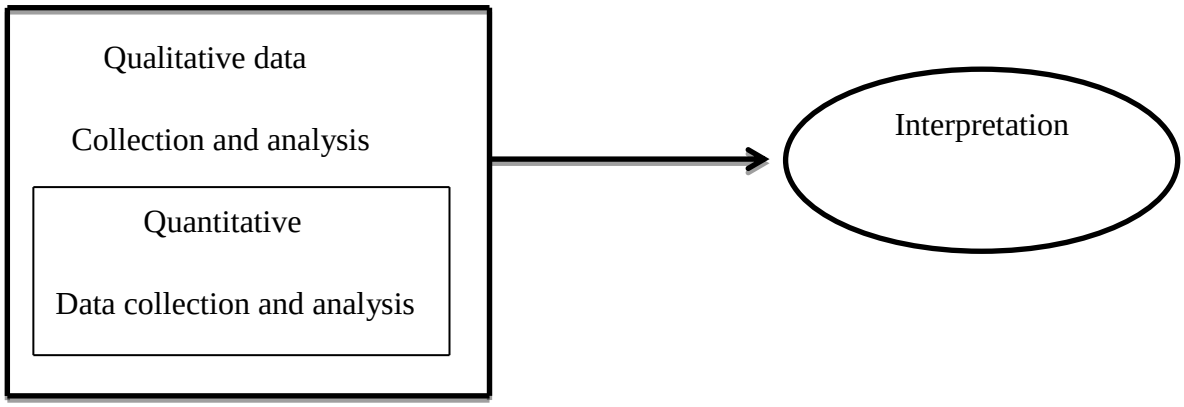

Figure 3.1 Embedded Design. Source: Creswell & Plano (2011)

The purpose of the embedded design is to collect quantitative and qualitative data simultaneously or sequentially but to have one form of data play a support role to the other form of data. The reason for collecting the second data is that it augments or supports the primary form of data. Masaiti (2013) explained that in the mixed method both numerical and text data collected either concurrently or sequentially should lead the researcher to understand the research problem. The method gave priority to one while the other performed a supporting role. In this study, quantitative data was generated to play a supporting role to qualitative data. Creswell (2012) expressed that priority refers to which method either qualitative or quantitative is given more prominence in the study and implementation refers to whether the qualitative and quantitative data collected and analysis come in chronological order or sequence.

3.4 Study Site

This study was conducted in Lusaka district, Zambia. The reason for selecting Lusaka district was because it is an urban area with a likelihood of having schools that have the necessary apparatus to facilitate the teaching and learning of physics.

Lusaka district also houses CDC and ECZ where subject specialists could be easily accessed as well as standard officers from MoGE headquarters. This helped the researcher to collect data from the right respondents.

3.5 Target Population

A population is defined as a group of elements or cases whether individual objects or events that conform to a specific criteria to which the research intends to generalise its results (Bryman, 2001). Kombo and Tromp (2006) explained that a population refers to the target group from which the sample is taken. In addition, they stated that a population also refers to the larger group from which the sample is taken. The target population for this study was all the grade twelve pupils and all the teachers of physics in Lusaka District. The population also included subject specialists from ECZ and CDC, standard officer as well as Director of National Science Centre.

3.6 Sampling Techniques

Sampling technique is the selection of components of the sample that will give a representative view of the whole population. In this study both non-probability and probability sampling techniques were used when selecting participants.

3.6.1 Purposive sampling

The non-probability sampling which was used to select physics specialists was purposive sampling. According to Bernard (2002) purposive sampling is a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with knowledgeable experts within. In purposive sampling the researcher decides on what needs to be known and targets people who can and are willing to provide the information by virtue of their knowledge or experience (Cohen, et al, 2007). For this study the researcher sampled one (1) physics specialist from CDC and one (1) from ECZ. Purposive sampling was also used to sample one (1) science standards officer and one (1) specialist from the National Science Centre. These specialists were sampled because they were knowledgeable about physics and were involved in the decision making about the subject in their respective positions.

Teachers of physics were selected from the four selected secondary schools using purposive sampling. Purposive sampling was ideal for the selection of the teachers of physics because they were deemed knowledgeable about PCK and curriculum design

for secondary school physics. The teachers who were sampled were those teaching physics to the pupils who were selected to take part in the research. Two teachers were sampled from each of the selected schools but only six (6) of them participated in the study. There were two teachers who declined to participate in the study as they had other delegated responsibilities in their respective schools as such they could not find time to be part of the research project.

3.6.2 Stratified and Simple Random Sampling

Lusaka district has thirty-one (31) secondary schools. The secondary schools were all located in the urban area. Some schools were co-education schools and some were single sex secondary schools. The schools were stratified into two strata of co-education and single sex education schools. Using simple random sampling two schools were sampled from each stratum by writing the names of the schools on small pieces of paper and stored in two boxes according to type of school. The names were raffled and the selection was done at random in each of the boxes until the required number of four schools was achieved. Stratified and simple random sampling was used to ensure that each of the schools had an equal and independent chance of being sampled. According to Kombo and Tromp (2006:79) simple random sampling is "a procedure in which all the individuals in the defined population have an equal and independent chance of being selected as a member of the sample".

In this study learners of physics in selected secondary schools in Lusaka district were sampled using stratified and simple random sampling. The target sample was grade twelve (12) pupils who had been learning physics for three years. Since the respondents were from both sexes, a stratified random sampling was used to come up with two strata, male and female for each co-education school. Then the names of respondents were written on small pieces of papers and stored in two boxes according to their sex. The names were raffled and the selection was done at random in each of the boxes until the required number of forty (40) learners from each school was attained. Only one single sex school was sampled and simple random was used to select an equal number of leaners from each class list in order to come up with forty (40) learners. The total number of learners that was sampled was one hundred and sixty (160) but only one hundred and fifty-eight participated. Two questionnaires were returned blank indicating that the two learners withdrew their participation.

3.7 Sample Size

Best and Khan (2006) explained that an ideal sample is a number that is large enough to serve as an adequate representation of the population which the researcher wishes to generalise and small enough to be selected economically in terms of subject availability and expense in both time and money. An ideal sample size may depend on the nature of the population and the type of data that needs to be collected and analysed. Every researcher needs to come up with a good and manageable sample representation of the population. The intended sample for the study was one hundred and seventy two (172) but only ended up one hundred and sixty seven (168) participants broken down as follows. One (1) physics specialist was sampled from CDC and one (1) from ECZ, one (1) standard officer from Lusaka district education board office and one (1) science specialist from the national science centre. This generated a total number of four (4) specialists. Two teachers were sampled from each of the participating schools giving a total number of eight (8) but only six (6) teachers of physics took part in the study. A total number of hundred and sixty (160) grade twelve (12) learners were sampled but only one hundred and fifty-eight participated. Table 3.1 shows a summary of the intended samples for this research.

Table 3.1 Summary of the Intended and Actual samples

Participants	Intended samples	Actual samples
Subject Specialist CDC	01	01
Subject Specialist ECZ	01	01
Standard Officer science (SESO)	01	01
Director National Science Centre	01	01
Teachers of physics	08	06
Learners of physics	160	158
Total	**172**	**168**

3.8 Research Instruments

According to Kombo and Tromp (2006) questionnaires, interview schedules, observation and focus group discussion guides are the most commonly used research instruments. For this study semi-structured interview schedules were used to conduct face to face interviews. Lesson observation guide were also used as well as

structured questionnaires. The three different instruments of data collection helped to triangulate in order to ensure validity and credibility of the research findings.

3.8.1 Questionnaire for Learners

A questionnaire is a research instrument that gathers data over a large sample (Kombo & Tromp, 2006) thus to collect data from the learners a questionnaire was used. The questionnaire for learners had both open-ended questions and closed-ended questions. Open-ended questions helped the researcher to gather added facts because respondents were free to express their views and ideals (Gosh, 1992). Learners were asked to give their perception of physics as one of the science subjects they learn in school. The learners were also asked to explain what effect their perception had on their performance. Closed-ended questions were used to collect categorised data about the way teachers presented the content of physics as well as how the alignment of topics affected the comprehension of physics. According to Kombo and Tromp (2006) the advantage of using questionnaires is that they can be used to gather data over a large sample and it saves time.

3.8.2 Semi-structured Interview Guides

Interviews are a system of inquiry which reveals a lot of information (Borg, 1963). Sapsford (2007) stated that a semi-structured interview does not have a standard format but there is an agenda that is used as a reminder to ensure that all the basic points are covered. The advantage is that semi-structured interview guide can give greater depth than a questionnaire, because the researcher can probe or encourage respondents to elaborate their answers and also can crosscheck information. Sapsford (2007) stated that a semi-structured interview does not have a standard format but there is an agenda that is used as a reminder to ensure that all the basic points are covered. By this strategy, one is able to pursue useful information by asking questions relating to why and how a given phenomenon occurs. Sarantakos (2005) noted that an interview guide or schedule is developed around a list of topics without fixed wording or fixed ordering of questions. The context of the interview is focused on the issues that are central to the research questions, but the type of questioning and discussion allow for greater flexibility than does the survey questionnaire. Creswell (2012) observed that the advantage of the interview guide is that it ensures that basically the same information is obtained from a number of people by covering the same material. The interview guide helps make interviewing across a number of

different people more systematic and comprehensive by delimiting in advance the issue or issues to be explored.

3.8.2.1 Semi-structured Interview Guide for Teachers

A Semi-structured interview guide was used in this study to gather information from teachers of physics. The researcher used the semi-structured interviews to investigate the effect that physics curriculum designing had on learner's comprehension of the subject. The researcher also used the semi-structured interviews to analyse the effectiveness of teachers PCK on learner's comprehension of physics. Structured interviews were suited for providing in-depth information about secondary school physics. The researcher also used the interviews to enquire from the teacher why learners perceived physics to be a difficult subject and what effect it had on their performance.

3.8.2.2 Semi-structured Interview Guide for Physics Specialists from CDC and ECZ

The semi-structured interview guide was used to collect data from physics specialists from CDC and ECZ. Respondent's responses were recorded by the interviewer, for later transcription. The recorded interviews also facilitated the extracting of verbatim expressions from the interviewees. While the respondents expressed themselves the researcher took handwritten notes as well. For this study, physics specialists were asked why learners in secondary schools perceived physics to be a difficult subject, what effect such a perception had on the learner's performance and what effect the curriculum designing had on learner's comprehension of physics. The researcher further asked the physics specialists to give insight on what PCK teachers of physics are supposed to possess to enhance comprehension of physics content.

3.8.2.3 Semi- structured Interview Guide for Standards Officer and the Director National Science Centre.

The content of the interview guide was based on the research questions. The Standards officer and the director of the National Science Centre were asked to give their view about learner's poor performance in physics. The interviewer inquired whether the curriculum designing of secondary physics was yielding intended results. The teacher PCK of physics was paramount to this study therefore the interviewer

endeavoured to find out the views of the Standards officers as well as the director of National Science Centre and how they linked it to learner performance. The interviews were conducted wherever the respondents felt most convenient and comfortable.

3.8.3 Observation Guide for Physics Lessons

A structured observation guide was used in this study for observing lessons of the teachers of physics who were interviewed. The observation were done to obtain information about PCK which the teachers of physics possessed as well as to observe learner behavioural change at the end of the lesson. The researcher used the lesson observation instrument in order to collect data on specific behaviour from the learners as well as the teacher's PCK during the lesson. Specific behaviour was outlined on the lesson observation instrument in the appendix. Creswell (2012) explained that behavioural observations are made by selecting an instrument on which to record behaviour and checking points on the scale that reflect behaviour. The advantage of this form of data is that one can identify an individual's actual behaviour rather than simply record the respondents view or perception.

3.9 Quality Control

Validity reliability and trustworthiness are very important features to consider for the credibility of research findings. It is for this reason that the researcher took into consideration all the three qualities to ensure quality of the research findings.

3.9.1 Validity and Reliability

Research findings are said to be valid if the research carried out reflects and brings out the exact information the researcher intends to bring out. In order to validate findings in this study, the researcher asked for permission from the respondents to record some of the interviews as way of counter checking some of the information given but it was not a must for respondents to have the interview recorded. The researcher was able to compare the findings from the interviews, observations and questionnaires in order to check whether the data represented the topic under study. About validity, Mulenga (2015) revealed that validity is the degree to which results obtained from the analysis of data represent the phenomena under study. The validity for this study was achieved through the use of different data collection method which is known as triangulation. Patton (1990) supported triangulation by expressing that

when methods are combined inconsistencies are taken care of thus valid and reliable data emerge. Validity was also achieved through expert checking of the instrument to see if the grammar was appropriate and if it would enable the researcher to collect the intended information from the participants. On reliability, Mugenda and Mugenda (1999) explained that reliability is the degree to which a research instrument yields consistent results or data after repeated trials. For this study, some questionnaires were piloted in selected schools in Kitwe to assess whether the questionnaires would yield the desired responses. This was done by piloting twenty (20) questionnaires in selected secondary schools in Kitwe district, Zambia. The exercise also helped the researcher to check if the questions phrased could draw a response from the respondents and if the sentences read well, as well as transmitting the same message to the respondents. After the piloting exercise the questionnaires were evaluated and corrections were made in order to come up with a good questionnaire. Corrections such adding open ended questions and more statements on the Linkert scale were done.

3.9.2 Trustworthiness

To ensure trustworthiness in every qualitative study the research findings should as truthful as possible. Trustworthiness can be described using concepts such as credibility, dependability, transferability and confirmability (Johnson & Goettsch, 2000). In this study, trustworthiness was achieved by endeavouring to give a clear and distinct description of the research context, selection and characteristics of respondents, data collection as well as the procedure for data analysis. In qualitative research, the concepts such as credibility, dependability and transferability have been used to describe various aspects of trustworthiness (Patton, 1987). Credibility is involved in establishing that the results of the research are believable. It depends on the richness of the data gathered. In this study, credibility was achieved through the use of various methods for data collection. Dependability ensures that the research findings are consistent and could be repeated. This implies that each process to be used can be described in detail so that further research on the same subject can yield similar results. In this case, dependability was ensured through inquiry audit. Transferability refers to the degree in which the research can be transferred to other contexts and in this study it was achieved through random sampling and thick descriptions. This was done to show that the research findings can be applicable to

other contexts (similar phenomena, population, circumstances and situations). Confirmability refers to the degree to which the results of an inquiry could be confirmed or corroborated by other researchers (Barxter & Eyles, 1997). Confirmability ensures that there is a degree of neutrality in the research findings and in this study it was achieved through ensuring that findings were based on participant's responses and not on any potential bias or personal motivation. Generally, trustworthiness in this study was achieved through giving a clear and distinctive description of the research context, selection and characteristics of the participants, data collection as well as the procedure for data analysis.

3.10 Data collection Procedures

In order to collect data the researcher got ethical clearance from the ethics committee at the University or Zambia and consent from the relevant authorities was sought. Permission was sought from the Assistant Dean Post Graduate in the School of Education. This was done in order for the researcher to be given permission to freely interact with the selected respondents without abrogating any protocol. Consent was also sought from all participants. The researcher first administered questionnaires to the grade twelve (12) learners from the four (4) secondary schools in Lusaka district. This was followed by conducting semi-structured interviews to the physics teachers of the selected grade twelve (12) learners from the four (4) selected secondary schools in Lusaka district. There after the researcher observed the physics lessons of the interviewed physics teachers using the lesson observation instrument. Then lastly, interviews were conducted for subject specialists from ECZ and CDC as well as the standard officer. Interviewing subject specialists and the Standards officer was done last to enable the researcher to gather more insight about what would have been observed during the physics lessons.

3.11 Data Analysis

Data analysis is the process of examining what has been collected in a research and making deductions and inferences. Kombo and Tromp (2006) indicated that data analysis involves uncovering the underlying structures, extracting important variable, detecting anomalies and testing assumptions.

3.11.1 Qualitative data

The qualitative data collected from interview and lesson observations was analysed using seven steps. According to Sjostrom and Dahlgren (2002) qualitative analysis involves seven (7) key steps which are, familiarisation, compilation of answers from respondents, condensation or reduction, preliminary comparison or classification, naming of categories and constructive comparison of categories. During familiarisation the researcher read through all the collected data so that data is easily understood and corrected by getting back to the respondents or recorded data. Compilation of responses from participants was next and at this stage vital responses were considered. At the condensation stage the researcher endeavoured to reduce individual responses by finding the vital aspects of the responses. Preliminary stage involved grouping or classifying responses that sounded familiar then coding was followed and the last step was contrastive comparison of categories where the description of each character of each category and similarities between categories was done in order to come up with similar emerging themes. Creswell (2009) explained that qualitative data collected from interviews and lesson observations shall be analysed from the seven (7) steps and can be coded into emerging themes and grouped into categories.

3.11.2 Quantitative Data Analysis

Quantitative data was collected using questionnaires and analysed through descriptive statistics and emerging themes. Frequencies, percentages, means and standard deviation were used. The quantitative results were compared with qualitative results before the conclusion was made.

3.12 Ethical Considerations

The term ethics or ethical means principles of conduct that are considered correct especially those of a given profession or group (Kumar, 1996). Certain behaviour in research such as causing harm to individuals, breaching confidentiality, using information improperly and introducing bias are unethical. For this reason ethical clearance was obtained from the ethics committee of the University of Zambia before going out for data collection. Responses in this study were treated with maximum confidentiality as the data was used purely for academic purposes. Since the researcher used interview schedules as one of the instruments for data collection care was taken when dealing with sensitive questions and participants were exposed in

anyway. Consideration was extended to the following informal consent, and anonymity and confidentiality.

3.12.1 Informed Consent

Informed consent is the communication between the researcher and the respondent. Informed consent was sought from respondents by informing them what the study was all about and their benefits in participating. This guided the respondents to decide on their own whether to participate in the study or not (Cohen et al, 2007). Permission was sought from relevant authorities such as the directors of ECZ and CDC in order for the researcher to have access to subject specialists. Permission was also sought from DEBS for Lusaka district in order for the researcher to freely interact with teachers of physics and the pupils in selected secondary schools in Lusaka district as well as the standards officers.

3.12.2 Anonymity and Confidentiality

All respondents were told not to write any name on the research instrument for names of respondents or schools have been mentioned in the study. Every response concerning the study was treated with high level of confidentiality and was used only for the purpose of the study but the researcher revealed her full identity to them. In any research study, the researcher is charged with the duty of ensuring that the privacy of research participants is guaranteed and upheld (Patton, 2002). This is done to make sure that participants are not easily identifiable in a research project and as a way of minimizing any repercussions on the participants in light of the results from any study, particularly when the results lead to some controversial and sensitive findings.

3.12.3 Reciprocity

Reciprocity refers to the researcher- participant relationship where a symbiotic relationship is expected. It is a form of compensation where the participant devotes their time and effort to shape the researchers study. The issue of whether or not to compensate research participants in cash or kind as a way of reciprocity is controversial because compensation can affect the level and quality of data (Patton, 2002). For this study the researcher ensured that no compensation was given in order to avoid compromising the research data.

3.13 Summary

The chapter covers discussion on the methodology that was used in this study. The paradigm which was used is the mixed method while the design is the embedded design. This design enabled the researcher to collect and analyse both quantitative and qualitative data. The sample size was 168 participants. The sampling technique used was both purposive and simple random in order to carter for both quantitative and qualitative data. The researcher took care of necessary ethical considerations.

CHAPTER FOUR: PRESENTATION OF FINDINGS

4.1 Overview

This chapter presents the findings of the study. These results are based on the data that was collected from all the respondents. The chapter begins by giving demographic details of the participants before presenting the findings of each research question. A number of themes emerged from the data that was collected and were aligned as answers to each research question.

4.2 Demography of respondents

This is a brief demographic description of the subject specialists from CDC and ECZ, Standards Officer from the Ministry of Education, Director from National science Council, physics teachers from selected secondary schools and learners of physics. Specialists and teachers information was presented in form of gender, qualification and years of service. Each of these items is presented, discussed and an explanation is given as to why the information was relevant to this study. The demography about the learners was presented as gender and age only.

4.2.1 Subject specialists

The researcher interviewed four subject specialists. One specialist was from CDC who is the Head of Department for Natural Science, from ECZ the physics subject specialist was interviewed and from Ministry of General Education the Standards Officer Natural Sciences. All the officers interviewed were male and it came to the researcher's knowledge that all the specialists were former science teachers who had taught physics content before. All the specialists had been in their respective positions for more than five (5) years indicating that they had sufficient experience to competently give reliable information about secondary school physics. Efforts to interview the Director for National Science Centre proved futile but instead one Liaison Officer was interviewed in his place.

4.2.2 Physics Teachers

From the six teachers of physics who participated in the study, five were male and one was female. Five of the teachers were diploma holders from different

colleges of education and only one was a graduate from the University of Zambia. As regards to their teaching experience, all five teachers with diplomas had taught for more than ten years while the teacher with a degree had only taught physics in secondary school for four years. This shows that all the teachers who participated in the study had sufficient interaction with physics content and the experience was also sufficient. Table 4.1 shows a summary presentation of percentage distribution of teachers by gender, qualification and work experience.

Table 4.1 Percentage distribution of teachers by gender, qualification and work experience

Characteristic	***f***	**(%)**
Sex		
Male	05	83.3
Female	01	16.7
Qualification		
Diploma	05	83.3
Bachelor's Degree	01	16.7
Experience		
More than 15 years	02	33.3
More than 10 years	03	50
Less than 10 years	01	16.7

4.2.3 Learners

This study targeted grade twelve learners and one hundred and sixty pupils were sampled (160). Out of the hundred and sixty (160) pupils, one hundred and fifty-eight pupils participated by completing the questionnaires thus giving a completion rate of ninety-five percent (95%). The demographic information of pupils was analysed in terms of gender and age as shown in table 4.2

(a) Gender

Almost an equal number of boys and girls participated in the study at forty-eight point seven percent (48.7%) and fifty-one point three percent

(51.3%) respectively. Table 4.2 shows the percentage distribution of learners who participated in the study by gender.

Table 4.2 Percentage distribution of learners by gender and age

Age	**Male (n=78)**		**Female (n=80)**		**Total**
	f	%	*f*	%	
15	02	2.6	nil	Nil	02
16	06	7.7	10	12.5	16
17	18	23.1	20	25	38
18	15	19.2	28	35	43
19	17	21.8	22	27.5	39
20	10	12.8	nil	Nil	10
21	03	3.8	nil	Nil	03
22	05	6.4	nil	Nil	05
23	01	1.3	nil	Nil	01
24	nil	Nil	nil	Nil	Nil
25	01	1.3	nil	Nil	01
Total	**78**	**100**	**80**	**100**	**158**

Table 4.2 indicates that most of the learners were between the ages of 17 and 19. This is an indication that many learners are completing their grade twelve (12) within the right age of 17 or 18. In Zambia, a child is enrolled into grade one (1) at the age of six (6) or seven (7) and he or she is likely to finish secondary education at the age of eighteen (18) or nineteen (19) respectively. Being of the right age in grade twelve (12) gives an indication that the learners are at the right cognitive level to comprehend concrete and abstract knowledge in physics and other subjects. The percentage distribution of learner's gender was 51.3% was female and 48.7% male which indicates that there was almost equal representation by gender.

4.3 Pilot Study

The pilot study was done amongst twenty (20) grade twelve (12) learners at one secondary school in Kitwe district. This was done to assess the validity of the research instrument. The pilot study enabled the researcher to find out whether the research instrument, the questionnaire, was measuring what it was supposed to measure. Also to find out whether the questions could provoke a response as well as to check for clarity of the wording if different participants could interpret the questions in a similar manner. The pilot findings indicated that the questions asked were adequate to an extent that learners were able to give the reasons why physics is perceived as a difficult subject. The pilot study also revealed that the questionnaire did not include the open ended questions and therefore amendments were made to the questionnaire. The numbers of statements in the Likert scale were increased so as to allow a clearer response from the learners.

4.4 Research Findings

As mentioned in chapter three, the research followed a mixed methods design specifically the embedded design where qualitative approach dominated while the quantitative approach was used to add detail to the data. It should also be noted that the research instruments that were used had similar questions in both the questionnaires and interview schedules in line with the study objectives in order to collect data on the same topic from different respondents. The researcher identified themes in relation to the research objectives as well as recurrent patterns in the opinions of the study participants and analysis was done using SPSS for quantitative data.

The findings from the teachers were presented alongside those from the subject specialists interviewed. Actual words said by respondents were used as much as possible in the descriptions, while other words have been paraphrased. It is important to note that some ideas presented were interrelated and could fall into more than one thematic section. Both qualitative and quantitative data sets were presented side by side.

4.4.1 Learner's Perception of Physics

Research question one sought answers from the learners and the teachers on why learners in secondary schools perceived physics to be a difficult subject. The research question was as follows;

Why did secondary school learners perceive physics to be a difficult subject?

In order to answer this question, the researcher saw it fit to first have an understanding from the learner's perspective of why they perceived physics to be a difficult subject. To address this, information was sought from learner's questionnaire under section A.

Grade twelve learners were asked to indicate on the Likert scales ranging from strongly disagree to strongly agree as a way of establishing their views on the perception of physics as a subject. The Likert scale statement for which views were given by the learners was *"I do not answer questions in class because I do not understand physics"* The learners responses are summarised in table 4.3.

Table 4.3 Percentage distribution of learner's perception of physics

	f	%	*Cumulative %*
Strongly disagree	31	19.6	19.6
Disagree	06	3.8	23.4
Neutral	16	10.1	33.5
Agree	56	35.4	68.9
Strongly agree	49	31.1	100
Total	158	100	

The responses from the learners showed that a high percentage, 66.5% of the learners were in agreement to the fact that they did not understand physics. The high percentage showed that there was a strong negative perception of physics among secondary school learners. Despite perceiving physics to be a difficult subject, some of the learners indicated that they liked physics the most among all science subjects and they represented twenty three point five percent (23.5%). Forty two point two percent (42.2%) indicated that they did not like physics while thirty four point three percent (34.3%) remained neutral. This prompted the researcher to inquire the

reasons why the learners perceived physics to be a difficult subject and various reasons were given.

4.4.2 Reasons why Learners Perceived Physics to be a Difficult Subject

When learners were asked why they perceived physics to be a difficult subject, 42.3% responded that they found physics to be difficult because their teachers said that physics was not easy. 34.2% said that they found physics to be boring while 23.5% said that they just did not like the subject. The percentage presentation of the reasons why learners perceived physics to be a difficult subject has been presented in figure4.1.

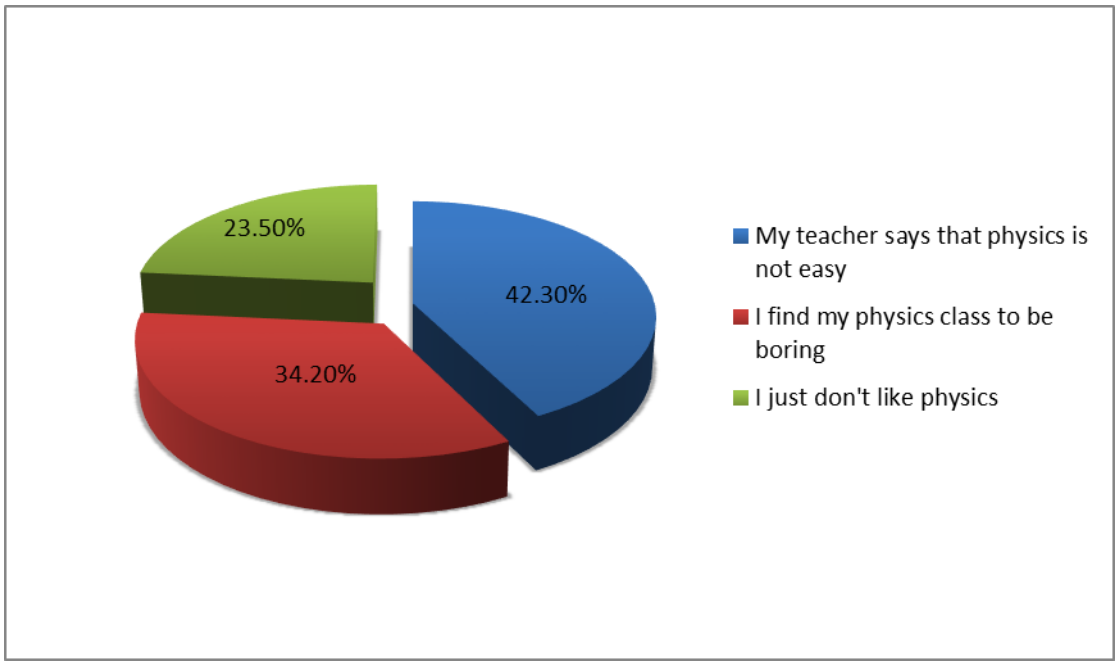

Figure 4.1 Reasons why learners perceived physics to be a difficult subject

The results showed that learners had different reasons for perceiving physics to be a difficult subject but the effect was the same. Learning is supposed to be an interesting activity therefore the fact that some learners found the subject boring was worrisome. The learners could also have been affected by what their teachers said about the subject.

When teachers were asked why learners perceived physics to be a difficult subject, their responses were very different from the learner's responses. One of the teachers said that;

It is not just perception that physics is difficult to the learners the truth of the matter is that physics is truly difficult to the learners.

Another teacher responded that,

The learners come to the physics class already defeated as a result they cannot understand anything. They are already filled with misconceptions about physics and there is very little us teachers can do to change their way of thinking.

In addition, some teachers told the researcher that the learners were not prepared to learn science especially physics due to the environment from which they came from. When probed further one teacher said that;

Some of the learners we teach have got no motivation to learn science as such subjects like physics are no match for them. They come from environments were innovation is not encouraged and the benefits of education are not visible so subject like physics are seen as too much trouble for them.

When the specialists from CDC and ECZ were asked the same question as to why learners perceived physics to be a difficult subject, there responses were totally different from the teacher's responses. One of the specialists said that learners perceived physics to be difficult because of the teacher's attitude. He lamented that;

Most teachers make physics to be difficult for the learners as a result the learners never get to experience the real joy of interacting with physics knowledge.

This statement by the specialist was in agreement with the findings from the learner's responses. As presented earlier, forty-two point three percent (42.3%) of the learners cited their teacher's remark that physics was a difficult subject as a reason why they perceived the subject to be a difficult. The teachers are supposed to be facilitators who spur their learners to like the subject they teach but the result indicated something different.

4.4.3 Common views about Physics among Learners

Using an open ended question in the learner's questionnaire (appendix 5) the researcher found out that learners had common views that they shared amongst themselves and some of the views included the following;

Physics should only be taken by those who want to pursue physics related courses in future.

This view was expressed by 17.6% of the learners. The view that drew the most responses was reflected in the statement that;

> *To pass physics is just by luck and not by studying because it is too complicated.*

This view was given by 41.8% of the learners. Then this was followed by 23% of the learners, who said that,

> *Physics is only understood by those who are naturally intelligent.*

While 16.7% was shared by those who said that,

> *Even teachers who teach physics did not pass the subject as well as physics should be left as an option after all it does not appear on the result transcript*.

The open ended question allowed the learners to give their own view other than what was presented by the statements from the likert scale. The outcome was that the common views about physics showed consistency in the learner's responses.

4.5 Summary of results on why secondary school learners perceived physics to be a difficult subject

The purpose of this section was to present results to answer research question one. Overall, results indicated that learners perceived physics to be a difficult subject because they did not understand the subject. Results showed that learners perceived physics to be a difficult subject due to a lot of reasons but lack of understanding was the major reason given by most learners. The other reason given by the learners was that teachers told them that physics was a difficult subject and only learners who were considered to be intelligent could understand it. On the other hand teachers explained in so many ways that physics being difficult to the learners was not just perception but that it was truly difficult to them. In the next section, results based on research question two will be presented.

4.6 Learner's Perception of Physics in Relation to their Performance

In this section, results to answer research question number two which sought information from secondary school learners, teachers, curriculum specialist and standards officer on the effects that perception had on the learner's performance was presented. The question was framed on the premise that perception of the subject by

the learners would have a positive or negative effect on their performance. It was therefore important to assess the effect of perception of physics as a subject by the learners on their performance in the subject and the question was stated as follows; *what effect did the learner's perception of physics have on their performance?*

4.6.1 Learner's Performance in Physics

The learners performance in physics in relation to perception were as shown in the frequency and percentage Table 4.4. The results in Table 4.4 show that learners strongly disagreed, disagreed, neutral, agreed and strongly agreed to statements that described the effect of their perception of physics as a difficult subject on their performance. This indicated that the learner's felt that the perception they held of physics as a subject contributed to how they had been performing in the subject. These results show a skewing of high percentage towards strongly agreeing and agreeing.

Table 4.4 Learner's performance in physics in relation to their perception of the subject

Statements	**Strongly Disagreed**		**Disagreed**		**Neutral**		**Agree**		**Strongly Agreed**	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
I don't perform well in physics because I don't like the subject	5	3.2	6	3.8	15	9.5	68	43	64	40.5
No matter how much I study, I never pass physics	11	7.0	20	12.7	31	19.6	40	25.3	56	35.4
O-level physics is not meant for everyone	15	9.5	20	16.5	35	22.2	35	22.2	47	29
I perform poorly in physics because my teacher says it is difficult	14	8.9	11	7.0	20	12.7	43	27.22	70	43.3
I don't care										

about physics because I have no use for it	42	51.9	47	29.7	21	13.3	4	2.5	4	2.5

As a response to the common reasons for poor performance in physics some of the learners expressed that no matter how much they studied, they never passed physics. The percentage of those who agreed to that stood at sixty point seven (60.7%). Learners also agreed to the statement that physics is not meant for everyone representing fifty-one point five percent (51.5%). Learners indicated that the reason why most of them performed poorly was because their teacher told them that physics was a difficult subject and the responses of the learners who strongly disagreed were 8.9%, disagreed 9.0%, neutral 7.0%, agreed 44.3% and strongly agreed 30.9%. Figure 4.2 was summarised by adding percentages for strongly disagreed and disagreed giving 17.9% for agreed and strongly agreed 75.1% while the response for neutral was at 7.0%.

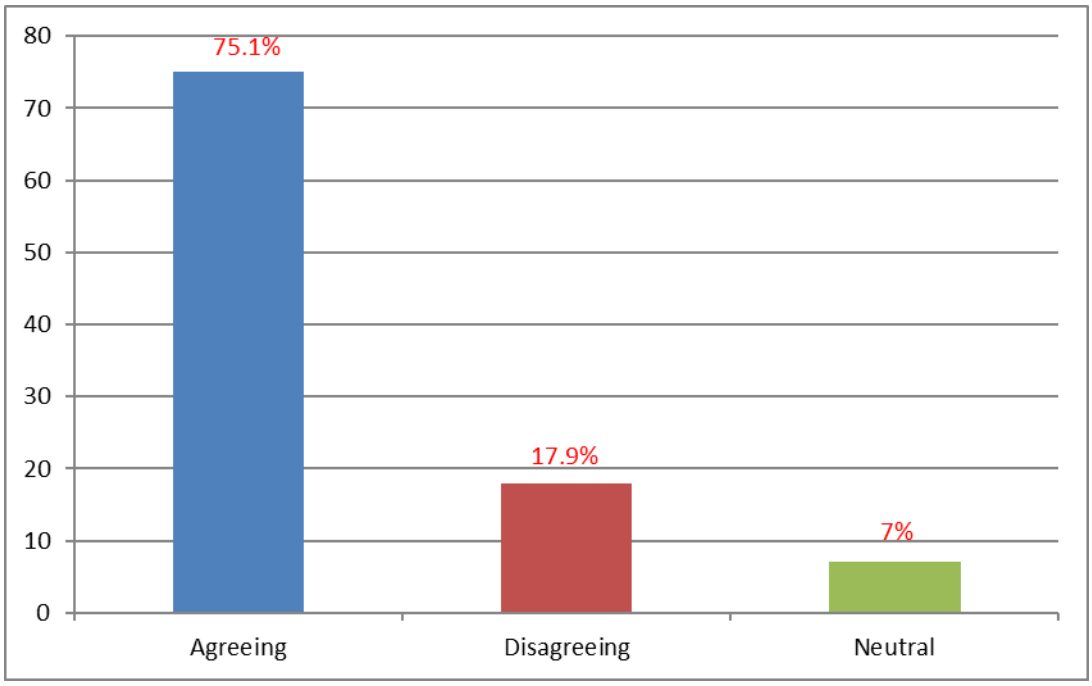

Figure 4.2 Percentage distribution of the learners affected by poor perception of physics.

From the open ended questions learners expressed that they performed poorly in physics due to a number of reasons that reflected their perception while others pointed to the way teachers taught the subject. The responses included the following,

(a) *Physics is for smart learners' and if you are not smart you cannot pass (41.7%).*

(b) *The questions which are brought during tests are different from what we learn in class that's why we do not perform well (24.3%).*

(c) *Teachers teach difficult things which are not in the text books so there is no chance of passing (18.9%).*

(d) *The physics notes are difficult to understand unless someone is able to explain (11.1%).*

(e) *Teachers do not simplify the information they just teach exactly the way it is in the text book (4.0%).*

The learner's views seemed to represent their perception of physics and it also revealed that what they thought affected their performance in relation to how they were taught. In order for learning to take place the right attitude from the learner and the teachers is cardinal. In this case it seems like the learners were demotivated even before they learned the subject and that there was a problem with the way physics was taught.

When teachers were asked to explain whether perception affected the learner's performance, one of the teachers told the researcher that,

> *The learners are not just serious with their studies and that most learners in government schools have a low cognitive level for learning physics. They prefer to believe their peers who encounter problems with physics than to come to class with an open mind.*

Another teacher said that,

> *Learners minds are saturated with illicit activities as a result physics content does not settle well with the learners.*

It appeared as though the teachers did not favour the fact that perception of physics as a difficult subject by the learners contributed to the learners performed in the subject.

However, these sentiments did not settle well with the curriculum specialists and one of them said that

> *It seems like teachers are out of touch with what they are supposed to do.*

Another specialist said that,

> *Teaching physics in an abstract manner is the reason why learners find problems with physics. There is tendency by the teachers to explain concepts theoretically even when they can demonstrate phenomena to the learners.*

He went on to explain how the perception affects performance of learners by stating that,

> *Studies have shown that perception is an important determinant of learner's behaviour and understanding. If learners have a negative perception of a subject their performance will be poor but if their perception is positive their performance will be excellent. It will be unfair to the learners if teachers down play the effect of perception on the learner's performance.*

However, the specialist did not cite any author to substantiate his statement. There were contradicting views that were given by the learners, the teachers and the specialists about the effect of perception on performance of the learners hence it came out as a blame game activity. To gain more information about the different positions taken by the specialists, teachers and the learners, they were further asked to rate the statements on a five point likert scale on how they viewed learning of physics.

4.6.2 Learner's Views about Learning of Physics

The learners were asked to state whether they valued the learning of physics as a subject. Using the five points likert scale from the learner's questionnaire, learners were requested to rate themselves on the extent to which they valued the learning of physics. The statement was stated as follows *I do not care about physics because I have no use for it* and Fifty point one percent (50.1%) strongly disagreed; thirty-one

point three percent (31.3%) disagreed while fourteen percent (9.4%) remained neutral. Only a small percentage of the learners agreed to the above statement and this was represented by nine point two percent (9.2%). Figure 4.3 represents a summary of learner's perception about learning of physics.

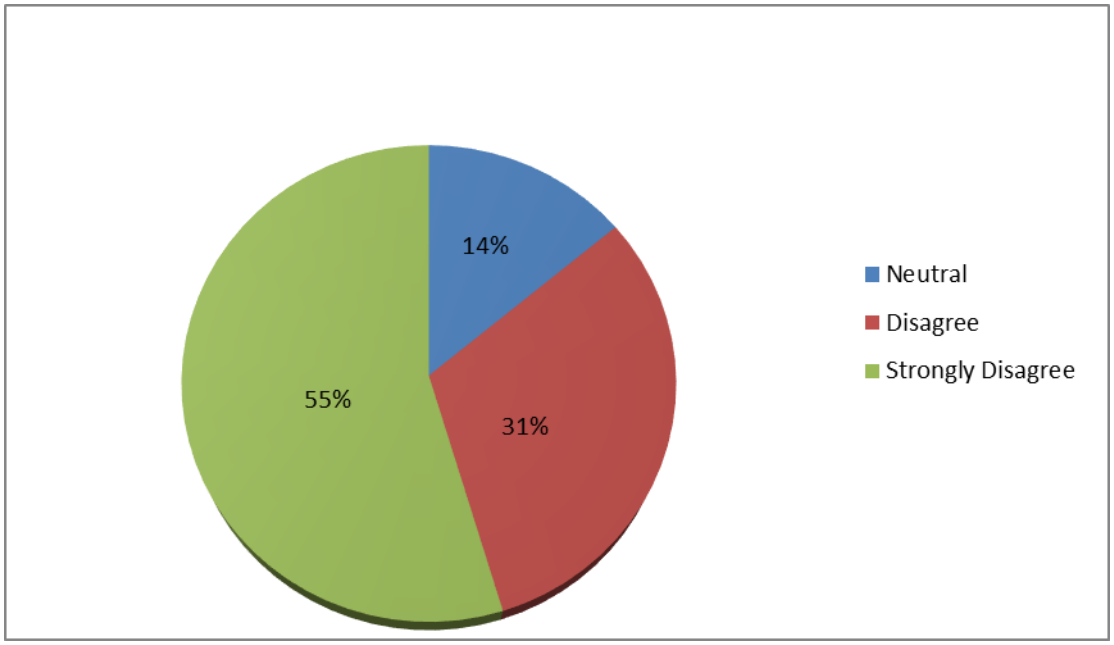

Figure 4.3 Percentage distribution of learners views about physics

The researcher was able to find out that despite learners having a poor perception of physics, they were aware that it was important to learn physics.

However, when teachers were asked about the learner's perception about the importance of learning physics, the teachers told the researcher something different. They explained that learners were not aware of the importance of physics knowledge in their lives that is why they performed badly. As such, one of the teachers said that,

> *The children we teach do not appreciate learning physics and it is much worse if you go to class after the Religious Education lesson. They visibly show that you are not wanted and we struggle to put them in the mood that is why they perform poorly in the subject.*

Another teacher told the researcher that,

Learners take the learning of physics as a bother because as physics teachers we are not even liked by our learners.

On the same question, another teacher responded that,

The learners we teach would be glad not to have physics on their timetable because they take it as a burden. This is evidenced by the way they become gloomy when you enter the class much worse if you go in immediately after religious education.

On the other hand, when the physics specialists were asked the same question, they explained that,

Teachers make physics to be very remote and yet it is content that learners interact with on a daily basis how can they not want to learn it.

He went on to say that,

It is this situation that makes learners to perceive physics to be a difficult subject.

Using the lesson observation schedule (appendix 6), the researcher observed a lesson on Mutual Induction. It was noticed that learners could not come up with any example of a transformer other than the one found in the ZESCO substation and yet they use cell phone chargers every day without knowing how they operate.

As a follow up question to how learners viewed learning of physics, one of the teachers revealed that sometimes learners referred to the outcome of an experiment as magic. He cited an example on the experiment on centre of mass and how objects balance once the centre has been established. He said that,

It is very frustrating because instead of the learners demonstrating behavioural change all they do is to start clapping as if it was the end of a magic show.

However, the lesson observed on the material day was theoretical not even a teaching aid was displayed and the cell phone charger was mentioned out of frustration when the learners failed to mention it as an example of a transformer.

4.7 Summary of results on what effect perception has on the learner's performance

The findings of this study revealed that most of the learners who participated in the study thought that their perception about physics affected their performance and this is reflected in figure 4.3. Most of the learners who participated in the study said that no matter how much time they spent studying physics, their performance did not improve. A good number also said that physics is not meant for everyone that is why they perform poorly. The teachers gave the view that the learners performed poorly not because of poor perspective but because they lacked proper focus. The specialists explained that the difficulties the learners were facing with physics were because the teachers presented physics to the learners in an abstract manner and made physics to appear too remote. The learners revealed that they were aware of the importance of learning physics while the teachers told the researcher that the learners were not aware of the importance of learning physics. This chapter revealed a blame game between the teacher's views and the learner's views as well the views of the specialists. The next section will be outlining the results related to research question number three, on how the designing of the Physics curriculum could have been part of the O-level Physics challenges faced by the learners.

4.8 O-Level Physics Curriculum Design

It is clear from the responses obtained so far that there is a blame game going on as far as the poor performance of the learners in physics is concerned. In order to gather more information attention was directed to the curriculum designing of physics and the role it played in this physics problem.

How did the curriculum design affect learner's comprehension of the subject?

In order to investigate research question number three (3), the researcher wanted to find out what the learners performance was generally. The information was sought mostly from the learners, teachers, standards officer and subject specialists. Using a five point Likert scale learners were asked to give their views by responding to different statements in the learner's questionnaire in appendix 5. The statements were designed to get the views of the learners on the curriculum design and its effect on their performance.

4.8.1 Effect of topic coverage on the Learner's Comprehension of Physics.

Learners where asked to give their views about the effect of the number of topics in the syllabus on their comprehension of physics. The views were to be given by strongly disagreeing, disagreeing, remaining neutral, agreeing or strongly agreeing to the statement that "*I do not perform well because physics has too many* topics". Twenty-six (26) learners strongly disagreed, twelve (12) learners disagreed, twenty-one (21) learners were neutral, fifty (50) learners agreed and forty-nine learners strongly agreed. Figure 4.4 shows a percentage distribution of the learner's responses.

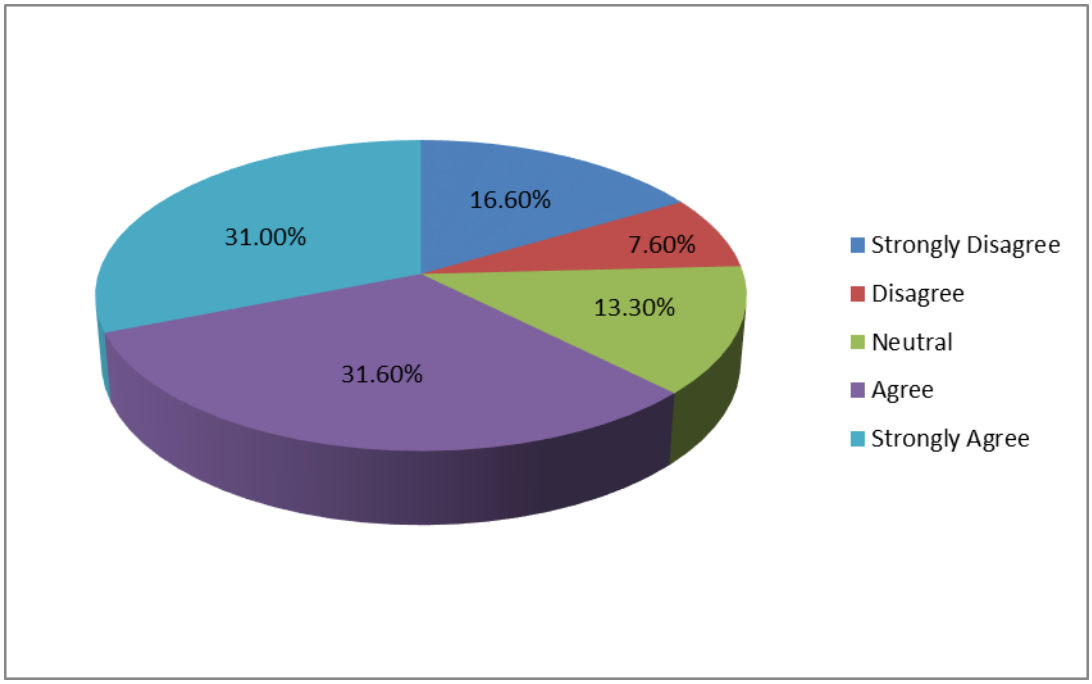

Figure 4.4 Percentage distributions of learners who agreed that physics had too many topics

The Likert scale further showed that learners overwhelmingly agreed to the statement that **"***physics had a lot of challenging topics*". The percentage of the learners who either strongly agreed or agreed put together gave eighty percent (80%).

The results showed that learners were overwhelmed by the number of topics they had to learn and probably not related to each other. The results also revealed that the learners found most of the topics challenging. These findings prompted the researcher to seek information from the teachers of physics.

When teachers were asked whether the physics syllabus had too many topics all the teachers interviewed agreed. The teachers agreed that physics has too many topics as well as that some topics were challenging to the learners. One teacher said that,

> *There are too many topics in the syllabus which are not even relevant to the learners.*

When asked to give an example the teacher said that,

> *Topics like kinetic theory of matter are too long and the content which is there can be learnt in biology and chemistry. Diffusion and evaporation are repetitions and this is what causes confusion in the minds of the leaners as there is a slight difference in the way it is presented in each subject.*

Another teacher expressed that instead of teaching for understanding teachers teach to finish the syllabus. The teacher said that,

> *The standard officers are only concerned with syllabus completion and not the learner's comprehension of the content and besides the numbers we deal with are too big as such all we do is to ensure that we complete all the topics for the term to avoid exculpation.*

The teachers also said that,

> *We are always in the catch up mode as there are too many interruptions in the course of the term which hinders syllabus completion.*

On the other hand the subject specialists had a different view about the syllabus of physics. One specialist said that,

> *Syllabus coverage of secondary school physics is adequate. It is just that there is a gap in the way government teachers handle the syllabus completion. Physics teachers in private schools and grant aided schools complete the syllabus in grade eleven (11) while government teachers let learners write their final examination without covering all the topics which is very unfortunate.*

According to the specialists lack of syllabus completion is what affects the learner's comprehension of the subject and not the number of topics. The topics aligned were adequate for the three year period allocated.

When the standards officer was asked about the effect of the length of the syllabus on the learner's comprehension of the content he said that,

Teachers are always looking for someone to blame for their failure to perform according to stipulated standard. There is a paradigm shift in the way the syllabus is covered and this is being covered during continuous professional development in all the clusters and the syllabus is organised at provincial level and we track the way teacher's progress during the term.

According to the standards officer the topics are adequate for the stipulated time. He said that,

Three years was adequate to cover all the outlined topics.

And when he was asked to comment on the level of difficult, he explained that,

The content is of the correct level and there should be no problem with the comprehension.

The views given by the specialists further revealed how much they put the blame on the teachers for all the difficulties the learners where facing. It was as if the standards officer and the curriculum specialists had their minds already decided about whom to blame for the learners poor performance in physics. It is not surprising that the curriculum specialists went all out to defend the syllabus since it was their own creation.

4.8.2 Sequencing of Physics content

To find out the views about the way physics topics were sequenced, the researcher asked the learners to give their views by strongly disagree, disagree, neutral, agree, or strongly agree to the following statement *"physics is confusing because it has many different skills in one topic".* The findings were that eighteen (18) learners strongly disagreed, thirteen (13) learners agreed, fifteen (15) chose to be neutral, eighty-eight (88) agreed and twenty-four (24) strongly agreed. Figure 4.5 Percentage representation of the learner's responses.

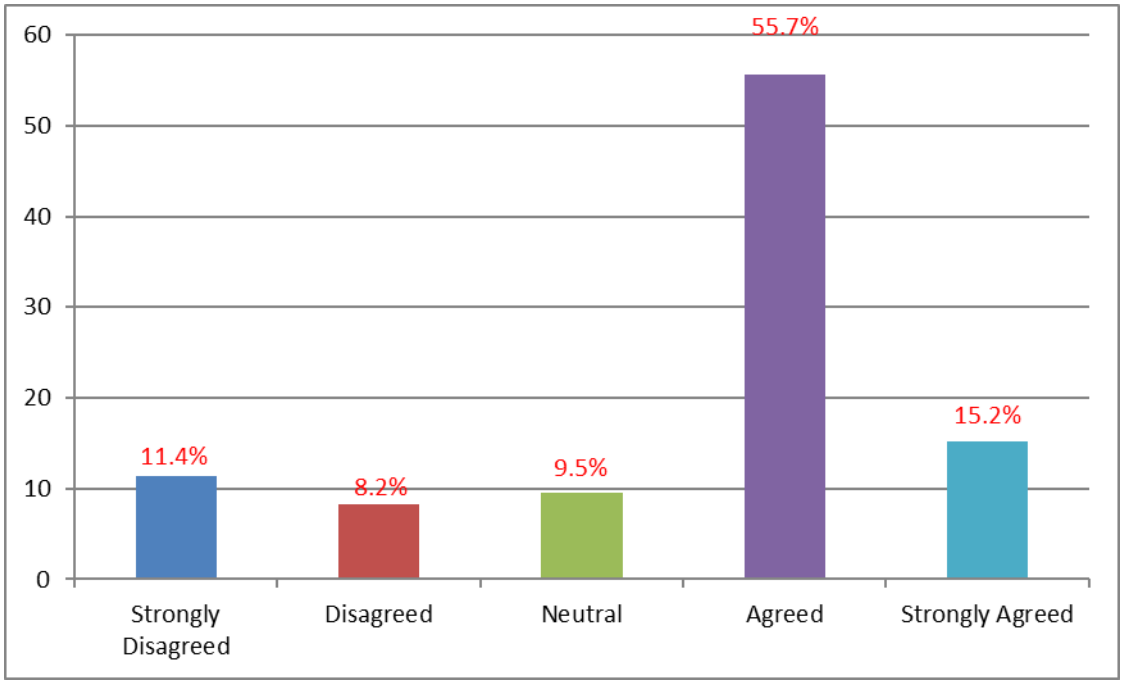

Figure 4.5 Percentage distribution of the learners who said that physics was challenging because it had different skills.

The learner's views showed that the way topics were sequenced affected their comprehension. One learner complained that,

> *Physics learning required us to know calculations, graphing techniques, and experiments as well as note taking this is too much to know in one subject.*

When the teachers were asked to comment about the sequencing of physics content, one of the teachers said that,

> *It is challenging for the learners to master note taking, plotting of graphs, formulas as well as experiments. My experience is that some learners will be good at calculations but face challenges in topics that require explanations.*

Another teacher told the researcher that sequencing of physics content had an effect on the learner's comprehension of physics. The teacher said that,

> *Topics are not always from simple to complex for example, the syllabus requires learners to learn about gas laws which have an aspect of pressure while the syllabus for physics (science) does not include pressure.*

When the specialists were asked about the sequencing of topics, their responses were different from the teachers and learners. As far as they were concerned, the topics were well sequenced and it was from simple to complex. One specialist said that,

> *Topics are sequenced in such a way that one topic is prerequisite to the next topic.*

He went on to say that,

> *Physics content is arranged in a logical manner and it is relevant in our everyday life as it has a lot of applications.*

Another specialist explained,

> *That teachers were part of the process of curriculum designing and I see no reason for them to condemn their failures on this fine document.*

According to the specialists, teachers were part of the curriculum designing and there was no reason for the teachers to blame the curriculum designing for the learner's lack of comprehension of physics content during the process of teaching and learning. However, there was a difference in the responses from the teachers to those of the specialists and there was no indication from the teachers that they were part of the curriculum development process.

4.9 Summary on the effect of the curriculum designing on learner's comprehension of Physics

The purpose of this section was to present the results on *how the physics curriculum design affected learner's comprehension of the subject.* The findings presented revealed that learners said that some of the challenges they have with physics are due to the fact that the Physics syllabus was too long and that they were required to master different skills in one topic. The teachers also said that some of the challenges the learners had was because of the way topics are aligned in the syllabus and that some of the topics were unrelated as a result learner's comprehension was affected. On the other hand, the specialists did not agree to the fact that the curriculum design posed challenges to the learners and they attributed all learners' challenges with Physics to the way teachers presented Physics to the learners. The speculations raised by the specialists about teachers contributing to the challenges learners were having with physics will be addressed through the results presented in the next section.

4.10Teacher's Pedagogical Content Knowledge

As alluded to in the last section, Physics specialists attributed learner's challenges with physics to the way teachers presented the subject to the learners. It should be noted that knowing and understanding Physics is different from having the skill to effectively make the learners acquire desirable knowledge and skills. The teacher with pedagogical content knowledge can convince the learners that the knowledge and skills contained in Physics are actually usable in real life. Therefore, this section presented results on the pedagogical content knowledge of the Physics teachers with reference to question four which read as follows;

How did teacher's pedagogical content knowledge affect learner's performance in secondary school physics?

To get information from the learners the researcher used a Likert scale in the learner's questionnaire which had several statements which expressed views about the teacher's pedagogical content knowledge. Table 4.5 shows the frequency and percentage distribution of the learner's responses.

Table 4.5 Frequencies and Percentage distribution of learner's responses from the Likert scale about teacher's Physics PCK

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
My teacher does not explain difficult terms	17 (10.8%)	17 (10.8%)	16 (10.1%)	69 (43.9%)	39 (24%)
My teacher does not connect what we learn to everyday life	24 (15.2%)	28 (17.7%)	9 (5.7%)	70 (44.3%)	27 (17.1%)
Physics is too theoretical	18 (11.4%)	14 (8.9%)	32 (20.3%)	59 (37.3)	35 (22.2%)
The teacher's attitude is very discouraging	24 (17.7%)	14 (8.9%)	13 (8.2%)	54 (34.2%)	49 (31.6%)
My teacher makes us think physics is for intellectuals	24 (15.2%)	23 (14.6%)	16 (10.1%)	50 (31.6%)	45 (28.5%)
Physics is complicated even to our teacher	40 (25.3%)	12 (7.6%)	7 (4.4%)	52 (32.9%)	47 (29.7%)

The results showed that most of the learners either strongly agreed or agreed to most of the statements that were representing views about their teacher's way of teaching. The statements covered teacher's attitude towards the learners during the process of teaching and learning physics as well as teacher's ability to make the subject simpler to the learners. The scale covered most of the statements that described aspects of teachers pedagogy for physics and the learners responses raised questions for the researcher to ask the teacher during interviews as well as what to look for during lesson observations. The learner's responses gave the researcher very important feedback about what aspects of the teacher's pedagogy affected their performance such as physics is too theoretical. This indicated to the researcher that it was likely that the teachers of physics taught physics as an information subject and therefore there was need to explore what effect it had on the learners' comprehension of physics.

4.10.1 Teacher's ability to explain scientific terms in physics

Most of the learners agreed to the statement that *the teacher had difficulties in explaining scientific terms in physics***.** Sixty- eight point four percent (68.4%) of the learners strongly agreed and agreed that teachers did not explain difficult terms in physics during the process of learning and teaching. Ten point one percent (10.1%) chose to be neutral and only twenty-one point six (21.6%) disagreed to the statement.

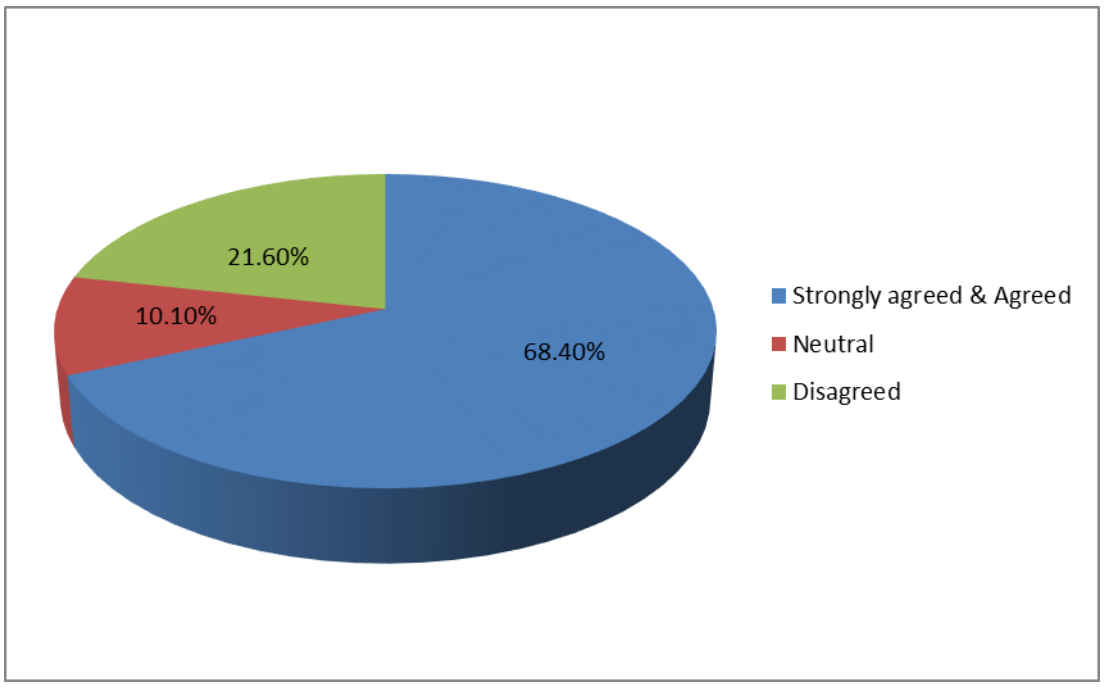

Figure 4.6 Percentage distribution of teacher's inability to explain scientific terms in physics

From the lesson observation, the researcher found out that some terms were being explained but not all of them. For example during, one lesson observation on current electricity, the teacher did not explain the difference between potential difference (**P.D**) and electromotive force (**E.M.F**) but just referred to both as voltage. During interviews with teachers one of the teachers explained that;

> *It is a waste of time to explain all the scientific terms we come across because to our learners nothing makes sense all we do is a formality. The government should think of excluding some schools like ours from taking science subjects like physics because in the end all they do is blame the learner's failures on the teacher.*

Another teacher revealed that,

> *Even if you break your back to explain in the simplest terms the learners further ask you to repeat your explanation in Nyanja, honestly, how can you achieve science education in Nyanja"?*

On the same theme the specialists confidently said that the terms that are contained in the secondary school physics content are friendly and can be adequately handled by any serious teacher of physics who has been trained.

One specialist said that,

> *The teachers of physics have been trained adequately to handle all the scientific terms that are in the content and besides all text books are accompanied by teachers hand books where the teacher can be given further guidance about the terms.*

Another specialist told the researcher that;

> *Failure to explain terms to learners during teaching and learning results from information about a certain terminology, teachers are encouraged to consult peers. It is old education where the teacher was seen to be the holder of all knowledge because knowledge is vast.*

The findings also revealed that learners strongly agreed to the statement that *"physics is complicated even to our teacher".* A total of ninety-nine (99) learner (62%) agree to the statement while those disagreeing stood at thirty-two point nine (32.9%) and four percent point four percent (4.4%) chose to remain neutral. As a response to open ended questions, one which was asked to inquire whether learners would pursue physics

beyond secondary school, the majority of the learners gave an emphatic "no" and they represented seventy six point three percent (76.3%). On the same theme, four (4) out of five (5) observed lessons showed that the teachers had some knowledge of the subject matter but the learners did not show that they had learnt something at the end of the lesson. This was evidenced by lack of learner activity that could have given feedback as indicated on the lesson observation sheet in appendix 6. However, one lesson showed that the learners had learnt something at the end of the lesson because they performed the given activity successfully and with less difficulty. The teacher also demonstrated knowledge of the subject matter in the way learners' difficulties with the topic were handled.

4.10.2 Applicability of Physics content to everyday life.

To find out information whether physics content was applicable to everyday life, the researcher used a Likert scale to find out the learner's views about this theme. The following statement was used, "m*y teacher does not connect what we learn to everyday life activities*" and the learner's responses were given as follows. Those that strongly agreed or agreed to the statement to the statement stood at forty-four point three percent (44.3%) and seventeen point one percent (17.1%) respectively and when combined it gave a total of (61.4%) of all those who are agreed that the teacher does not connect what they learn to everyday life, (5.7%) remained neutral and (32%) of the learners disagreed to the statement.

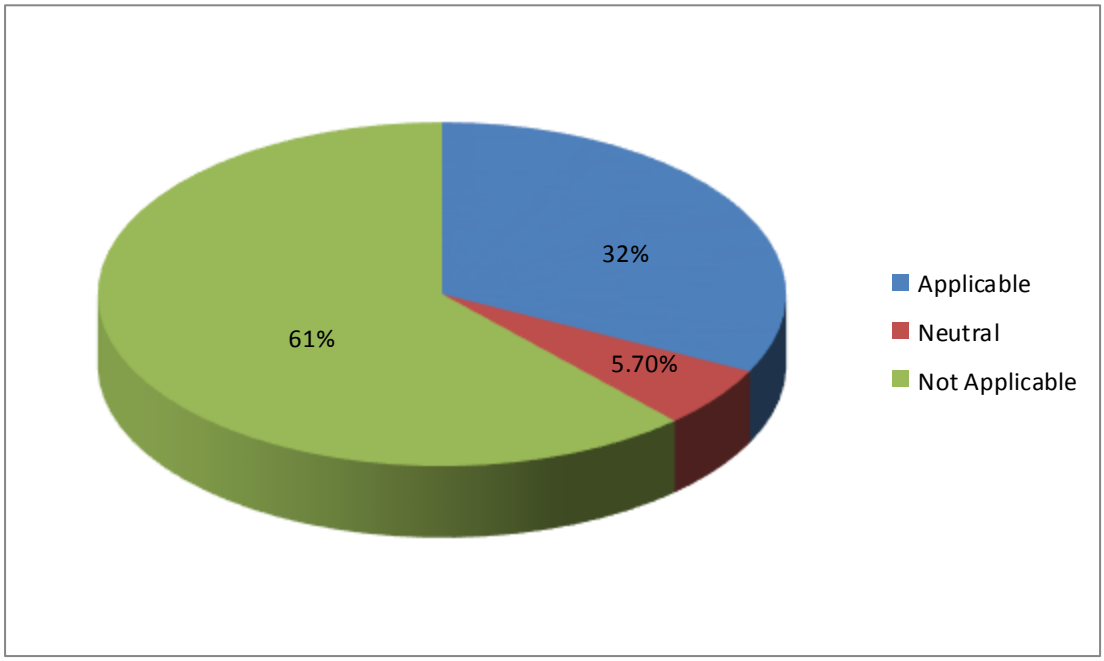

Figure 4.7 Percentage presentation of learner's views about the applicability of physics to everyday life.

Figure 4.7 Percentage distribution of learner's views about the applicability of physics

Learners were asked to give their views about how they felt Physics applied to everyday life and some of their responses were as follows;

(a) Teachers should make physics as practical as possible (49.7%)

(b) Physics is all about solving problems and nothing practical (24.4%)

(C) Teachers are supposed to help us understand what we learn in class by connecting to what we do every day (15.1%)

(d) We can only understand if we do experiments (6.0%)

(e) Physics deals with things that we deal with every day but why is it hard to understand? (3.9%)

These were some of the common responses that were given by the learners but there was one unique response from one learner who said that;

> *The problem is that from grade ten(10) to grade eleven (11), we were given a very complicated teacher who complicated things for us, but the one we have now makes physics simpler but what are we going to do about our grade ten (10) and eleven (11) topics.*

The findings from one lesson observation on calculating the cost of electricity were that, the teacher correctly applied the formula based on an example from the textbook about Singapore without making reference to the domestic calculations of energy by Zambia Electricity Supply Corporation (ZESCO) units. It was also noted that the learners did not inquire from their teacher if domestic electric energy was also calculated in the same way. Hence, when one of the teachers was asked whether they connected what they taught to everyday life activities, the teacher commented that,

> *The learners we teach are very shallow. They have no ability of connecting what we teach them to what they go through in everyday life. For example, explaining to them after the lesson to go and sensitise others about changing from using incandescent bulbs to energy savers in order to save energy, my learners refused to let go of the misconception that energy savers cause cancer, so what can you do with such learners?"*

Another teacher expressed that,

> *Our learners fail to function at the knowledge level, what more if you push them to higher levels such as application, nothing can come out of it.*

This teacher went on to say that,

> *The problem is with the process of selection to grade ten (10). Schools like ours are left with low performers while the high performers are taken to school grant aided schools and technical schools but when it comes to grade twelve (12) results they compare us using the same standards, we are not miracle workers you know.*

However, different views were expressed by subject specialists who contended that,

> *There is a paradigm shift in the way teaching is done but teachers are still lagging behind.*

The specialist from CDC went on to explain that,

> *The rationale for each lesson should be explained in order for learners to know why they are learning a certain topic before teaching.*

He gave an example on relating the electromagnetic spectrum to radio and television which they are familiar with other than just introducing the electromagnetic spectrum on its on as it may seem theoretical to the learners. He further commented that,

> *Teachers lack the art of teaching these days. All they do is follow what has been prescribed by the book without contextualising the content into what learners can identify with.*

The specialist response further exposed the blame game that was revealed between the specialists and the teachers of physics. Even if the two differing parties never sat down around one table to harmonise the differences, the findings revealed a strong stance from each end leaving no room for compromise. Like earlier alluded to, the learners seem not to have an advocate on this matter as the findings have revealed a defence pattern emerging from the teachers as well as from the specialists.

4.10.3 The Pedagogical Skill of the Teacher of Physics

A five point Likert scale presented statements that reflected teacher pedagogical skills and learners were required to rate by strongly disagreeing, agreeing, neutral, agreeing or strongly agreeing and the statements were presented in Table 4.6. The learner's responses were analysed using the mean and standard deviation and the findings revealed that learners did not have much confidence in rating the teacher's pedagogical skills.

Table 4.6 mean and standard deviation about learner's confidence in teacher pedagogical content knowledge.

Statement	n	Min	Maxi	Mean	Std. deviation
Physics is complicated to my teacher	158	1.00	5.00	3.341	1.583
My					

teacher does not explain difficult terms	158	1.00	5.0	3.6076	1.26610
My teacher does not connect what we learn to everyday activities	158	1.0	5.0	3.3038	1.35303
Physics is too theoretical	158	1.0	5.0	3.5000	1.25048
My teacher's attitude is very discouraging	158	1.0	5.0	3.5190	1.45734
My teacher makes us think that physics is for intellectuals	158	1.0	5.0	3.4367	1.42513

The standard deviation of 1.58 showed that learners had little or no confidence in the pedagogical skill of their teachers. It is worth noting that 62% of the learners said that Physics was complicated even to their teacher.

More information about the teaching skills which the participating teachers possessed was obtained through the lesson observation schedule, interviews as well

as open ended questions from the learners questionnaires. Through observation of the lessons, the findings revealed that,

Four of the lessons observed were mostly about teacher exposition. There was lack of creativity and critical thinking and the chalk board was the only available teaching and learning aid. No learner centred method was fully employed and time management was poor as reflected by failure to engage the learners in a class activity such that two out of the four lessons class activity was given as homework while the other two ignored it altogether. However, the teachers displayed appropriate knowledge of subject matter but learners remained passive throughout the lesson hence it could not be measured that they had learnt something at the end of the lessons.

However, one lesson had the following observations; the lesson introduction motivated the learners. Problem solving was introduced early in the lesson through a variety of questions which were asked to the learners and critical thinking was stimulated. A teaching and learning aid was effectively used and it was a model made out of wire to demonstrate the motor effect of an electric current. Content was appropriate for the level of the learners and the class activity was employed within the learning time. The teacher had a good command of the subject matter and the learners did the exercise with less difficult.

One participating teacher refused to have his lesson observed because he had to attend to delegated responsibilities, so five lessons were observed.

The teachers also gave their views about the way lessons were conducted normally and the following were some of their responses;

(a) the syllabus is too long and the only way out is to use the lecture method

(b) the learners are too passive so if you ask questions they go unanswered, so we just resort to teaching without asking questions during class exercises or tests

(c) *the learners are too many, so if you employ learners centred approaches, you cannot finish the syllabus and these days, standard officers are very concerned about syllabus completion.*

(d) *there are no labs, as a result it is very cumbersome to transport apparatus to different classes every time I need to teach.*

(e) *there is no lab assistant at this school and I have too many classes to teach so I do the best I can and that is to trot from one class to another.*

According to the findings on the normal practice of conducting physics lessons by secondary school teachers, one of the subject specialists lamented that

No book, chalk and talk is a wrong way to teach physics

He gave the following expression to emphasise his point,

If you tell me, I may forget, if you show me, I may remember; if I do I will remember.

He continued to say that,

Lack of learner involvement during the lesson is a killer of Physics lessons.

And another specialist expressed that,

Teachers should stop presenting themselves as masters of everything because the modern teacher is a facilitator.

Another specialist lamented that,

The mushrooming of universities and colleges has impacted negatively on teacher pedagogical skill because quality is not being adhered to. Physics teachers trained by the University of Zambia and Copperbelt University possess adequate pedagogical content skill, the problem is that the two universities do not train sufficient numbers of science teachers.

The Specialists speculations could be supported by the demographic information of the teachers of Physics were only one teacher of physics was from the University of

Zambia and the rest from colleges. However, whether qualification had a bearing on the pedagogical skills of the teachers is an issue for another study.

4.11 Summary of the results on teacher's pedagogical content knowledge

The purpose of this section was to answer question four. *How did the teacher's pedagogical content knowledge affect learner's comprehension of secondary school physics?*

Overall responses from the learners and the subject specialists indicated that there was a problem with teacher's pedagogical content knowledge and that it negatively affected the learner's comprehension in secondary school physics. The learners through the Likert scale expressed that their teacher did not explain scientific terms that they encountered in physics by strongly agreeing to the statements. The learners also expressed that the teachers also faced challenges in the process of teaching and learning and that made it worse for the learners. The specialists attributed learner's poor comprehension of physics to the fact that teachers did not use appropriate teaching methods suitable for certain type of content as well as failure by the teacher to relate class activities to everyday life. On the other hand, it was found out that the teachers held a different view and that they blamed the learners for their own failure to comprehend physics as well as biased selection to grade ten (10) where the best performers are taken by technical and grant aided schools while the rest are taken to government schools. The next chapter is a presentation of the discussion of the findings.

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Overview

The discussion in this chapter was based on the findings presented in chapter four. The discussion has been done under main themes derived from the findings and relating to the theoretical framework that guided this study. It also referred to the literature that was reviewed in chapter two. In this chapter effort has been made to explore current knowledge and thinking about curriculum designing and teacher pedagogical content knowledge with regards to learner's poor performance and understanding of physics in selected secondary schools in Lusaka district. This helped in the interpretation of the findings for this study.

5.2 Learner's Perception of Physics

Learners are very important in the process of teaching and learning because they are the very reason why a curriculum is developed. They are one of the major stake holders in the curriculum implementation process therefore their perception of a subject should be taken into consideration. Learners are the ones who are directly affected by the implementation of a curriculum and it was for this reason that the researcher thought that the perception that the learners had about physics would bring valuable insight to this study. Findings from the analysis of the data that was collected as shown in table 4.3 indicated that learners perceived physics to be a difficult subject because of various reasons. The reasons given by the learners indicated that their poor perception of physics as a subject emanated from their teachers. For some reason, it appeared like teachers were instilling fear in the minds of the learners that physics was a difficult subject. Figure 4.2 showed a larger percentage of the learners expressing that their teacher said that physics was not easy. On the contrary, teachers said that physics being difficult to the learners was not because of perception but that it was a fact learners faced difficulties with the subject. This finding is worrisome because the role of the teacher is to motivate the learners to aspire for greater understanding of the subject as alluded to by Chishiko (2011) who said that secondary school physics teachers have a great responsibility to ascertain that the enthusiasm of the learners of physics is captured right at the beginning when the learner's curiosity about the environment is at its highest.

Specialists from the Curriculum Development Centre (CDC) and Examination Council of Zambia (ECZ) explained that the teacher's attitude towards the subject contributed greatly to how learners perceived the subject. This was not far from the truth because it was found that teachers came up with various reasons as to why learners perceived physics to be a difficult subject such as blaming the learners because of the environment where they came from. According to these findings, the teacher of physics in secondary school can play a very vital role of helping the learner's perception of physics to be positive. Instead of the teacher condemning the environment where the learners come from, the teacher knowing the importance of physics knowledge to society should be using the classroom platform to change the mind of the learners. The American Physics Society (2008) explained that Physics is a central part of human culture and will continue to inspire many people as it reveals important universal truths not withstanding certain strands of post-modern thought. If only the teacher of physics can take advantage of the learner's availability instead of blaming the learners who are open to change and engage them during physics lessons so that they in turn can change the space they live in.

The findings revealed that when learners were left to themselves they shared views about physics which were mostly negative. This may have resulted from learners not having an informed thought about the subject they interacted with on a regular basis as well as poor representation of the subject by the teachers themselves. Some learners were of the view that, *to pass physics was just by luck and not by studying*. This indicated a state of complacency on the part of the learners as if the case for physics had already been decided for them. There was also another view by the learners that *even the teachers did not pass physics* and this implied that there was lack of confidence in their teachers. Teachers may have contributed greatly to this poor perception of not only the subject but the teacher as well and this was confirmed by what one of the specialists had mentioned earlier on that the teacher's attitude is to blame for the learner's poor perception of physics. Batwini (2010) noted that teachers' perceptions and beliefs influence and shape the meanings that the teachers eventually attach to the new reforms, which in turn play a vital role in their acceptance and classroom implementation. The way the teacher presents a subject to the learners has got a great influence on their perception of the subject and the

learners themselves need to be enthusiastic although Rose and Meyer (2002) said that when education fails, the learner should not take the blame .

5.3 Learner's Performance in Physics in relation to Perception

Learner's perception of a subject has a great bearing on how they are to perform in that subject. Eggen and Kauchak (2002) gave a cognitive dimension of perception as the process by which people attach meaning to experiences. Perception is critical because it has the ability to determine the information that can be committed to memory. According to Wasike, Ndurumo and Kisilu (2013) background knowledge in the form of schemas affects perception and subsequent learning. The findings from the study were that the performances of the learners of secondary school physics were affected by the poor perception of physics. In the previous section, learners gave various reasons as to why they perceived physics to be a difficult subject and the researcher saw them as reasons why learners performed poorly in physics. From the likert scale in table 4.4, it was clear to the researcher that learner's perception of physics affected their performance in the subject. The findings revealed that 60.7% of the learners agreed to the statement that *no matter how much I study, I never pass physics.* It of great concern to have learners agree strongly to such a strong statement because it gave an impression that the learners were helpless about the subject.

Consequently, it can be said that there was an element of truth in the reason given by one of teachers that learners perform poorly in physics because they were not serious with their studies. The learners did not indicate any effort they were putting in to help themselves understand physics better except to put the blame on the teacher and the subject. This thinking can also be confirmed by the other responses from the learners where 51.5% agreed to the statement that *physics is not meant for everyone.* One of the teachers attributed poor performance of the learners in physics to an increase in illicit activities among the learners. If that is the case, all subjects and not just physics could have been affected but probably the other part of his reason which made reference to the cognitive level of the learners though this may be a gap for another research.

However, the Specialists from CDC, ECZ and the Standards Officers submitted that the teachers of physics were the ones responsible for the poor performance of the learners in the subject. The reason cited by the specialists for blaming the teachers

was teachers teaching physics in an abstract manner. This could not be disputed as some of the lessons observed were indeed abstract in nature which contradicted the way of teaching physics as explained by Lawrence et al (1996) that visualising of physical phenomena through techniques such as experiments, demonstrations and models contribute much to learners understanding of physics concepts.

5.4 Learner's views about the Importance of Learning Physics

Although the learners perceived physics to be a difficult subject and performed poorly thereof, there was no doubt that the learners were aware of the importance of physics. Through a likert scale, 50.1% of the learners disagreed to the statement that *I do not care about physics because I have no use for it.* This finding gives the impression that the learners may think of physics as only ending within the wall of the school as suggested by Kafatwa and Mbetwa (2016) who said that in Zambia, learners perceive physics as being educational rather than its applicability to life. In thinking about this, there was a possibility that the importance attached to physics was not being communicated to the learners by their teachers. Oon and Subramanian (2011) revealed that some teachers of physics where uncertain about carrier prospects on physics graduates as physics seemed to be a difficult and abstract subject to the learners. Contrally to this view, the teachers told the researcher that the learners were not aware of the importance of learning physics hence their poor performance. This contrast in views between the learners and the teachers showed that there was no quality interaction between the teachers and the learners and this could have led to a situation such as the one at hand. One of the teacher's explained that *the children we teach do not appreciate learning physics.* There is a possibility that the teachers do not engage with their learners beyond teaching which is an impediment on the creation of a friendly environment for teaching and learning physics. It would be helpful if teachers were to engage learners more so that some of the difficulties and perceptions the learners hold can be corrected.

On the other hand, the specialists explained that learners could be aware of the importance of physics but the correct information is not being transmitted by the teachers. One specialist said that *teachers make physics to be remote* and this was confirmed during the lesson which was observed on the topic *Cost of electrical energy.* It was observed how the teacher used the equation correctly on an example

which cited the currency for Singapore probably the book was authored there, without making reference to how the domestic energy is calculated. The problem with this occurrence was that none of the learners asked their teacher how the power utility company which is Zambia Electricity Supply Corporation (ZESCO) calculated the local cost for electrical energy. This was contrary to what Chishiko (2011) said that the cultural value of physics depends on the way it is taught and the teacher must not stop where facts are discovered but must proceed on to unravel the application to the real world in a social set up. This is one of the things missing in the process of teaching and learning physics and it contributes greatly to the physics problem in secondary schools. If teachers of physics would endeavour to contextualise physics phenomena, most likely, the learners would perceive physics differently and this can lead to a better understanding of the subject.

5.5 The Effect of Syllabus Coverage on the Learner's Comprehension of the Subject

According to the schema theory, human beings use schema to organise, retrieve and encode chunks of important information (Hewson & Posner, 1984) and McGovern (2017) explained that learners learn best when they can relate new knowledge to previous knowledge by use of schema. The new and previous knowledge for physics is contained in the syllabus. The problems with physics in secondary schools indicate that there is failure by the learners to integrate new information. From the findings presented in figure 4.5, learner's performance was affected by the number of the numerous topics they were required to cover in the physics syllabus. The syllabus was formulated according to how the curriculum was designed and for physics it had to include all content that completed the idea presented in the curriculum design. On this matter, Steinberg (2008) explained that, in order to have a skilful and knowledgeable learner, the physics curriculum and syllabus is loaded with content as a response to the demands of the international standards. The researcher is of the view that the learner's complaint about their performance being affected by the number of topics they have to cover is unfounded because the curriculum was designed to enable the learners to acquire relevant knowledge, skills and attitudes needed for apprenticeship and for life.

In this respect, the researcher agreed with the physics specialist from CDC who said that the physics syllabus coverage is adequate for secondary school level. The researcher agreed with this view only to the extent that the designers endeavoured to present the complete plan in the syllabus that would bring about a finished product which had relevant knowledge, skills and attitudes which can be acceptable at the international standard. However, the specialists contradicted themselves when one of them said that,

> *Physics teachers in private and grant aided schools complete the physics syllabus in grade eleven while government teachers let the learners write the examination without covering all topics which is very unfortunate.*

This is a contradiction in the sense that if the syllabus is supposed to cover a period of 3 years, what criteria did the said teachers employ in order to finish it in two years? This created an impression that there was a problem with the way physics was designed and there is need therefore to harmonise the said differences in timing. Instead of the specialists praising the teachers who finished the syllabus before the planned time and condemning those who fail to finish on time, they should find a way of harmonising the two extremes. Thus the teacher's responses on this matter also contain relevant information that can help in the harmonisation process. According to the teachers of physics, some topics included in the physics syllabus were a repetition from chemistry and biology. One of the teachers cited kinetic theory of matter as one of those topics that was too theoretical in comparison to other topics. It also contains content that was covered in chemistry and hence giving reason enough for the specialists to look at the curriculum design and effect minimal changes that could bring about smooth implementation of the curriculum. There is a possibility that this could be affecting the integration of knowledge in the schema of the learners as suggested by the Mcgovern (2017).

5.6 Sequencing of Physics Content

The other theme that came out was the sequencing of content. This aspect of curriculum designing is very important as it ensures that there was a smooth flow of information in a logical manner. Since knowledge in acquired through the schema there is need that it is presented in a coherent manner so that it makes sense to the learners and it becomes integrated. According to Hewson and Posner (1984), a schema is a set of coherent knowledge that is created in a set of similar context or

situation. This implies that there should be a regular pattern that should be created in the process of teaching and learning physics so that schemas can be formulated. Therefore, the sequencing of physics content is an important aspect and it should be considered with reference to what learners and teachers said in this study.

According to the findings, most of the learners said that physics content had different modes of study and that this posed a challenge to the learner's comprehension of the subject. What was meant by different modes of study was that physics content includes calculations, graphing, experiments and explanations as well. One of the teachers said that,

> *It is challenging for the learners to master note taking, graphing techniques, and formulas as well as performing experiments. My experience is that some learners would be good at calculations but have challenges in graphing techniques or explanations.*

True as this statement by the teachers' may be, there is likelihood that the situation may be true for the teacher as well. If that can be the case then there is a possibility that the teachers are the ones passing on the challenges to the learners and not the design. However, there is a possibility that learners may find one method easier than the other which is acceptable. Then one statement from one of the teachers if true can make the learners complaints to be genuine. One of the teachers said that,

> *Topics are not always from simple to complex*

This statement was disputed by the physics specialists, who said that,

> *Topics are sequenced in such a way that they are from simple to complex*

This statement is the ideal situation for a well sequenced syllabus however, teachers were able to give specific examples of topics which they felt were not sequenced from simple to complex. One teacher explained by giving an example that,

> *Learners are taught thermal expansion of matter followed by calculation of gas laws which require the knowledge of pressure which is not included in their syllabus*.

The teacher's example should be a source of concern for the curriculum specialist and it is reason enough to cause them to take another look at the physics syllabus but it is worrisome to see the specialists always being in defence of the syllabus without listening to the curriculum implementer. The stance taken by the curriculum specialist confirms findings by Mwanza (2017) that teachers were included or consulted in the process of curriculum designing which should not be the case. The

success of a curriculum is always ensured if the teachers are included in the process of curriculum development as is the case with Finland whose education is ranked the best in the world (Lonka, 2018). According to the Finish National Board of Education (2010) utilization of teachers as valued experts who develop the school-based curriculum as a source for different approaches to school work is the best approach to curriculum development. It is a well-known fact that within a period 50 years, Finland has progressed from austere conditions to the global cutting edge (Lonka, 2018). The specialists can take note of findings by Mwanza (2017) and start involving teachers in curriculum development if the education system can record any success as is the case with Finland. The issues highlighted by the teachers and the learners may have the potential of negatively affecting the learner's comprehension of physics hence the need to take them into consideration. According to the schema theory by Hewson and Posner (1984), if there is no relationship between new knowledge and previous knowledge, learners can have a problem to integrate new physics content and thus lead to a situation as is prevailing in secondary schools with physics.

5.7 Teacher Pedagogical Content Knowledge

The quality of a curriculum is only as good as the quality of the teacher (Bishop, 1985). Therefore, it is important that the pedagogical content knowledge of the teacher is taken into consideration in order to address the problem at hand. Shulman (1987) described pedagogical content knowledge (PCK) as an important aspect of teaching that allows teachers to effectively relay and make the subject matter and curricular knowledge comprehensible to the learners. The teacher should know more than what an ordinary person would know on the subject matter. Mulenga (2015) explained that a teacher with PCK would know how to effectively sequence the teaching and learning materials so that learners can easily comprehend the content. However, there are speculations by Examination Council of Zambia (ECZ, 2016) that the performance in physics at grade twelve could be as result of the usage of strategies that were not compatible with the demands of the subject. The findings of the study revealed that there was likelihood that the PCK of the teacher of physics in secondary school posed challenges to the learners. The PCK of the teacher of physics was analysed among other things by finding out the ability of the teacher to explain

scientific terms as well as the teacher's ability to relate physics content to everyday life.

5.7.1 The Ability of the Teacher to Explain Scientific Terms

The findings in figure 4.6 indicated how the learners viewed their teacher's ability to explain scientific terms during the teaching and learning experiences. Sixty eight percent (68%) of the learners agreed with the statement on the likert scale that stated that *the teacher has difficulties in explaining scientific terms.* The learners based their responses on their experiences with asking questions to the teacher about unfamiliar scientific terms as well as the teacher's failure to simplify terms. The researcher agreed with the learner's views because of what was observed during one lesson on current electricity. The teacher did not explain the difference between potential difference (P.D) and electromotive force (E.M.F) but just referred to both as voltage. There was a need during the lesson for the teacher to differentiate the two but since it was not done, the learners were correct about the teacher's lack of giving explanations about scientific terms and this is of great concern.

However, the teachers gave a different view to support their inability to explain or simplify scientific terms to the learners. One of the teachers called it a waste of time and he said,

> *It is a waste of time to explain all the scientific terms we come across because to our learners nothing makes sense.*

It appears that teachers feel bothered to simplify some of the terms that the learners encounter difficulties with. However, making content easier to the learners is one aspect of the PCK. Park and Oliver (2008) explained PCK as what the teacher understands and the enactment of how to help a group of learners understand specific subject matter using multiple instructions. This can make one to wonder whether failure to explain scientific terms was as a result of bad attitude by the teacher as suggested by the physics Specialist or it was as a result of poor PCK. According to one response from the specialist, teacher's failure to explain scientific terms was as a result of failure to prepare adequately for the lesson. If that was to be the case, what would make the teachers to go to class without adequate preparation for the lesson? This could be the reason why 62% of the learners felt that physics was complicated even to their teachers. The researcher is of the view that, failure to prepare for a

lesson is a sign of lack of PCK and this hinders the ability of the learner to integrate new information in their schema.

5.7.2 Applicability of Physics Content to Everyday Life

The researcher went on to find out if the teachers of physics endeavoured to connect physics content to everyday life. The learners responded to a statement on a likert scale which was stated that *my teacher does not connect what we learn to everyday life activities* was represented by 44.3% of those who agreed to this statement as shown in figure 4.8. This indicated that there was failure by the teacher of physics to relate content to things the learners were familiar with. It can be seen from the findings that the learners were unable to connect physics content to natural phenomena they interacted with on a daily basis. According to Zaoyao (2002) the study of physics explains the essence of natural phenomena. This part seemed to be lacking in the teaching and learning of physics as was observed during a physics lesson where the teacher gave an example on the situation cited in the text book without referring to the local situation. The example on the calculation of electrical energy as referred to earlier was a very good opportunity by the teacher to explain everyday life activity using classroom interaction with physics content. It is distressful because the teachers put the blame on the learner's ability to connect classroom content with natural phenomena but how could the learners do that without the teacher doing it first? The teachers blamed several factors such as the intellectual capabilities of the learners and selection of the learners to grade ten. The findings revealed that the teacher's skill to guide learning of physics in the way that it becomes comprehensible to the learners was lacking. It appeared as though the teachers were not aware of the problem they were grappling with thus put the blame on the learners. This revealed a negative attitude by the teachers which was affecting effective creation of coherent physics knowledge which in turn was affecting the learners comprehension of the subject which can support integration of knowledge through the schema (Mcgovern, 2017).

However, the physics specialists expressed different views as has been the trend throughout the presentation of findings. According to information obtained from the specialists, teachers of physics had failed to adapt to the new paradigm shift in teaching which is a very important aspect of teacher pedagogical skills. Like earlier

alluded to by the specialists, teacher's attitude demonstrated during this study confirms what has been mentioned already about the teacher's attitude contributing to the current situation with physics. Teacher's attitudes are a major predictor of the use of new technologies in instructional settings (Isleem, 2003). This implies that failure by the teachers to adapt to the new way of teaching means failure to effectively implement the curriculum. In this case no matter how good the curriculum maybe failure by the teacher to do the correct thing affects the outcome of the curriculum.

Meanwhile, the Physics Specialists maintained their defence by continuing to focus on the teachers as the reason why there was a problem with physics education in secondary schools in Zambia. Another reason advanced by the specialists was that teachers failed to give a rationale that could help the learners appreciate the learning of certain topics. Additionally, the rationale is important as it can help the learners to identify with the topic under study. The rationale for each topic aims at emphasising the point why it was important for the learners to acquire certain knowledge, skill and attitude relating to a certain topic. Mulenga (2015) explained that teachers play a very important role in facilitation of the learner's acquisition of the desirable knowledge skills, values and attitudes. In this case, it is up to the teacher to make the learners aware of the rare knowledge, skills and attitudes that they can acquire only from learning a certain topic in physics. Shulman (1986) explained that teachers must not only be capable of explaining to pupils the defined skills and knowledge for secondary school domain but must explain why a particular proposition is deemed warranted, why it is worth knowing and how it relates to other propositions and concepts. For example, only after learning about the electromagnetic spectrum in physics would learners have knowledge and skills to appreciate the source, use and effect of various waves such as radio waves, X-rays and Infra-red radiation. Therefore, if the rationale is effectively used by the teacher, it can turn the learners around and bring them to a point where they drop the poor perception of physics and begin to comprehend physics better than they were doing.

5.8 The blame game.

Findings of the study revealed that the sources of information namely; the learners, teachers, standards officer and subject specialists were standing at different positions

on the same matter and that the teachers of physics took the larger share of the blame. The finding of the study was that learners did not rate the teacher's pedagogy poorly through the statements provided in figure 4.6 rather their rating was average. The standard deviation reflected from the learner's views was around 1.3892 with an average of 3.4514 indicating that the learner's views were neither in support nor in dispute with their teacher's pedagogical skills. This indicated that the learners were not in a position to confidently rate their teacher's pedagogical skills as being poor or excellent and it can be said that the negative elements about the teacher and the curriculum design from the learners was not biased and so could be genuine. On the other hand, the teacher's blame on the learner's attitude and ability could be as a result of the teacher's ignorance of the subject matter as well as the learner's abilities. Conant (1963) explained that, if a teacher is largely ignorant about the subject content and the learners abilities he can do much harm as is the situation in selected secondary schools in Lusaka district. However, the blame between the teachers and the specialists should be considered with keen interest as these two groups of people are well informed and what they submitted should be analysed critically in order to come up with informed decisions that can help in the current physics situation.

Findings presented were that teachers were blaming the curriculum specialists for a long physics syllabus as one of the reasons why learners were performing poorly in physics as well as the unrealistic demands from standards officers. It is quite evident that teachers did not attribute any of the learner's difficulties with physics to the way they conducted the lessons as well as their attitude towards the learners. According to Borich (2007) in order for physics learners to achieve their potential in schools, it would be essential that teachers engage in effective teaching because genuine and helpful interaction helps in the retention of knowledge and skills. If teachers had engaged in any efforts to improve learner performance in physics, it could have been highlighted in the interviews conducted but instead all that came out was blame for the learners, Specialists and the Standards officer as well as the syllabus. Therefore, there is lack of commitment to the physics problem by the teachers as such it would be very difficult for the teachers to realise that they contributed greatly to the success or failure of the learners.

Similarly, blame was echoed by the standards officers who were responsible for ensuring that the teachers were doing the right things in the classrooms with the learners in terms of curriculum implementation. The standards officer strongly blamed the teacher at every opportunity given to them and one can wonder how they have allowed the physics situation to deteriorate to such levels when they could have intervened since they are aware of the teacher's short comings. There is a possibility that the Standards officer and the physics subject Specialists from CDC and ECZ could have just been defending the Ministry of General Education out of duty and not out of principle. Mwanza (2017) explained that teachers who were not involved in the development of the curriculum that they use may not have a clear picture of what exactly is to be done. They are likely to have no competence, knowledge, propensity and mind-set that are required to make perfect decisions about it. However, teachers did not make reference to being left out in the curriculum design but findings by Mwanza may just be one of the reasons for the teacher's bad attitude which the Specialists complained about. Unfortunately, the blame game going on around physics education has the learners as the immediate casualties while the country will eventually be void of emerging innovators.

5.9 Summary

In this chapter, the findings of the study have been discussed. The discussion was done under themes emerging from the findings of the study which are informed by the objectives and conceptual framework. The themes presented what the study established from the findings. These emerging themes were (1) physics was difficult to the learners and not just perception (2) Poor perception of physics by the learners affected their performance in the subject (3) The physics curriculum had an effect on the learners comprehension to a certain extent and (4) PCK of the teacher affected learner's comprehension of the subject. Based on the findings and the discussion that have been done in this chapter, the next chapter is about the conclusion and recommendations.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview

In this final chapter, the conclusion is given to show that the research questions raised in chapter one have been answered. The researcher has also endeavoured to show that the gap in knowledge that was identified during literature review has been narrowed. In this chapter efforts have been made to remind the reader of the purpose of the study and then a summary of the main research findings and conclusion. Based on the findings of the study conclusions and recommendations have been made.

6.2 Conclusions

As a reminder to the readers, this study was an analysis of the curriculum designing and teacher pedagogical content knowledge for secondary school physics in selected secondary schools in Lusaka district. The problem that was identified for this study was that physics was becoming unpopular among secondary school learners which detrimental to economic and technological development of the country. The study identified areas that needed urgent attention in order to come up with a solution to this problem and that is the curriculum design and teacher pedagogical content knowledge. The summary of the main findings are presented here in the sections that follow.

6.2.1 Learners Perception of Physics

Research question number one sought to collect data that provided answers to why secondary school learners perceived physics to be a difficult subject. The results of interviews for the specialists and physics teachers and questionnaire responses from learners clearly showed that besides learners perceiving physics to be a difficult subject they also faced challenges with the subject. The major reason identified for this predicament was that teachers told the learners that physics was not easy to learn. The learners also performed poorly because they believed that physics was for intelligent learners as such no effort was made by the learners to improve their comprehension of the subject. However, the teachers said that it was not just perception but that physics was difficult to the learners. They attributed the challenges learners were facing in physics to the environment learners came from, low intelligence level as well as lack of seriousness. On the other hand Specialists

mentioned that the teacher's poor attitude was the reason learners perceived physics as a difficult subject. The conclusion therefore, is that the learner's poor perception of physics could be attributed to teacher's poor attitude of telling learners that physics was a difficult subject and learner's misconceptions about the subject.

6.2.2 Learner's Perception of Physics in relation to their performance of the Subject

Research question two was meant to facilitate the collection of data which would provide answers to the question on whether poor perception of physics affected the learner's comprehension in the subject. The results from the learners were analysed using descriptive statistics while the data from the interviews was analysed using emerging themes. The results from the learners showed that indeed the learner's performance was affected due to the poor perception they held of the subject. There was no dispute on this fact from all the participants in the study therefore it can be concluded that learner's performance in physics was affected by their poor perception of the subject.

6.2.3 Curriculum Design of Physics and Learner's Comprehension of the subject

Research question three solicited data which helped the researcher to investigate the effect of the curriculum designing of physics on the learner's comprehension. Views were obtained from the learners who said that the syllabus was too long and complicated because it needed the learners to know different aspects of physics content such as graphing, formulas, experiments as well as mastering theories, The teachers were in agreement with what the learners said and they added that some aspects of the physics syllabus are irrelevant as well as repetitions which are included in the other science subjects. However, there were different views expressed by the physics specialists who said that the physics syllabus was perfect with content appropriate for the level of the learners. The study revealed that learners were the main victims of the blame game between the teachers and the specialists who were visibly standing on two different sides of the same coin. It can be concluded therefore that the curriculum designing contributed to learner's failure to comprehend physics content.

6.2.4 Teacher's PCK and its Effect on Learners Comprehension of Physics

Research question four sought to elicit data on the effect of pedagogical content knowledge of the teacher of physics on the comprehension of the learners. Findings from the learners were analysed using descriptive statistics and all the learners did was to agree or disagree to statements provided on a five point Likert scale. The learners agreed to statements that were describing aspects of the teacher's pedagogical content knowledge but when it came to rating, they rated the teacher's PCK as average. The findings from interviews for the teachers and the specialists was analysed using themes. The teachers blamed the learners and the specialists while the specialists blamed the teachers and the blame game continued. It was concluded that the lack of PCK by the teacher made teachers not to teach well and this affected learner's comprehension.

6.3 Recommendations

The following recommendations arose from the research findings, discussions and conclusions drawn in this study.

i. It was recommended that the Physics Specialists at CDC should revise physics syllabus so that it contains topics that require similar way of teaching and learning other than having all skills in one topic.

ii. Standards Officers to ensure that continuous professional development is enhanced for physics teachers with an input from recommended universities on teacher pedagogical content knowledge with an aspect of certification.

iii. A round table discussion should be initiated by the Curriculum Development Centre to engage the teachers in order to get feedback that can help address topics which appear in all the three sciences.

iv. There should be a system of ensuring that quality teachers are graduating from learning institutions by the Higher education authority and that The University of Zambia and Copperbelt University should increase the enrolment of students training to be physics teachers.

v. Teachers should make a deliberate emphasis on the rationale for each topic with reference to everyday life activities in order to arouse interest in the learners

6.4. Proposed areas for Future Research

In view of the findings of this study which was an analysis of curriculum design and pedagogical content knowledge for O-level physics, it is therefore necessary to propose the following as areas for further research.

i. The effect of intelligence level of the learner on the comprehension of physics

ii. Investigating the effect of the environment were the school is located on the learner's perception of physics.

iii. Effect of learner attitude on performance in Physics

iv. Involving teachers in curriculum designing through subject teams in districts.

REFERENCES

Alsop, S. & Hicks, K. (2001). *Analysing Exemplary Science Teaching*. New York: McGraw- Hill Education.

American Physics Society. (2008). *Why Study Physics*?http://www.aps.org/program/edu/whystudyphysics.cfn retrieved on 6th February, 2016.

Awoniyi, S.A. & Aderanti, R.A. (2013). *Understanding Test and Measurement in Education*. Kwara: Fatyusuf Printing Production.

Banda, B. (2004). "Enhancing *Classroom Activities for Quality Teaching and Learning in Zambia". A Paper Presented at the NANGENDA, ZAME, ZASE, and ZATE Annual General Conference,* 1-2 September, 2004. Lusaka: Zambia.

Barmby, P. & Deffty, N. (2012). *Secondary School Pupils perception of Physics. Research in Zambian Secondary Schools. A Baseline Study Report.* Lusaka: Jica/MOE.

Bantwini, B.D. (2010). How Teachers Perceive the New Curriculum Reform: Lessons from a School District in the Eastern Cape Provincial South Africa. *International Journal of Education Development. 30, 83-90.*

Bernard, H. R. (2002). *Research Methods in Anthropology. Qualitative and Quantitative Methods 3.* Walnut Creek: Altamira Press.

Best, J. W. & Khan, J. V. (2006). *Research in Education (10th Ed).* New Jersey: Prentice Hall.

Bless, C. & Achola, P. (1988). *Fundamentals of Social Research Methods: An African Perspective.* Lusaka: Government Printers.

Bishop, G. (1985*). Curriculum Development. A Text Book for Students*. London: Macmillan Education Ltd.

Borg, W. R. (1963). Educational Research: An Introduction. New York: David McKay and Company.

Borich, G. D. (2007). *Effective Teaching Methods Research Based Practice*: New York: Prentice Hall.

Brassel, H. (1987). The Effect of the Real Time Laboratory Graphic Representation of Distance And Velocity. *Journal of Research in Science teaching* 31 (14) 323-344.

Bryman, A. (2001). *Social Research Methods.* New York: Oxford University Press.

Buabeng, I. & Ntow, D. F. (2010). A Comparison Study of Students‟ Reasons View. For Choosing/Not Choosing Physics Between Undergraduate Non Physics and Physics Studens at University of Cape Coast. *International Journal of Research i*n *Education,* 2 (2) 44-53.

Chamberlin, M. T. (2007). *Teachers Considering Implications for Mathematics Learning in* the Context of their Own Learning During Professional Development. In Lamberg, T. & Wiest, *L. R. (Eds), Proceedings of the 29th Annual Meeting of the North American Chapter of the International Group of the Psychology of Mathematics Education (pp 893-895).* Stateline (Lake Tahoe). NV: University of Nevada, Reno.

Chishiko, S. (2011). *Perspective of Education Administration towards the Teaching and Learning of O-level Physics. A Case of Copperbelt Province Zambia.* Med Dissertation: Lusaka: The University of Zambia.

Cohen, D.K. (2009). *Teaching Practice and its predicaments.* Cambridge, PhD Thesis. Harvard University Press.

Cohen, L., Manion, L. & Morrison, K. (2007). *Research Methods in Education* (6th Ed). New York: Madison Avenue.

Creswell, J. *W. (2012). Education Research, Planning, Conducting an Evaluating Quantitative and Qualitative Research, (4th Ed).* New York: Pearson.

Creswell, J. W. *(2003). Research Design; Qualitative, Quantitative and Mixed Methods Approaches.(3rd Ed).* London: Sage Publications.

Creswell, J. W. *(2009). Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. California: Sage Publication.

Creswell, J. W. (2013). "*Steps in Conducting a Scholarly Mixed Methods Study". DBER Speaker Series pp 48. Http:// digital commons. unl.edu/dber speaker/48. Retrieved on 19th February 2018.*

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods Research.* London: Sage Publishers.

Creswell, J. W & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Methods Research (2nd ed).* Thousand Oaks, C A: Sage Books.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods approaches (3rd ed).* London: Sage Publications.

Conant, J. (1963). *The Education of American Teachers*. New York: McGraw-Hill.

Curriculum Research and Development Division (CRDD). (2008). *Teaching Syllabus for Physics-Senior High School.* Accra: Ghana Education Services.

Darling-Hammand, L, Wise, A.E. & Kline, S.P. (1999*). A License to Teach: Raising Standards for Teaching.* San Francisco, CA: Jossey-Bass.

Darling-Hammand, L. (2000). How Teacher Education Matters. *Journal of Teacher Education* 51(3) 166-173.

Delgado, A. (2012). *Curriculum Designing.* San Isidro: General De Jesus College Press.

Eggen, P. & Kauchak, D. (2002*). Strategies for Teachers: Teaching Content and Thinking Skills* (4th ed). Needham Heights: M.A Allyn and Bacon.

Examination Council of Zambia (2015). *Highlights of the 2015 Grade 12 Examination Results Statistics*. Lusaka. The Research and Test Department.

Examination Council of Zambia. (2015). *Highlights of the 2015 Grade 12 Examination Results Statistics.* Lusaka: The Research and Test Development Department, ECZ.

Examination Council of Zambia. (2016*). 2015 Examination Performance Review Report for National Sciences*. Lusaka: Examination Council of Zambia Type Setting Section, ECZ.

Fonceca, J. & Conboy, J. (1999). Introducing Physics for non-Physics Majors. A case Study. *Journal of College Science Teaching* 28 (4) 272-277.

Fonseca, J. (2003). Students at Risk to Academically Successful Students. *A Model for Reform in the International Context*. 23(5)314-318.

Frazer, T. & Walberg, R. (1995). What Matters For Students Learning Outcomes; A Meta-Analysis of Studies Exploring Factors of Effective Teaching. *Teaching and*

Teacher Education 36(10) 143-152.

Ghosh, B. N. (1992). *Scientific Methods. Qualitative and Quantitative Approaches.* Nairobi: Acts Press.

Ghosh, B.N. (1992). *Scientific Methods and Social Research*. New Delhi: Sterling Publishers Private Limited.

Government Republic of Zambia (2006). Vision 2030- *A Prosperous Middle Income Nation by 2030*. Lusaka: Government Printers.

Haambokoma, et al (2002). *Strengthening of Science and Mathematics education in Zambia Secondary Schools.* A baseline Study Report, Lusaka: JICA/MoE.

Hewson, P. & Posner, G. (1984). The Use of Schema Theory in The Design Of Instructional Materials. A Physics Example: *Instructional Science Journal* 13 (2) 119-139.

Holubova, R. (2008). Effective Teaching Methods. Project- Based learning in Physics. *Us-China Education Review* 5(12)26-36.

Intuitor (2002). *Physics is a Neglected Science*. http://www.intuitor.com/physics. Retrieved On 14th November, 2017.

Isleem, M. (2003). *Relationships of Selected Factors and Level of Computer Use from Instructional Purpose by Technology Education Teachers in Ohio Public Schools: A State Wide Survey*. Doctorial Dissertation. The Ohio State University.

IUPAP.(1999). *Importance of Physics In Society*.http://www.triumf.info/hosted/IUPAP/CIZ/UIPAPAIMShtm. Retrieved on 20th March, 2018.

Johnson, B. & Goettsch, K. (2000). In Search of Knowledge Base of Language Teaching. Explanations by Teachers. *Canadian Modern Language Review*, 56 (3) 437-468.

Kabwita, J. (2014). *A Study of the Understanding and Use of Mathematical Concepts by Secondary School Teachers of Physics. A Case of Selected Schools in Lusaka District, Zambia.* M Ed Dissertation. Lusaka: The University of Zambia.

Kadzere, D. (2016). *Harvards Most Infamous and Hardest Courses.* Massachusetts: Harvard University Press.

Kafata, F. & Mbetwa, K.S. (2016). An Investigation into the Failure Rate in Mathematics and Science at Grade Twelve (12) Examinations and its Impact to the School of Engineering: A Case Study of Kitwe District of Zambia. *International Journal of Scientific & Technology Research*. 5 (8) 12-14.

Kajander, A. (2010). Elementary Mathematics Teacher Preparation in an Era of Reform. The Development and Assesment of Mathematics for Teaching. *Canadian Journal of Education*, 33 (1). 288-255.

Kaulu, G. (2011). *Effectiveness of the Physics Classroom Computer Software in Learning Kinematics in High School at Munali Boys in Lusaka*. M Ed Dissertation. Lusaka: The University of Zambia.

Kasonde-Ngandu, S. (2013). *Writing a Research proposal in Educational Research.* Lusaka: Unza Press.

Kenya National Examiation Council (2005). *Kenya National Examination Council Regulation and Syllabus (2006-2007).* Nairobi. KNEC.

Kingsbury, K. (2004). *Physics is Difficult.* http://www.korpenelais.com/physics/index. Retrieved on 20th December, 2017.

KNEC. (2005). *Kenya National Examination Council regulation and syllabus (2006-2007).* Nairobi. KNEC.

Kombo, D. K. & Tromp, D. L. A. (2006). *Proposal and Thesis Writing. An Introduction.* Nairobi: Paulines Publications.

Kostyuk, V.S (2004). Background and Professional Qualification of Secondary *School* Physics Teachers in Zambia. *ZANGO*. Lusaka: UNZA Press.

Kumar, R. (1996). *Research Methodology: A Step By Step Guide for Beginners:* New Delhi:Thousand Oaks &Addison Wesley Longman.

Lawrence, T.E., Grabhom, R. & Zollman, D.A. (1996). *Application of Interface Digital Video in a Physics Classroom*. Manhattan: Kansas State University.

Long, K. (2018). Education Lifted Finland out of Poverty But we Need to Keep Developing to Remain at the Cutting Edge. *Education News. University of Helsinki*. 12 (6) 2018.

Mafuleka, W.N.M. (2012). *Science and Technology Policy in Zambia, 1964-1989.* Its *Genesis, Development and Future Prospects.* MEd Dissertation. Lusaka: The University Of Zambia.

Maguswi, B.V.(2011). *Factors Contributing to Under Achievement of Zambian Female Examinations. A Case of Selected High Schools in Central Province.* Med Dissertation. Lusaka: The University Of Zambia.

Masaiti, G. & Manchishi, P.C. (2011). The University of Zambia Pre-Service Teacher Education Programme; Is It Responsive to Schools and CommunitiesAspirations? *European Journal of Educational Studies*, 3(2) 311-324.

Masaiti, G. (2013). *Re-engineering Public University Financing Policy in Zambia. An Emperical Study with a Mixed Method.* PhD Thesis. Huazong: HuazongUniversity of Science and Technology.

McGovern, E. (2017). *Schema Theory and the Learning of Science. htt://canvas.vt.ed.com. Retrieved on 25th May, 2018.*

Meo, G. (2008). *Curriculum Planning for all Learners: Applying Universal Design for Learning (UDL) to a High School Reading Comprehension Program, Preventing School Failure* 52 (2) 21-30.

Meyer, A. & Rose, D. (2000). Universal Design for Individual Differences: *Educational Leadership Journal* 58 (12) 39-43.

Michael, K. (2011*). A Complete Course in Communication Skills With a Day to Day Grammar*. Dar es Salaam: Afroplus Industries Ltd.

Ministry of Education. (1996). *Educating Our Future National Policy on Education*. Lusaka: Zambia Educational Publishing House.

MoE (2011*). Action to Improve English, Mathematics and science Module 3*. Lusaka: ZEPH.

MoE (2013). *Zambia Education Curriculum Framework*. Lusaka: CDC.

MoESVTE (2015). *Zambia Educational Curriculum Framework.* Lusaka: CDC.

Morris, A.K., Hiebert, J. & Spitzer, S. M. (2009). Mathematical Knowledge for Teaching in Planning and Evaluation Instruction: What can Pre-service teachers learn? *Journal for Research in Mathematics Education*. 40 (5) 491-529

Mugenda, O.M. & Mugenda, A.G. (1999). *Research Methods: quantitative And Qualitative Approaches*: Nairobi: Acts Press.

Mulenga, I.M. (2015). *English Language Teacher Education Curriculum Designing: A Mixed Methods Analysis of The University of Zambia*. PhD Thesis. The University of Zambia.

Murphy, P. & Whitelegg, E. (2006). *Girls in the Physics Classroom. A Review of the Research on the Participation of Girls in Physics.* Milton Keynes: Open University.

Mwanza,C. (2017). *Teacher Involvement in Curriculum Development in Zambia: A Role Analysis of Selected Secondary Schools Teachers in Selected Secondary Schools in Lusaka District, Zambia*. MEd Dissertation. Lusaka: The University of Zambia.

National Research Council (2014). *National Education Standards.* Washington, DC: National Academic Press.

Ndashye, M. (2007). *Response of Administrators to Poor Performance in O-Level Physics Examination. The Case of Copperbelt Province.* M Ed Dissertation. Lusaka: The University Of Zambia.

Nelson, H. & Thomson, P. V. (2009). Physics in Upper Secondary Schools in Denmark. *European Journal of Science Education, Taylor & Francis.* 7 (1) 95-106.

Ogula, P.A (2002). *Monitoring and Evaluation of Educational Projects and Programmes.* Nairobi: New Kemit Publishers.

Ogunleye, B.O. (2012). *Towards The Optimal Utilization and Management of Resources for the Effective Teaching and Learning of Physics in Schools. Proceedings of the 41st Annual Conference of the of the Science Teachers Association of Nigeria*. Lagos: University of Lagos.

Ogunniyi, M.B. (1996). Science Technology and Mathematics. The Problem of Developing Critical Human Capacity in Africa. *International Journal of Science Education.* 42 (12) 130-150.

Onwioduoki, F. A. (2012). *Difficult Concepts in Physics as Experienced by Senior Secondary School*. Lagos: Ijebuodu Jimmy Press Ltd.

Oon, P. T. & Subramaniam, R. (2011). Declining Interest IN Physics Among Students –Teacher‟s Perspective. *International Journal of Science Education* 33(5)727-746.

Owen, S., Dickson, D., Stanisstreet, M. & Boyees, E. (2008). Teaching physics Students Atitudes Towards Different Learning activities. *Research in Science and Technology Education. Taylor & Francis* 9 (23) 67-7.

Pamphilion, B. (2000). *The Role of Education in Development of Critical Thinking Skills. How to develop Thinking Skills*. Bangkok: Chulalongkon University.

Park, S. & Oliver, J. S. (2008). Revisiting the Conceptualisation of Pedagogical Content Knowledge PCK. PCK as a Conceptual Tool to Understand Teachers as

Professionals. *Research in Science Education.* 38 (26) 261-284.

Patton, M. (1990). *Qualitative Evaluation and Research Methods (2nd Ed).* Newburg Park: Longman.

Patton, M. (1990). *Qualitative Evaluation Methods (2nd Ed).* Newbury Park: Longman.

Print, M. (2007). *Curriculum Development and Design (3rd Ed).* Sydney: Allen and Unwin.

Redish, E. F. (1994). *Computers in Physics Instruction.* North Carolina: Addison Wesley Publishing Company.

Republic of Kenya. (1999). *Commission of Inquiry in the Education System of Kenya.* Nairobi: Government Printers.

Rief, F. (1985). *Acquiring on Effective Understanding of Scientific Concepts*. *Cognitives*. FL. Orlando: Academic Press.

Rose, D. & Meyer, A. (2002). *Teaching Every Student in the Digital Age Universal Design for Teaching.* V.A: Association of Supervision and Curriculum Development.

Sapsford, R. (2007). *Survey Research. (2nd).* London: Sage Publications.

Sarantakos, S. (2005). *Social Rsearch. New York: Macmillan.*

Serway, R. A. & Faughn, J. S. (1999). *Holt Physics.* Texas: Holt, Rinehart & Winston.

Shulman, L. S. (1986). Those who Understand Knowledge Growth in Teaching. *Educational Researcher, 15 (2), 4-14*.

Shulman, L.S. (1987). Knowledge and Teaching: Foundations of the New Reform. Havard *Educational Review*, 57 (1) 1-122.

Sjostrom, B. & Dahlgren, L.O. (2002). Applying Phenomenography in Nursing Research: *Journal of Advanced Nursing.* 4 (1) 339-345.

Steinberg, R. (2008). Real Challenges of Teaching Physics in High School Physics in Urban Environment. *American Physical Society* 8(12)18-21.

Strauss, A & Cobin, J. (1998). *Basics of Qualitative Research. Techniques and Procedures For Developing Grounded Theory*. Theus And Oak:

Tanzania Institute of Education (2010). *Curriculum for Advanced Level Secondary Education*. Dar es Salaam: Tanzania Institute of Education.

Taylor, R. (1984). A Comparison of Scalar Multiple Expansions. *Journal of Applied Physics* 56 (11) 463-477.

The Finish National Board of Education (2010). *Basic Education in Finland the Top Ranked Education System? Presentation at Building Blocks for Education. Whole System Reform – Conference 13-14 September, 2010.*

Till, W.V. (1971). *Curriculum; Quest for Relevance.* New York: Hongten Muffin Company.

UKzambia Media (2013). 200 *Schools to Get Mobile Labs.* http://www.ukzambians.com Accessed on 27th July, 2017.

UNESCO (1985). *Special Project On Scientific and Technology Education at Primary and Secondary School*. Harare: UNESCO.

UNESCO (2006). *Developing and Using Indicators of ICT Use in Education.* Bangkok: UNESCO Asia and Pacific Regional Bureau for Education.

UNESCO. (2007). *Special Project on Scientific, Technical and Vocational Education of Girls in Africa.* Africa Chapter: UNESCO.

UNESCO (2014). *Teacher Adoption of Technology: A Perceptual Control:* Bangkok: UNESCO.

UNESCO (2015). *Special Project on Scientific and Technology Education at Primary and Secondary.* Harare: UNESCO.

Wambungu, P. W. & changeiywo, J. (2007). Effects of Mastery Learning Approach on Secondary school Students physics Achievement. *Eurasia Journal of Mathematics, Science & Technology Education.* Egerton: 4 (3) 293-302.

Wasike, A., Ndurumo, M. & Kisilu, K. J. (2013*).* The Impact of Perception on Performance in Mathematics of Female Students in Secondary Schools in Teso District, Kenya. *Journal of Education and Practice* 4(20)104-110.

William, et al (2015). Why Aren't Secondary Schools Interested in Physics? *Physics Educational Journal.* 38 (4) 200-210.

ZASE (2015). *National Conference Result Analysis.* http://. www.zase-conference.com Retrieved on 8th June, 2017.

Zhaoyao, M. (2002). Physics Education for the 21st Century. Avoiding a crisis. *Physics Education* 37 (1) 18-24.

Appendix 1

INTERVIIEW GUIDE FOR PROVINCIAL STANDARDS OFFICER NATURAL SCIENCES.

1. For how long have you been in this office as provincial standards officer natural Sciences?
2. As a specialist, why do learners perceive physics to be a difficult subject in secondary school?
3. How does the learner's perception of physics affect their performance?
4. As a specialist what is your view on the sequencing of the physics content?
5. Is the content in the physics syllabus suitable for secondary school level?
6. Is there enough time in the school calendar to cover all the prescribed content?
7. Is the pedagogical content knowledge of the teacher suitable enough to help learners understand physics content?
8. According to your findings when you go out in the schools, is outcome based education being implemented in physics education?
9. What general comment can you give with regards to learner's performance in secondary school physics?

Appendix 2

INTERVIEW GUIDE FOR THE DIRECTOR NATIONAL SCIENCE CENTRE

1. For how long have you been in this office as director of national science centre?
2. Why do secondary school learners perceive physics to be a difficult subject?
3. How does poor perception of a subject affect performance of the learners?
4. Do you consider the physics curriculum to be sequenced in a logical manner?
5. Does it contain sufficient content for secondary school level?
6. Is the content of secondary school physics relevant to everyday life activities?
7. Do you consider the pedagogical content knowledge of the teacher of physics suitable enough to help learner's comprehension of physics?
8. What are your areas of concern as far as physics education is concerned?
9. Does the national science centre institute offer continuous professional development sessions for physics teachers?
10. What general comment can you make about the performance of the learners of physics during examinations?

Appendix 3

INTERVIEW QUIDE FOR PHYSICS SPECIALISTS FROM ECZ AND CDC

1. For how long have you been in this office as a physics specialist?
2. Why do s0econdary school learners perceive physics to be a difficult subject?
3. How does the perception that physics is a difficulty subject affect the learner's comprehension of the subject?
4. Are the topics in the physics syllabus sequenced in a logical manner?
5. As a specialist, do you think the topics help learners to build on previous knowledge?
6. Is the content relevant to everyday activities?
7. How are teachers of physics involved in curriculum designing?
8. Is the period set for syllabus coverage adequate to cover the designed content of Secondary school physics?
9. Do you consult curriculum implementers when setting the examination date?
10. Do you have any concerns about the teaching and learning of physics in secondary

    School in terms of

i. teacher methodology

ii. Content the teacher possess about the subject matter?

11. What general comment can you make about the performance of the learners in Physics in secondary schools?

Appendix 4

INTERVIEW GUIDE FOR THE TEACHERS OF PHYSICS

1. For how long have you been teaching at this school?
2. What is your highest level of education?
3. Why do learners perceive physics to be a difficulty subject?
4. As a teacher can you say that the perception of a subject is related to learner performance?
5. Is the physics content arranged in a manner that makes it easy for learners to understand?
6. What can you say about the level of difficult of content with regards to your learners?
7. Do you have enough time to cover the syllabus?
8. Does the school have science laboratories?
9. Do you have teaching and learning materials available for conducting experiments?
10. Which topics do you consider to be challenging for you to teach?
11. Which complaints do learners make about physics learning?
12. What activities do you include in the teaching and learning of physics to make learners active participants?
13. How would you relate the scientific concepts to everyday life?
14. What is your general comment about the teaching and learning of physics in your school?

Appendix 5
THE UNIVERSITY OF ZAMBIA

SCHOOL OF EDUCATION

DEPARTMENT OF LANGUAGE AND SOCIAL SCIENCE

QUESTIONNAIRE FOR PUPILS

Dear Pupil, I am a postgraduate student at the University of Zambia I am carrying out an

Academic study in which your assistance is very important. The study is an analysis of O-level

Physics curriculum design and teacher pedagogical content knowledge in selected Secondary schools in Lusaka district, Zambia.

Please kindly respond as truthful as possible to the items in the instrument by putting a tick

(√) under your preferred response. The information you will give will be treated with utmost

Confidence and will only be used for the sole purpose of this particular study.

Thank you for your cooperation and for taking your time within your busy schedule.

God bless you.

Yours sincerely

Jacqueline Zulu

General information.

Name of school._____

Age_____ Sex_____

Section A- learner's perception of physics

		Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	Among all science subjects I like physics the most.					
2	Physics is a very interesting subject.					
3	I do not answer questions in class because I do not understand physics.					
4	I find my physics					

	class to be boring.					
5	My teacher tells us that physics is not an easy subject.					
6	My teacher only concentrates on those who answer questions.					

7. Explain your answer in (6) above_____
_____
_____
_____
_____

8. Suggest any other common views about physics among learners_____
_____
_____
_____
_____

Section B. Perception and learner performance

		Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
9	I do not perform well in physics because I do not like the subject.					
10	No matter how much I study I never pass physics					
11	O-level physics is not meant for every learner					
12	I perform poorly in physics because my teacher says that it is difficult to understand					
13	I do not care about physics because I have no use for it					

14. Explain your answer in (13) above
_____

_____
_____
_____
15.
_____
_____
_____
_____
_____

Section C. Curriculum designing and learner performance

		Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
16	I do not perform well because physics has too many topics					
17	Physics has a lot of challenging topics					
18	There is enough time to master physics content					
19	I do not perform well in physics because it has a lot of calculations					
20	Physics is confusing because it has many methods					

21. Explain how you find dealing with information, formulas, graphs and experiments in physics

_____
_____
_____
_____
_____

Section D- effectiveness of methods used by the physics teacher

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
22	My teacher does not explain difficult terms					
23	My teacher does not connect what we learn in physics to everyday life activities					
24	Physics is too theoretical					

25	The teacher's attitude is very discouraging					
26	My teacher makes us think that physics is for intellectuals					
27	Physics is complicated even to our teacher					

28. Explain your answer in (27) above_____
_____
_____
_____
_____

29. Make any comment about teaching and learning of physics
_____
_____
_____
_____

30. Do you think of pursuing physics beyond secondary school?_____
_____
_____
_____

Appendix 6

LESSON OBSERVATION SCHEDULE FOR TEACHERS IN SELECTED SECONDARY
SCHOOLS.

OBSERVER: ----------

SCHOOL: ---------- DATE: ----------

DURATION; ----------

TOPIC: ---------- LESSON: ----------

S/N	INDICATOR	YES	NO	COMMENT
01	Lesson introduced in a traditional way			
02	Subjective learning through problem solving employed in the lesson.			
03	Methods of teaching in the lesson development- question and answer, group work. demonstration, class discussion, lecture etc.			
04	Good questioning techniques that promote creativity and analytical thinking.			
05	Availability and effective use of teaching /learning aids.			
06	Learner centred method employed fully			
07	Appropriateness of the content to the learners.			
08	Appropriateness of class activities to the lesson and the learners			
09	Teacher's knowledge of the subject matter			
10	Any indication of achievement of lesson objectives			
11	Time /class management			
12	Learner's involvement in the lesson conclusion.			

Appendix 7

INDIVIDUAL PARTICIPANT'S INFORMED CONSENT FORM

Dear respondent,

This serves to inform you about the purpose of this study and what will be followed in the process of conducting it. You will be requested to sign this form to indicate that you have willingly volunteered to participate in this exercise.

1. Description of the study: This is purely an academic education research where all respondents will not be identified in person for their participation. The researcher is a University of Zambia student pursuing a Master of Education degree in Curriculum Studies.

2. Purpose: To analyse O-Level Physics curriculum design and teacher pedagogical content knowledge in selected secondary schools in Lusaka District Zambia.

3. Consent: Participation in this study is voluntary.

4. Confidentiality: Every information that will be collected in this study shall be treated with high level of confidentiality. Names or identity of respondents in this study shall not be revealed to anyone. In the case where the conversation is recorded, information will be kept under key and lock and shall be destroyed after data has been analysed.

5. Rights of respondents: The rights of every respondent shall be respected and protected and the researcher will ensure that no respondent shall suffer any harm as a result of their participation in this study.

6. Declaration of consent by the respondent

I have clearly read and understood every detail of this document and I therefore willingly and freely agree to participate in this study.

Signature: …….

PAPERS PRESENTED

1. Presented a paper during the 1st National Conference on Pedagogy under the theme " *Transforming pedagogy and harnessing best practices through stake holder engagement"Which was held from 29th -30th* November, 2018 at Golden Peacock Hotel, Lusaka Zambia.